FORUM

Defining Goals and Criteria for Ecosystem-Based Management

D. SCOTT SLOCOMBE
Department of Geography and Environmental Studies
Wilfrid Laurier University
Waterloo, Ontario, Canada, N2L 3C5

ABSTRACT / Identifying goals or targets for landscape and ecosystem management is now a widely recognized need that has received little systematic attention. At a micro-level most planners and managers of both ecosystems and economies continue to pursue traditional goals and targets that miss many desirable characteristics of ecosystem-based management goals. Desirable characteristics of ecosystem and landscape management goals and targets include: addressing complexity, transdisciplinarity, and the dynamic nature of natural systems; reflecting the wide range of interests and goals that exist; recognizing goals and values and limits; involving people and being explainable and implementable in a consistent way to different people and groups; and evolving adaptively as conditions and knowledge change. Substantive and procedural goals can be distinguished; the latter supporting the former. Substantive goals can be grouped according to their relationship to system structure, organization, and process/dynamics, and their disciplinary or subsystemic breadth. These discussions are illustrated by a review of the goals of biodiversity, sustainability, ecological health, and integrity. An example of a hierarchical framework of procedural goals and objectives that supports achievement of substantive goals is also provided. The conclusion is that a parallel, linked system of substantive and procedural goals at different levels of complexity and disciplinarity is needed to facilitate ecosystem-based management.

Ecosystem management is best thought of as shorthand for ''the process of ecosystem-based management of human activities'' (Grumbine 1994; Kay and Schneider 1994; Slocombe 1993a). It is deliberate management of an entire regional ecosystem with the intention of maintaining ecological sustainability and/or integrity. Ecosystem-based management may often necessarily be a dispersed and collaborative activity, but the key is the focus on the whole ecosystem, defined in local, biophysical, and cultural terms, and on development of an integrative process for planning and management. Thus ecosystem-based management is not the same as ecological management: an outside agency looking at an ecosystem, examining the agencies active there and the ecological problems and needs from an ecological perspective, and prescribing solutions that may not take into account all aspects of the greater ecosystem. Greater Yellowstone in the United States, the Crown of the Continent in Alberta and Montana, and the Australian Alps may be examples of ecosystem-based management, but most other ecologically managed areas are not (Clark and Minta 1994; Gunderson and others 1995; Slocombe 1993b; 1998); neither are most protected areas, regions, cities, or organizations, although they all could be.

The two greatest barriers to ecosystem-based management processes are often seen to be institutional territoriality and complacency/weak goals (Cortner and others 1994, Gunderson and others 1995, Slocombe 1993a). Common strategies to address this include redefining management units and expectations combined with senior leadership and local implementation (Slocombe 1998). This paper looks at another key dimension: goals, objectives, and criteria. Goals and objectives, reflecting individual, organizational, and/or societal values and philosophies, are critical to any planning or management process (e.g., Wolman 1981). While the importance of goals, objectives, and specific action plans in ecosystem-based management is increasingly recognized (e.g., Ecological Society of America 1995, Grumbine 1991, Kessler and others 1992, Salwasser 1991), few have looked at the subject conceptually and systemically. As a minimum, clear goals and supporting objectives guide activities and individuals at all levels and help reduce value conflicts among participants—although of course the greater the disparity in values the harder it is to agree on goals and objectives (cf., Barber and Taylor 1990 on fisheries management). Clear goals and objectives contribute to developing a common set of indicators, which many also see as necessary to ecosystem-based management (Hartig 1995).

