FORUM

Formulating an Ecosystem Approach to Environmental Protection

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ABSTRACT / The U.S. Environmental Protection Agency (EPA) has embraced a new strategy of environmental protection that is place-driven rather than program-driven. This new approach focuses on the protection of entire ecosystems. To develop an effective strategy of ecosystem protection, however, EPA will need to: (1) determine how to define and delineate ecosystems and (2) categorize threats to individual ecosystems and priority rank ecosystems at risk. Current definitions of ecosystem in use at EPA are inadequate for meaningful use in a management or regulatory context. A landscape-based definition that describes an ecosystem as a volumetric unit delineated by climatic and landscape features is suggested. Following this definition, ecosystems are organized hierarchically, from megaecosystems, which exist on a continental scale (e.g., Great Lakes), to small local ecosystems.

Threats to ecosystems can generally be categorized as: (1) ecosystem degradation (occurs mainly through pollution) (2) ecosystem alteration (physical changes such as water diversion), and (3) ecosystem removal (e.g., conversion of wetlands or forest to urban or agricultural lands). Level of threat (i.e., how imminent), and distance from desired future condition are also important in evaluating threats to ecosystems. Category of threat, level of threat, and "distance" from desired future condition can be combined into a three-dimensional ranking system for ecosystems at risk. The purpose of the proposed ranking system is to suggest a preliminary framework for agencies such as EPA to prioritize responses to ecosystems at risk.

Over the past several years there has been a growing awareness in the US Environmental Protection Agency (EPA) that compliance with media-based (e.g., air, water, solid waste) regulations can not ensure protection of entire ecosystems (EPA 1987, 1990a, 1994). Over the past two years the EPA has embraced a shift away from a media-based program-driven focus for the agency to one that is place-driven and ecosystem-based (EPA 1994). State agencies with responsibilities similar to EPA's may also wish to develop an ecosystem-based approach for environmental protection. To develop an effective strategy of ecosystem protection, however, the EPA and other agencies will need to: (1) determine how to define and delineate ecosystems, and (2) rank threats to individual ecosystems at risk as a means of prioritizing agency response. In this paper I suggest how to meet these two needs. The definition of ecosystem and the framework for ranking ecosystems at risk introduced herein can be used to help implement a policy of focusing on ecosystems, rather than distinct media, in programming environmental protection.

KEY WORDS: Ecosystem approach; Ecological risk assessment; Environmental protection; EPA

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How to Define and Delineate Ecosystems

"Ecosystem" is a familiar term to many people, yet its meaning varies depending on the user. This is true even for those working in the environmental arena. A small marsh near a city, a large forest stand, a group of sand dunes on Lake Michigan, or the entire Great Lakes can all be considered ecosystems, although they differ by a few to several orders of magnitude in size. A place-based or ecosystem approach to environmental protection will require a definition of ecosystem that is both scientifically defensible and administratively practical. However, most standard ecology texts (e.g., Odum 1971, Ricklefs 1983, Begon and others 1990) present ecosystem as a vague concept, rather than as a definable, measurable construct on the ground. A current definition of ecosystem in use at EPA is: "a dynamic complex of plant, animal, and micro-organism communities and their non-living environment interacting in a functional unit" (EPA 1994). This definition is typical of those found in standard ecology text books. However, such definitions are inadequate, imprecise, and not workable in a management or regulatory context. To derive a better definition, we must first consider an ecosystem as a place.

Concept of an Ecosystem as a Place: A Landscape-Centered View

Whether one considers an ecosystem a place depends on one's general concept of ecosystem. Is the ecosystem conceived as a function of the organism or a function of the environment? For example, to a wildlife biologist, a grizzly bear's ecosystem is defined by all the land, water, plant, and animal resources used by the bear. If the spatial distribution of those resources were to change (e.g., high densities of prey animals shifting to new locations), then so would the boundaries of the ecosystem. In this organism-centered view of the ecosystem, boundaries are drawn around the areas used by the organism(s) (usually animal) of interest. This is congruent with the population-community view of ecosystems described by O'Neill and others (1986), the naturalist view described by Suter and Bartell (1993), and the bioecologist view described by Rowe and Barnes (1994). If the needs and habits of the animal were to change, so would the boundaries of the ecosystem. Thus, the ecosystem is conceived as a function of the animal.