Ecosystem-based management activities need broad, relevant goals, related objectives that can be applied in many program areas, and examples of measurable

KEY WORDS: Ecosystem management; Goals and objectives; Assessment criteria

Table 1. Desirable characteristics of ecosystem management goals and objectives based on the theory and practice of ecosystem approaches and management[a]

1. Imply and reflect specific values and limits (normative)
2. Reflect ‘‘higher’’ values and ethical principles and rules (principled)
3. Reflect the wide range of interests, goals and objectives that exist (integrative)
4. Work with, not artificially reduce, complexity (complex)
5. Accept and recognize the inevitability of change (dynamic)
6. Synthesize a wide range of information and knowledge (transdisciplinary)
7. Be applicable to a wide range of ecosystem types and conditions (applicable)
8. Involve actors, stakeholders, public (participatory)
9. Be explainable and implementable in a consistent way to different people and groups (understandable)
10. Be inherently tentative and evolving as conditions and knowledge change (adaptive)

[a]After Grumbine (1994), Kay and Schneider (1994), and Slocombe (1993a, 1998).

targets and criteria to foster assessment of progress. Goals and objectives are needed to establish measurable targets and to drive development of criteria to assess programs. As with sustainable development, a persistent lack of serious development of specific goals, objectives, targets, and criteria could lead to ecosystem-based management becoming seen as an irrelevant generality or cliché.

Given the frequent confusion, debate, and idiosyncracies around the concepts of goals, objectives, measurable targets, and criteria, I want at least to make clear how the terms are used here. Goals should be broad and generally agreed upon, with a degree of normativeness. A goal usually has a wide, almost ethical, dimension of rightness. Objectives are the specific, doable tasks needed to achieve the goal. Ideally, goals and objectives will be compatible with some ‘‘higher’’ ethical principles and rules (Westra 1993). Targets are readily observable, usually quantifiable, events or characteristics that can be aimed for as part of a goal or objective. Targets are a subset of the broad set of indicators, which are a priori identified system characteristics that can provide feedback on progress toward goals and objectives. Criteria are specific targets, often thresholds, that indicate when explicit, normative goals and objectives have been met. In this paper criteria are also discussed in terms of ways to assess or think about goals and objectives.

At a micro-level most ecological and economic managers continue to pursue traditional goals and targets such as specific employment, GNP, inflation, or quantitative emissions reductions levels. This is a problem because ecosystem-based management would be facilitated by more systemic, more positive goals; we need to aim for more than removing obstacles such as low employment and high pollution (Hartig 1995; Slocombe 1998). In ecosystem-based management there will be broad goals to be identified by those within the ecosystem such as jobs, environmental protection, or self-reliance. In addition more specific targets for the ecosystem and its management, e.g., levels of wildlife populations, extent of burning, harvest levels, etc., must be identified. This paper focuses on goals and objectives and provides some examples of general ones. Targets and criteria, and even goals and objectives, must be identified for a particular ecosystem through a local, ecosystem-based process as discussed below, but this general examination may contribute to the development of those processes.

What goals do we have now and how good are they? As a basis for addressing this question, desirable characteristics of ecosystem-based management goals and objectives are discussed, and the character and utility of the existing goals of biodiversity, sustainability, and ecosystem health and integrity are examined. This leads to a discussion of two fundamental types of goals, substantive and procedural, and ways to improve and operationalize these and other concepts as goals for ecosystem-based management.

Desirable Characteristics of Ecosystem Management Goals

Table 1 presents a composite list of desirable characteristics for ecosystem-based management goals and objectives. It derives from both the theory of ecosystem approaches and nonequilibrium systems (Slocombe 1993b, Kay and Schneider 1994) and the practice and experience of ecosystem-based management (Slocombe 1993b, 1996, Grumbine 1994). The rationale for and implications of each characteristic are discussed briefly below.

The first three characteristics are linked. If they are to make a difference, goals and objectives need to be normative. They need to provide some direction for thinking and action, perhaps even for prescription. If goals and objectives are to be normative, then they ought to be principled; that is, they should reflect basic, fundamental, higher values and ethics (cf. Westra 1993). This can help to reduce the chances of contradictory or equivocal goals, which may result from consensus processes and which are of limited utility in identifying targets and actions. Values such as intra- and intergenerational equity, ecocentrism, self-determination, and self-reliance are common but need discussing/resolving. Of course, even those values are not always unanimously agreed upon; but developing them in a particular place through an appropriate participative process is a start. Values and ethics cannot be escaped. Top-level goals must reflect relevant ethical principles, both to provide legitimacy and to underscore the basic values that are being pursued. Without this link, economics and expediency can too easily override particular objectives.