Alternatively, the ecosystem can be conceived as a function of the environment. In this landscape-centered view, ecosystems are fixed places on the landscape encompassing physical, chemical, and biological resources and processes, along with various organisms. This concept of the ecosystem as a fixed place is probably most familiar to geologists, hydrologists, and landscape ecologists and is well described by Rowe and Barnes (1994) as the geoecologist view. It is similar to a material cycling perspective (Suter and Bartell 1993), or a process-functional view of ecosystems (O'Neill and others 1986). Foresters are also familiar with the concept of the forest site, which identifies the ecosystem as a physical location (Spurr and Barnes 1980). The landscape-centered view of ecosystems is also consistent with a place-driven approach to environmental protection because the ecosystem has a definite location.

Workable Definition of Ecosystem

A broad, place-driven strategy of environmental protection that can be implemented and agreed upon by all relevant parties must begin with a sound definition of ecosystem. Rowe (1961) introduced the notion of an ecosystem as a "volume of land and air" on the earth's surface. Rowe and Sheard (1981) described the landscape as a hierarchy of ecosystems, large and small, nested within one another. Acknowledging the contributions of these authors, I propose the following definition of ecosystem:

> A volume of land, air, and water with natural boundaries, delineated primarily by landscape features and climatic factors. It encompasses a set of natural ecological processes, organisms, and anthropogenic processes that function within a nested hierarchy of volumes.

The advantages of this definition over most others commonly used is that it is: (1) functional within a spatial and temporal hierarchy of ecosystems and (2) landscape-based, thus boundaries can be delimited in the field and on maps with a fair degree of permanence. As such, ecosystems are conceived as places, large and small, nested, and functional within one another in a hierarchy of spatial sizes.

Hierarchy of Ecosystems

Ecosystem is a term applied across a wide variety of spatial scales. For example some ecosystems may be 10,000 sq km or larger (e.g., Greater Yellowstone ecosystem), while others (e.g., a small patch of forest) may be only 1 sq km or smaller. Functionally, as well as spatially, ecosystems exist in a nested hierarchy (Figure 1). Watersheds can be used as a convenient illustration of this concept. For example, the Great Lakes, which extend into seven US states and one Canadian province, constitute a megaecosystem comprised of many smaller ecosystems. At a lower level in scale, the Lake Erie watershed could be considered a large regional ecosystem, within which is nested the Detroit River watershed, a small regional ecosystem. Smallest is the tiny Rouge River, which flows through neighborhoods near the city of Detroit and connects to the larger Detroit River. Each of these ecosystems is a place, with smaller ones nested within larger ones, forming a spatial hierarchy. A functional hierarchy also exists because activities at a higher level in the hierarchy affect ecosystems at the lower levels. Conversely, improvement of environmental quality at an upper level of the hierarchy is often a function of success in the ecosystems comprising the lower levels.

In a nested hierarchy of ecosystems, higher levels contain and are composed of all the ecosystems at lower levels (O'Neill and others 1986). Boundaries of ecosystems may be both structural and functional (Allen and Starr 1982). If the differences found between one side of a boundary and the other are significant, than the boundary is true, or natural. If the differences are not significant, than the boundary is artificial (Allen and Starr 1982) and may not define separate ecosystems.

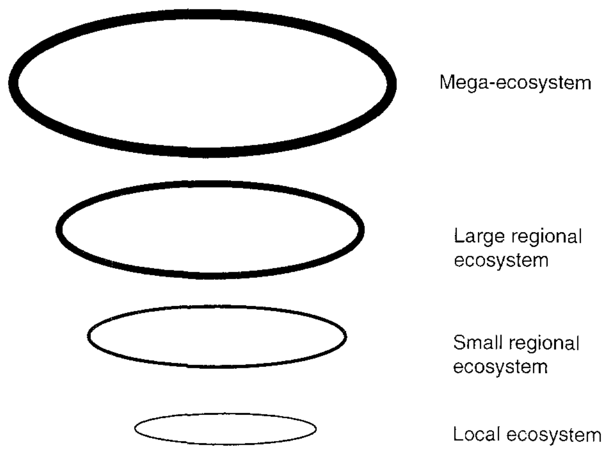

Figure 1. Nested hierarchy of ecosystems.