This diversity of belief and situations is the rationale for the third characteristic of goals: to strive to be integrative. Goals need to be as specific as possible while encompassing a range of individual goals and objectives. In part this may mean deriving them from compromise and negotiation, finding common ground, and reflecting it in innovative goals, such as is reflected in ''The Natural Step'' approach (Hawken 1995).

Ecosystem-based management is not a simple, linear activity. It is based on large areas that are diverse ecologically, economically, and socially, and complexly connected and interacting. It entails scientific, descriptive components as well as normative components. From the perspective of complexity a good goal retains the essential elements of the roots of the complexity of the real system. It seeks to reduce and work with, rather than eliminate or ignore complexity. Thus goals must themselves be complex, but in the sense of a good model: understandable and capable of producing surprise that can then be dissected to produce understanding. Ecosystem-based management must also work and have meaning at several spatial scales (Slocombe 1992, Kay and Schneider 1994). Some of the characteristics of goals identified in Table 1 will be more applicable at certain scales than others. For example, items 3, 6, and 7 may be more applicable at large scales than small, although in practice most characteristics ought to be considered at most scales even if the emphasis may vary. The complexity of ecosystems also gives rise to dynamism, which also ought to be reflected in the goals and objectives of ecosystem-based management, most obviously by avoiding goals that seek to freeze the ecosystem. For example, goals and objectives need to link land-use changes that affect landscape pattern, in turn affecting species and populations, and dynamic feedbacks, altering land uses and landscape patterns (Franklin 1993, Lee and others 1992). A good set of goals and objectives must also reflect spatial and temporal scales, the relative significance and magnitude of different issues, and the nonequilibrium character of regional ecosystems (Dovers 1995, Heaton and Hollick 1994, Slocombe 1990, 1992, Kay and Schneider 1994). Finally, ecosystem-based management objectives should consider systemic characteristics such as stability and resilience.

The complexity and diversity of ecosystems give rise to the need for transdisciplinarity, the effort to integrate different kinds of knowledge about different parts of the ecosystem. This is fundamentally a reflection of the need to combine reductionist and holistic analysis and synthesis (Miller 1993, Grzybowski and Slocombe 1988). Transdisciplinarity will likely be one key to integrating ecological, economic, and social concerns into both understanding and action. A transdisciplinary goal is one whose proper definition and use requires integration of information and understanding from multiple disciplines (cf. Harris and others 1987, Norgaard 1992).

Goals and objectives should guide and contribute to each of the components of ecosystem-based management identified by Slocombe (1993b): defining management units, developing understanding, and creating planning and management frameworks. Good goals consider practical matters and lead to criteria for choosing action (for examples, see Ecosystem Objectives Subgroup 1993, Hartig 1995).

As far as possible, goals and objectives should be as widely applicable as possible for simplicity's sake, for consistency, and as some rough measure of their robustness. They also, however, must be tailored to the particular ecosystem. On practical grounds goals and objectives ought to be developed participatively to foster support and implementation of action. This in turn implies that such goals be understandable and meaningful to residents of the ecosystem (cf. Gardner and Roseland 1989), and the many case-studies in Jacobson (1995).

Inevitably, there are limits to the comprehensiveness and applicability of any goals. There are limits to predictability and certainty, and as ecosystems change so too must goals and objectives. The literature on uncertainty emphasizes adaptibility, flexibility, and anticipation. Ludwig and others (1993) urge managers to distrust claims of sustainability and confront uncertainty. They provide a good list of common sense strategies for adaptive management. This need must run through all of ecosystem-based management, but it points us particularly strongly in the direction of having adaptable, flexible goals developed and revised through a similar, ongoing process.

In summary, ecosystem-based management needs a linked set of criteria and goals that vary by place, scale,

Table 2. Hierarchical contexts and character of substantive goals and objectives for ecosystem-based management

	Structure	Organization	Process
Biophysical environment	Areas, amounts, patterns, including biodiversity	Ecological linkages, flows	Sustainability
Community and society	Demographic, economic, social amounts, patterns	Human, societal, economic linkages	Quality of life, sustainability
Whole ecosystem	Health	Integrity	Evolutionary complexity

and time and that are pursued in an on-going, adaptive process.