For example, a small wildlife refuge may be designated inside a larger wetland area. Yet, ecologically there may be no difference between the refuge and the rest of the wetland not designated as a refuge; thus the refuge border would be an artificial boundary. Natural boundaries should be used for most delineations of ecosystems. Nevertheless, sometimes artificial boundaries (e.g., political borders such as county lines) must be used to bound ecosystems into administratively practical units.

According to hierarchy theory, hierarchical systems should be "nearly decomposable" (Simon 1962), meaning they can be divided into subsystems such that interactions within a subsystem are both more numerous and stronger than interactions between subsystems (Platt 1969, Allen and Starr 1982). For example, a megaecosystem such as the Great Lakes can be readily decomposed to its five constituent lake watersheds (large regional ecosystems), each of which can be decomposed to smaller subwatersheds (small regional ecosystems). The relative strength and number of interactions can be used conceptually to help determine where one ecosystem ends and another begins. Ecological interactions are both constrained and fostered by boundaries such as:

(1) landform (e.g., hills, mountains, valleys, eskers, kettles, kames, river floodplains),
(2) air patterns (speed, direction, and temporal quality of winds),
(3) patterns of precipitation and temperature,
(4) Land use/land cover (e.g., agriculture, urban, forest, grassland, wetland), and
(5) chemical and physical traits (e.g., concentrations of certain chemicals in air, water or soil; temperature of stream water).

All of these factors could be used in delineating ecosystems.

Delineating Boundaries for Ecosystems

There are a number of ways one might reasonably delineate boundaries for ecosystems. The appropriateness of one way over another depends on the ecological questions one wants to ask. For example, both the ecoregions of the United States delineated by Bailey (1983) and Omernik (1987) represent divisions of the US landscape into regions, each relatively homogeneous internally in landform, soil, and other characteristics. Such delineations can be useful in describing the potential natural vegetation of an area. Another important use is in predicting the response of a site to management practices or other human impacts based on the response of other sites in the same ecoregion (Bailey 1983, Omernik 1987).

However, while ecosystems can be delineated based on homogeneity, some of EPA's interests might be better served using another basis of delineation. This is because in employing a place-driven approach to environmental protection, a regulatory agency such as EPA needs to determine how human activities affect air and water and the places to which the air and water are naturally transported. To understand how a particular place is influenced by activities, one must recognize the functional linkage between the condition of one location and activities in others. Air and water often provide the conduit for these functional linkages. Thus, for EPA and similar agencies, ecosystem delineations will be most useful if they are based on functionality. Under an emphasis on functionality, patterns of waterflow and airflow functionally linked to an area on the landscape would be used to help delineate a volume of land, air, and water as an ecosystem.

For example, at ground level, a large regional ecosystem, such as a watershed, is bounded by landform. However, high above ground, air patterns may transport particulates to and from areas beyond the boundary of the watershed. Similarly, below ground, an aquifer may extend beyond the ground-level boundary of an ecosystem. If activities in areas beyond the ecosystem's land-surface borders affect the aquifer, then they also affect the ecosystem. Functionally, these other areas are part of an ecosystem where the land boundaries may be smaller. Thus, land, air, and subsurface boundaries of an ecosystem need not be congruent (Figure 2).

Ideally, the higher-level boundaries selected for ecosystems should be fairly permanent and be relevant to EPA's traditional authorities over air and water quality. The suggested scheme for delineating ecosystems is:

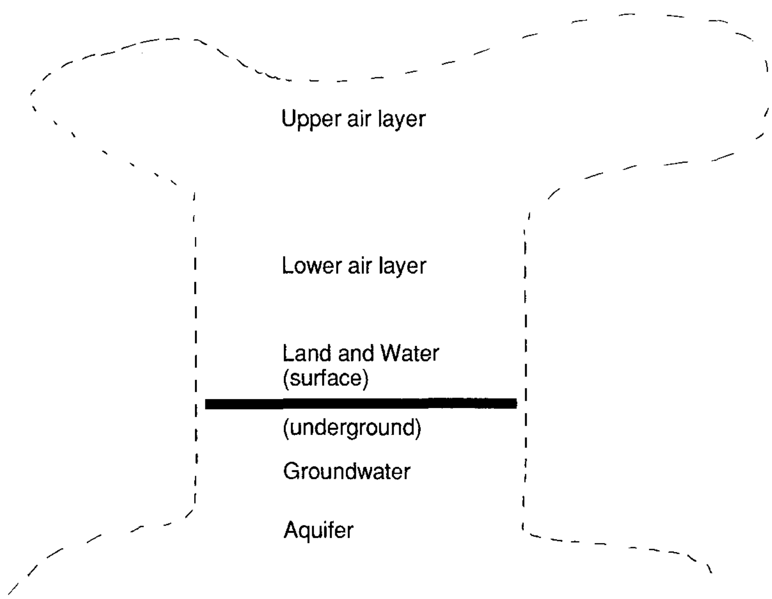

Figure 2. Conceptual boundaries of an ecosystem.

Climate (considered at macro and local scales)
  Hydrology (watersheds, subwatersheds)
    Land Use/Land cover (agriculture, industry, forest, wetland, etc.)
      Political boundaries (town lines, county lines, etc.)

Climate (as it relates to wind patterns and patterns of wet and dry deposition) and hydrology (as it relates to drainage basins, watersheds, and surface and groundwater flow) are the two most important factors to use in delineating ecosystem boundaries. General climate trends and wind patterns are essentially permanent, as are the landscape features that delimit watersheds. Another factor to be used to further delineate ecosystem boundaries is dominant land use (as it relates to the practicalities of regulation—urban, agricultural, industrial, forest, grassland, wetland, etc.). Although artificial, political boundaries (as they relate to jurisdictional authority) may also need to be considered when delineating ecosystems. Nevertheless, ecosystems should primarily be delineated so that their boundaries are the true borders of the ecological processes of interest.

Major ecosystem processes are climate-driven, governed by broad regimes of temperature and precipitation. Within a climatic regime, landform exerts the main influences over mesoclimate and ecosystem processes (Rowe and Sheard 1981, Barnes and others 1982, Bailey 1985, 1987, Albert and others 1986, Swanson and others 1988). Landforms bind ecosystems both structurally and functionally. Landform influences water flow, moisture availability, local wind patterns, and the reception and distribution of solar energy. In addition, landform is the most stable component of an ecosystem, and thus provides a basis for ecosystem delineation within a climatic regime (Rowe and Sheard 1981). Therefore, landform boundaries can be useful as boundaries for processes. At a fine scale within a watershed, land use and land cover will be useful for making practical delineations of ecosystems.

Implications for Monitoring of Ecosystems

Monitoring programs designed to detect environmental problems will need to be scale-specific. This is because many ecosystem properties are scale-dependent. In moving vertically through a nested hierarchy of ecosystems from a megaecosystem down to local ecosystems, changes occur in ecosystem properties such as size, process rates, permanence, stability of boundaries, and rate of change in condition (Figure 3). Ocean beach ecosystems can be used to illustrate how the hierarchy of ecosystem processes and properties are related to ecosystem size. For example, some of the most ephemeral ecosystems are tidal pools, which can disappear and reappear within a day. However, changes in coastal sand dune size, shape, and location may occur over a period of years or decades, while wide-scale changes might only be detectable over centuries or perhaps millennia. Another example of a scale-dependent property is ground-level ozone concentrations. In urban areas, the ozone concentration may fluctuate more rapidly on a local level than on a regional level.

O'Neill and others (1986) suggest that higher levels in the hierarchy reflect "only the averaged and inte-

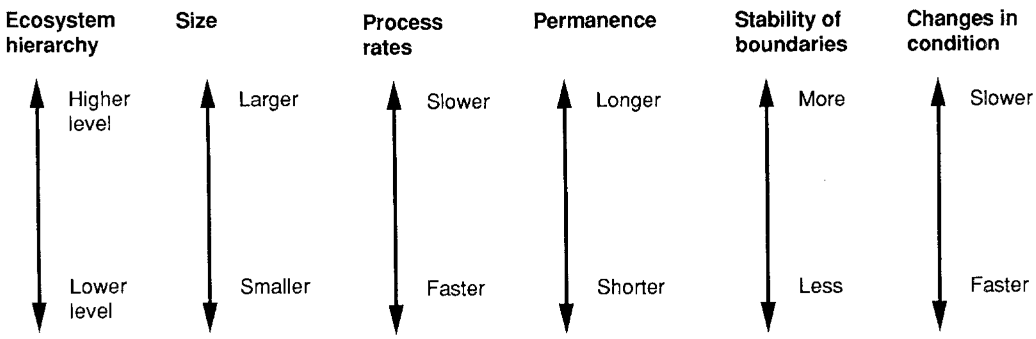

Figure 3. Relationship between ecosystem hierarchy levels and ecosystem properties.