Ecosystem Management Goals

There are at least two fundamentally different types of ecosystem-based management goals. Substantive goals refer to desired states or characteristics of the ecosystem being managed, in part following Gardner (1989). Procedural goals address how to achieve or implement substantive goals. In the following sections each of these is briefly treated, with some examples, but full discussion of what are appropriate, specific goals of each type is beyond the scope of this paper.

Substantive Goals

Table 2 highlights the need for a range, and a range of types, of goals by identifying nine groups of substantive goals based on ecosystem dimensions (biophysical, community/society, integrated) and system components (structure, function, process). These form a hierarchy in which levels further from the top left of the table include those closer.

Structural goals mainly relate to areas, amounts, diversity, and patterns and to description of the structure of the ecosystem. In the biophysical environment this could include desired air-quality levels, water-quality and -flow levels, ecological succession, areas and patterns of habitats, numbers of species, and other measures derived from conservation biology, ecosystem science, landscape ecology, and other relevant sciences. In the context of community and society we may be interested in population demographics, resource consumption rates, economic and employment characteristics, and cultural and linguistic characteristics. At the integrated, whole ecosystem level characteristics such as overall biodiversity and landscape mosaic would be relevant. In general terms structural characteristics relate to system health, providing indicators of state and symptoms.

Organizational goals relate to the maintenance of connectedness and complex organization of the system. Broadly speaking, we are concerned here with integrity of the system: ecological, economic, and human. Biophysical examples include aquifer recharge, ecological productivity, natural hazard modification, and matrix and connectivity measures in landscapes. Community/society examples include human and economic development, and sense of place. The best integrative whole system example is overall integrity, or wholeness and consistency of the system.

Substantive process goals relate to maintaining the capacity for change and evolution of the system. In both biophysical systems and socioeconomic systems there are concepts of sustainability and viability/quality of life that address this, at least as long as they are conceived such that activity in one subsystem does not impact negatively on other subsystems or the system as a whole. At the integrative, whole system level the existence and possibility of evolutionary complexity and change is key.

Several complex, presumptively integrative, transdisciplinary concepts have begun to be widely used as goals. An increasingly wide range of conservation and environmental planning and management activities is being guided by, or seeking, one or more of the goals of biodiversity, sustainability, or ecological health and integrity. This must be seen as a positive step, insofar as it is a move away from single, narrow goals such as economic growth or area of protected areas or employment growth. Here the substantive goals of biodiversity, ecosystem integrity and health, and sustainability are briefly discussed to illustrate some of the implications of a scheme such as Table 2.

While useful, and deserving more attention in some ecosystems and resource management sectors (see Hughes and Noss 1992, Probst and Crow 1991), biodiversity is a relatively narrow concept. It is structural, quantitative, and integrative only within a context of ecological structure across temporal and spatial scales (cf., Franklin 1993). Biodiversity can contribute to defining whole ecosystem boundaries and surfaces, but ecosystem-based management is hierarchical rather than simply aggregative and recognizes the need to manage properties that cannot be reduced to aggregates of parts. As a management goal biodiversity needs to be seen in hierarchical terms as a component of landscape-level goals related to health, processes, and integrity (Norton and Ulanowicz 1992). For example, biodiversity may be linked to ecosystem services (per capita: Cairns 1993, or in detail: de Groot 1992).

Ecosystem integrity and health are broader and more systemically integrative than biodiversity but hard to define. For example, Rapport (1989) talks about health as absence of distress syndrome and resilience. Karr (1991) has provided a quantitatively defined measure of integrity in terms of ecological community function and structure. There have been detailed critiques of ecosystem health as an index based on the different and incommensurable variables used, as well as the risk of confusing health assessment with disease diagnosis and cure (Suter 1993). Still, linked to functional ecosystem characteristics and based in knowledge of ecosystem structure such as biodiversity, health is a useful, but not comprehensive or sufficient, goal for ecosystem-based management. Integrity, in contrast to health, stresses maintenance of system organization and evolutionary potential. Thus Kay (1991) and Kay and Schneider (1994) outline three ecosystem organizational facets of integrity: maintaining normal functions under varied conditions, resilience to stress, and continued self-organization. Such definitions would seem to make integrity particularly useful in efforts to guide management of large, complex regions for protection of large-scale, systemic characteristics (cf. Woodley and Freedman 1995). The key is operationalizing the concept through an adequate process and identification of common ground.