grated responses of the components." The effects of local heterogeneity are averaged out at the broader scales of higher levels in the ecosystem hierarchy (Wiens 1989, King 1993). Thus, there may be significant disruption of a component ecosystem at a lower level in the hierarchy that does not perceptibly affect the higher-level ecosystem. Yet, the smoothing of fine-scale variability at broad scales is useful because it removes some of the noise from observations, making it possible to detect broad-scale trends (e.g., rise in atmospheric CO_2 and other greenhouse gases). Nevertheless, this smoothing may mask fine-scale signals that may be indicative of emerging environmental problems (King 1993). Therefore, one may need to use a "zoom-lens" approach, moving through the nested hierarchy and back again in order to more clearly see at which scale monitoring is appropriate.

O'Neill and others (1986) further suggest that an ecosystem cannot be defined arbitrarily in space and time, but must be "defined relative to the scale of the problem being addressed." This further emphasizes the importance of choosing the proper level within a nested hierarchy of ecosystems when monitoring environmental problems. According to hierarchy theory, each level of an ecosystem hierarchy operates at a relatively distinct temporal and spatial scale (O'Neill and others 1989). The most rapid response to environmental changes can be found in the lower levels of the ecosystem hierarchy (Klijn and Udo de Haes 1994). The response of a nested hierarchy of ecosystems to a certain stress may be significant at a lower level in the hierarchy, but appear only as a minor one at a higher level (Overton 1977 as cited in O'Neill and others 1986). Thus, if the scale of monitoring is inappropriate, a significant response could be missed (Overton 1977 as cited in O'Neill and others 1986).

Implications for Ranking Ecosystems at Risk

Just as monitoring of ecological problems must be sensitive to scale, so must the determining of threats to ecosystems and the ranking of ecosystems for agency response. As ecosystems at risk are compared for the purpose of setting priorities for action by EPA, it is important that comparisons only be made among ecosystems at the same level in the ecosystem hierarchy. For example, when determining which ecosystems are a high priority for action by EPA, small regional ecosystems at risk would not be compared with large regional ecosystems at risk, since the scale of the problems (and the corrective actions required) would differ significantly. Thus, it is important for ecosystems to be properly delineated so that ecological threats can be correctly assessed.

Categorizing and Ranking Threats to Ecosystems

Threats to ecosystems vary in type, severity, extent, and imminence. As EPA embraces the goal of protecting entire ecosystems, it will need to rank ecosystems at risk in order to set priorities for agency action. At present, ecological risk assessment primarily involves estimating risks to indicator organisms from exposure to certain chemical agents introduced into the ecosystem (EPA 1992, Suter 1993). However, ecosystems contain a multitude of species exposed to multiple chemical agents over various periods of time. The problem of assessing ecological risk is further complicated by differences in ecosystem size and number of organisms, often varying over a few orders of magnitude. Moreover, threats to ecosystems are not limited to point discharges of pollutants but include other activities, such as alterations to the physical structure of the ecosystem, which may degrade ecosystem quality.

As an early step towards formulating a strategy for ecosystem protection, I propose a preliminary ranking system for ecosystems at risk. By using ecosystem ranking solely to prioritize agency response, a fairly qualitative ranking system can be employed. This system would allow greater flexibility in the use of EPA scientific expertise (as well as that of partner agencies or organizations) to make recommendations regarding important threats to ecosystems.

The proposed ranking system for ecosystems-at-risk has three main parts:

(1) category of threat,
(2) level or class of threat, and
(3) distance from desired future condition (i.e., distance from the goal).

A description of each of these parts, and the way in which they may be combined conceptually in developing response strategies, is discussed below.

Category of Threat to Ecosystems

I suggest the following three broad categories of threat:

(1) Ecosystem degradation—occurs mainly through pollution, but could also be from selective removal of species (e.g., overfishing, overhunting, etc.);
(2) Ecosystem alteration—major physical changes (such as dredging, water diversion) and major removal of species (i.e., extinction); and
(3) Ecosystem removal—highest level of alteration (e.g., destruction of wetlands due to urbanization, conversion of forest to cropland, etc.)