Sustainability is a very comprehensive, and in theory, integrative goal; but it is interpreted extremely differently and often superficially by different people and organizations. Part of the problem with the original idea of ''sustainable development'' is the lack of specific goals and related indicators for assessing progress. Much effort has gone into defining goals, objectives, and indicators for sustainability in different parts of the world (e.g., Carpenter 1990, Liverman and others 1988; Redclift 1992, Slocombe and Van Bers 1992) and that will not be reviewed here. Sustainability goals would seem to be most useful when they do integrate biophysical and socioeconomic characteristics at a functional level, much as biodiversity is most useful when it integrates information from several ecological levels (e.g., Hughes and Noss 1992).

Sustainability and health are emergent, systems properties that are not simply countable or enumerable. They are broad terms whose precise meaning and implications depend on the context. Biodiversity is narrowest in a disciplinary, systemic sense, sustainability widest. Biodiversity primarily refers to ecological structure (but see Noss 1990), health to ecological function, integrity to systemic processes and change, and sustainability to a complex mix of biophysical and socioeconomic structure and function.

Like ecosystem-based management itself, all four of these integrative, synthetic goals require separate, difficult elaboration of criteria and objectives and cannot be solely defined through the traditional, objective, scientific process: they require public input and consultation, special processes including participation and target-setting, and environmental reporting and monitoring. All are difficult to operationalize in a rigorous, quantitative, practical way. Biodiversity, health, integrity, and sustainability are endstates that should not be pursued in isolation because no single one encompasses enough to be independent and complete. Taken together in an interdependent and somewhat overlapping fashion, they could provide an excellent starting point for research and planning, focusing attention on a range of past and present system characteristics.

This analysis underscores the need for multiple goals, of different kinds, in ecosystem-based management. Grumbine's (1994) five goals for ecosystem-based management (maintaining viable populations, ecosystem representation, ecological processes, evolutionary processes, and accommodating human use in light of the first four) provide an example.

Before using any substantive goals in a planning and management exercise one should have identified broad definitions, general criteria, and context-specific requirements or implications for planning and management. None of these goals, except perhaps biodiversity protection, can be achieved by incremental change. All require fundamental qualitative changes in planning, management, and understanding. Still more important, without a series of procedural goals and processes to implement them, substantive goals may be little more than a way of seeking predictability. However obvious, it is worth stressing the need to avoid the use of these concepts, intentionally or unintentionally, in simple-minded, superficial, or plain wrong ways. All of these difficulties and caveats underscore the need for procedural as well as substantive goals, to facilitate ''doing it right''—however that is defined by different groups in different places, taking into account the best scientific data and knowledge about the ecosystem.

Procedural Goals

In effect, substantive goals, such as biodiversity, integrity, and sustainability, must be integrated with and evolve from, the implementation of procedural goals and related activities. Good science and ethics could produce state-of-the-art substantive goals, targets, and

Table 3. Hierarchy of procedural goals, objectives, and tasks for ecosystem-based management

1. Develop consensus
   a. Define the ecosystem
      core characteristics, uniqueness, commonalities
      identify boundaries, hard or soft, and their basis
      highlight critical issues and conflicts
   b. Identify core, common values and visions
      identify relevant philosophies, ethics and associated values
      develop alternative scenarios, desired futuress
   c. Define core criteria for assessing goals, objectives, actions, etc.
   d. Define substantive goals and objectives: ecological, social, cultural, economic, including identifying limits to human action
   e. Establish ongoing, independent, public consultation and oversight mechanisms
2. Develop understanding of the ecosystem
   a. Obtain and synthesize all available information
      evaluate quality of information and emphasize use of the best
      organize, map, and display information on the basis of the ecosystem
   b. Interpret information based on systems, transdisciplinary methods and insights, as well as the best theory from relevant disciplines
      understand the larger context and implications of actions
      understand the spatial variability and pattern of the ecosystem
   c. Foster use of science and generation of policy relevant information
      develop a complementary research and monitoring agenda
      identify indicators such as critical species assemblages, contaminants
   d. Establish targets and baselines for planning and management
      species, populations
      communities, habitat, landscape mosaic
      disturbance and processes
      assimilative capacity
   e. Upgrade and provide tools and expertise for working with ecosystem information and for understanding ecosystem function
3. Implement a framework for planning and management
   a. Find leadership
   b. Build on existing administrative units and institutions
   c. Ensure consistency of institutional, agency mandates, goals & objectives
   d. Ensure adaptable, flexible, iterative processes
   e. Gain legitimacy by involving people, groups, making a difference, etc.
   f Provide incentives for cooperation and coordination
      develop back-stop legislation
      economic incentives such as tax breaks for protection, tied support programmes, etc.
   g. Undertake periodic review
4. Make a Difference
   a. Develop partnerships
   b. Use demonstration projects
   c. Offer technical training and assistance
   d. Focus on end results
   e. Educate at all levels: schools, public, planners and managers, decision makers

indicators, but without the simultaneous or earlier attention to a range of procedural goals the substantive ones will be irrelevant. Good substantive goals are scarce, but they are less scarce than good implementation. Many studies of ecosystem-based management efforts stress the importance of process in terms of participation, legitimacy, agreed upon decision-making processes, and the like (e.g., Frissell and Bayles 1996, Lee 1991, MacKenzie 1996, Slocombe 1993b, Gunderson and others 1995). There is a huge literature, of course, on these issues in environmental management, strategic planning, and urban and regional planning, to name a few. This section is meant to draw attention to process in ecosystem-based management.

Procedural goals are also in many ways more easily derived from experience than substantive ones, because their results are usually more quickly apparent, easier to observe, and better defined in a common sense way. Table 3 provides an outline of a hierarchical set of procedural goals and objectives that would facilitate the development and implementation of substantive goals for ecosystem-based management. These derive in part

Table 4. Comparison of the degree of consistency of the substantive goals from Tables 2 and 3 with the desired characteristics of Table 1[a]

	Goals									
	1	2	3	4	5	6	7	8	9	10
Flows, amounts, areas		−	−	−	+		+		+	
Biodiversity	+	+					+		+	
Health	+		+	+	+	+			+	+
Sustainability	+	+	+	+	+	+	+	+		+
Integrity			+	+	+	+	+	−	−	
Quality of life	−		+	+		+	+			+
Developing consensus	−	+	+	+	+		+	+		+
Developing understanding			+	+	+	+				+
Planning and management	+	+	+	−	+			+		+
Doing things	−		−	+	+		+	+	+	+

[a]A plus sign indicates strong consistency; a blank space, moderate consistency, and a minus sign, not consistent. 1, normative; 2, principled; 3, integrative; 4, complex; 5, dynamic; 6, transdisciplinary; 7, applicable; 8, participatory; 9, understandable; 10, adaptive.

from the lessons of experience and the literature. Common areas of concern include defining the ecosystem in space and time, defining management problems, defining ecosystem-based management, defining the status of ecosystem knowledge and theory, (see, especially, Clark and Minta 1994, and also Ecosystem Objectives Subgroup 1993, Hartig 1995, Hughes and Noss 1992, Kessler and others 1992, Probst and Crow 1991, Slocombe 1998).

This hierarchy, at least in its lower levels, must be tailored to the particular ecosystem or region. It must reflect biophysical and socioeconomic conditions and traditions of the particular ecosystem, as well as locally relevant or traditional ethical and ecological principles. Similarly, goals must reflect spatial and temporal variability and the history of the particular system being examined. All available reliable information should be used. For example, Keith (1994), writing on northern Canada, emphasized the implications for management of understanding whole systems, supporting self-organization processes, using no single expertise, using all available expertise including traditional ecological knowledge, and adopting a precautionary approach combined with environmental monitoring.