Different types of threats will require different types of response from EPA. For example, in many cases, ecosystem degradation, the threat most within EPA's traditional authority, might require more of a regulatory response. Alternatively, responses to other threats might require more interagency policy leadership or facilitation among many stakeholders.

Furthermore, as EPA's five-year strategic plan (EPA 1994) clearly sets forth, responses to environmental threats cannot be solely regulatory. Response at the ecosystem level provides an opportunity to work with stakeholders of all types (e.g., corporate environmental education initiatives, ecosystem-wide pollution prevention programs, initiatives to reduce chemicals in agricultural runoff) in a particular place towards achieving improved environmental quality.

Level of Threat to Ecosystems

I propose the following four levels of threat to ecosystems:

Class 1—without intervention, the ecosystem's status will be largely unchanged five years from now.
Class 2—without intervention, the ecosystem's status will have declined somewhat five years from now.
Class 3—without intervention, the ecosystem's status will have dramatically declined, perhaps resulting in ecosystem disappearance five years from now.
Class 4—collapse or disappearance of the ecosystem is imminent (less than two years).

EPA scientists could work with scientists from partner agencies and organizations. A high degree of interagency cooperation at various scales will be required for an ecosystem approach to be workable and successful (MacKenzie 1993, Grumbine 1994). Together (within states and EPA regions), EPA and partner agency or organization scientific staffs could review relevant data and information to determine the appropriate category and level of threat to an ecosystem. Five years is a commonly used planning horizon in many institutions and agencies. It is a reasonable period for attempting to estimate future conditions of an ecosystem following certain actions. It also would probably be more difficult to achieve a consensus opinion if longer planning horizons were used.

Distance from Desired Future Condition

Beyond achieving regulation compliance, EPA, working with other agencies and stakeholders, may set goals or form a consensus for the desired future condition of an ecosystem. The desired future condition or goal for an ecosystem in an industrial area may differ from one near a recreation or wilderness area. Both scientists and stakeholders would qualitatively determine how close to or far from (i.e., "distance") the desired future condition an ecosystem was.

The "distance" from desired future condition scale is simple, consisting of four distances:

(1) close,
(2) moderate,
(3) far,
(4) very far.

Three-Dimensional Ranking

Category of threat, level or class of threat, and distance from desired future condition comprise the three

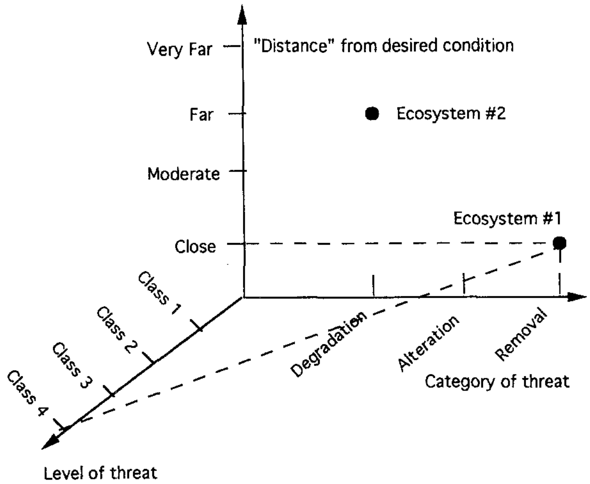

Figure 4. Three dimensional ranking of ecosystems at risk (ecosystem 1). Note: angles are modified for ease of illustration.

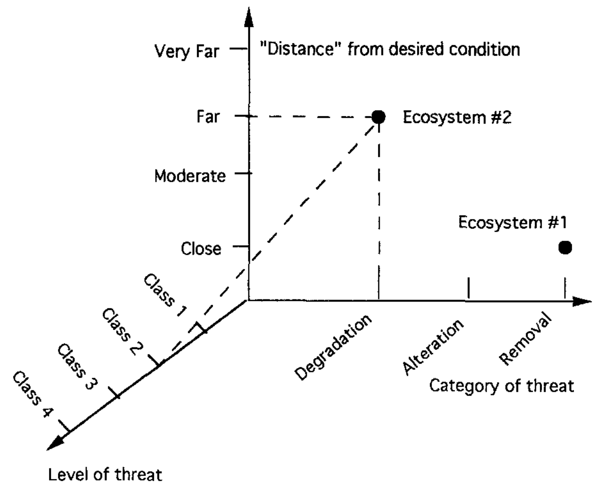

Figure 5. Three dimensional ranking of ecosystems at risk (ecosystem 2) Note: angles are modified for ease of illustration.