Procedural goals must, above all, facilitate consensus, coordination, integration, and monitoring. Ultimately ecosystem-based management must generate specific action plans, and attention to procedural as well as substantive goals is a fundamental prerequisite. Hartig (1995) has done this for an ecosystem approach in the Great Lakes Basin, discussing specific actions and goals under headings related to major issues/goals for the basin such as watershed-based land-use planning, point and nonpoint source pollution, transportation planning, and economic development for sustainability.

Assessing and Improving Ecosystem Management Goals

It should be no surprise that some goals are stronger on certain of the criteria identified earlier than others: biodiversity is applicable and understandable and even principled, but not really complex and transdisciplinary. Sustainability and integrity are stronger on the complexity and transdisciplinary character, but perhaps less understandable and applicable. Table 4 compares these and other goals in terms of the desired characteristics of goals identified in Table 1.

Developing more integrative, systemic substantive goals—goals that each meet more of the criteria in Table 1—may or may not be feasible, and it may or may not be desirable. Earlier sections have highlighted the potentials of combining several high-level goals. More research and experience are needed to address these questions; this paper is intended to assist with the exploration. Some possible approaches to developing substantive goals include integrating them with systems knowledge and understanding [e.g., the work of Costanza and others (1993) on connections between biodiversity and environmental predictability and scale], putting goals in the context of significance and magnitude (Dovers 1995), and modifying activities by scale as well as by recognizing the differences of systems at different scales (cf. Heaton and Hollick 1994; Kay and Schneider 1994, Noss 1990).

Others have emphasized the need to protect integrity, especially of organizational processes, as a paramount goal, regarding biodiversity as a criterion of success more than a goal, and the importance of linking landscape and ecosystem approaches with indicators at different hierarchical levels (Angermeier and Karr

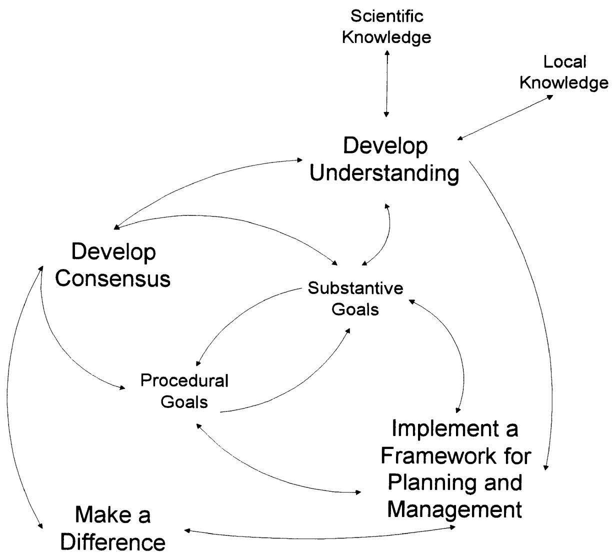

Figure 1. Schematic outline of ecosystem-based management process.

1994). Somewhat alternatively, biodiversity might be linked to ecological function (e.g., Mosquin 1995) or to processes, disturbance, and activity at different hierarchical and spatial levels (e.g., Hansen and others 1991) to increase its significance as a goal.

For some people, goals may be a way of seeking certainty or predictability. Really, however, we need goals that help us anticipate and adapt to unpredictability and to maintain it in the systems that we are to manage. Here again procedural goals can help, particularly if utilized in an iterative, interactive, or adaptive way (Figure 1). Maintaining a management process and related goals—a planning and management framework—is one way of helping to ensure an iterative, adaptive approach to identifying substantive goals. This is a prerequisite for addressing and seeking substantive goals, but it raises special issues of maintaining and introducing specialized knowledge and understanding in a public, consultative, interagency planning and management process (cf. Schoenfeld 1981).

On a grand scale goals need to be linked to values and ethics (Westra 1993), and on a micro-scale to what people in a particular place at a particular time value. Balancing these two dimensions, and integrating them with the best scientific understanding is the true challenge. The Great Lakes ecosystem approach long ago developed statements about beneficial and impaired uses as normative goals, and similar statements could be appropriate for many ecosystems (cf. Ecosystem Objectives Subgroup 1993, Francis and others 1985). Consensually derived goals are a way to reduce the effects of vested self-interest in ecosystem-based management.

Can definitions and criteria for successful ecosystem-based management be derived? Tables 2 and 3 provided an extensive, illustrative list. More broadly, many writers come back to variations on maintenance of natural change, landscape ecosystem level diversity, maintenance of traditional land- and wildlife-based activities, and maintenance of ecosystem resilience. At root, it must be recognized that no single goal is appropriate, that in fact perhaps an ongoing understanding of system state and dynamics may be necessary. At minimum, goals and objectives that address the biophysical environment and socioeconomic community in terms of structure, function, and process at an integrated ecosystem level are needed. This may come down to a combination of biodiversity, integrity, and sustainability—a suite of three values reflecting the structural, organizational, and human ecological dimensions of a region, landscape, or ecosystem.

Certainly there are examples of programs using the substantive goals discussed here: biodiversity and ecological integrity in wildlife and protected areas planning (e.g., Kim and Weaver 1994, Woodley 1993); health and integrity are widely used in Great Lakes planning and management (e.g., Bertram and Reynoldson 1992, Ecosystem Objectives Subgroup 1993); and sustainability is widely if often loosely used as a goal (e.g., Hodge and others 1995). Good examples of explicitly procedural-goal-led processes are scarcer, at least beyond the basic similarities of some comprehensive regional planning or integrated resource management exercises (e.g., Anderson and Baum 1987).

There are few, if any, ecosystem-based planning and management exercises that have explicitly and comprehensively sought to use an integrated set of procedural and substantive goals such as discussed here. The experience with remedial action plans (RAPs) for areas of concern around the North American Great Lakes Basin (MacKenzie 1996) and with national conservation and sustainable development strategies in various countries around the world (Carew-Reid and others 1994) is at least instructive. Integration of substantive and procedural goals is really a function of the overall process, as Figure 1 tries to make explicit.

Conclusion

Identifying substantive goals for ecosystem-based management, such as biodiversity, ecosystem integrity, and sustainability, is an important activity. Such interdisciplinary goals are undeniably complex, broad, and subject to varied interpretations. Complex goals are definable and useful when they are developed as part of a hierarchy of goals, objectives, and assessment criteria that addresses both multiple dimensions of the ecosystem and system structure, process, and evolution. Overall, substantive goals need to reflect the continuum from goal to objective to target to criterion; from conceptual simplicity, generality, and comprehensiveness to conceptual sophistication, specialization, and narrowness. This is the first prerequisite for ensuring that complex, synthetic goals provide guidance to on-the-ground planners and managers.

Implementing ecosystem-based management requires a hierarchical set of goals and objectives that can be extended to identified activities and actions and supported by targets, indicators, and monitoring. Such a suite of goals can be integrated to produce a range of objectives and tailored to provide targets for particular ecosystems. Monitoring then becomes critical for tracking whether targets are being met. Biodiversity, integrity, and sustainability can provide a good mix of goals, but they should be used in combination with more detailed lists of goals and objectives developed participatorily for a particular ecosystem or region. The process of development of Great Lakes water-quality indicators provides a useful example of the integration of scientific knowledge and social and economic relationships to an ecosystem (e.g., Indicators for Evaluation Task Force 1996).

The second prerequisite for substantive goal relevance and usefulness is procedural goals and related processes that foster the appropriateness of higher-level goals and objectives and their incorporation into a process that will be used and accepted by ecosystem planners and managers.

This is where procedural goals become critical. Procedural goals and objectives should encourage anticipatory, consensual planning and management. Contrary to what some have suggested, restoration is not really the test for ecology and environmental management: the test is avoiding the need for restoration. Procedural goals must aim to foster reform before crisis. There are many specific, practical things that can be done to foster ecosystem-based management, and procedural goals and objectives embody these and provide the framework needed for substantive goals to make a difference.

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