dimensions with which a rank for an ecosystem at risk may be derived. Graphically, each of these dimensions is an axis, and a rank is an x–y–z coordinate of the three axes (Figures 4 and 5). Thus, the priority ranking of an ecosystem is a function of the category and class of threat, as well as the distance from the desired future condition. An ecosystem is represented as a point in three-dimensional space, a coordinate of all three axes. The further away a point is from the origin of the three axes, the more that ecosystem requires protection relative to other ranked ecosystems.

For example, in Figure 4 the two dots represent two different ecosystems. Ecosystem 1 is close to its desired future condition; however, its disappearance due to ecosystem removal (category of threat) is imminent (class 4 level of threat). In Figure 5, ecosystem 2 is shown to be threatened by degradation and far from its desired future condition. However, without intervention, the ecosystem will have declined within five years (class 2 level of threat), but does not face imminent disappearance as in the case of ecosystem 1. In comparing the two ecosystems, ecosystem 1, which faces imminent removal, is further away from the origin of the axes than ecosystem 2. Thus, ecosystem 1 is a higher priority for action than ecosystem 2. The further away a dot is from the origin of the three axes, the higher priority the ecosystem it represents is for intervention.

In developing this ranking system, the distances of tic marks on the axes can be modified to increase their relative weights in the rank. For example, if it was decided that a class 4 level of threat should be accorded more importance, the class 4 tic can be moved further out on the level of threat axis. An ecosystem with a class 4 level of threat would now be further away from the origin, thereby increasing its priority rank.

Using the Three-Dimensional Ranking System

There are three basic types of ranking methods: negotiated consensus, voting, and formulas (EPA 1993). The three-dimensional ranking system proposed in this paper uses negotiated consensus along with a simple additive formula. Negotiated consensus would be used to determine where an ecosystem should fall in each axis. The distance covered on each axis could be quantified with a numerical score (e.g., on the category of threat axis, removal would get a higher number than alteration). Thus, a value would be placed on each of the categories, classes, and distances of their respective axes. Once the values for an ecosystem have been added together, the sum can be compared to other rated ecosystems and be priority ranked.

Decisions on two of the three dimensions, category of threat and level of threat, could be made by a scientific panel composed of representatives from EPA, conservation organizations, stakeholder groups, and other appropriate agencies (federal, state, or local). Although category of threat and level of threat are mainly qualitative determinations by the panel, they would be based on the panel's review of quantitative information. These determinations would represent a negotiated consensus of expert judgment. The panel should emphasize the use of site-specific data. These data are often found in studies conducted by local universities, conservation organizations, and state and county agencies. However, such information is often not available on a national basis. Thus, a place-driven ecosystem approach seeks and uses as much information as possible linked to the ecosystem (i.e., location) of interest.

Judgment regarding distance from desired future condition, the third dimension, should be the purview of an expanded panel with heavy stakeholder involvement. To reach consensus, the desires of the community regarding the standard an ecosystem acheives or maintains must be recognized. The distance (i.e., time and effort required) from that desired state, however, is more a scientific question and would probably be handled best by the scientific panel.

Each of the three axes, category of threat, level of threat, and distance from desired future condition, is a continuum. The farther out a point is on the level of threat axis, the higher the threat class. Similarly, the farther out on the distance from the desired future condition axis, the greater the effort and time needed for ecosystem recovery. Category of threat can be considered a continuum of reversibility, with ecosystem removal being the least reversible effect. Conceptually, the further away from the origin the x–y–z coordinate point is, the higher priority that ecosystem is for agency response.

Comparison with Other Ranking Systems

Other ranking systems for ecological risk consider a variety of threats (for examples, see EPA 1990b, TNC 1994, EPA Region III no date). Some common disadvantages of a number of other ranking systems is that they: (1) may not be able to separate problems occurring at different scales, (2) are not place-specific, (3) do not consider consequences of action or inaction within a certain time period (e.g., without intervention ecosystem will have declined five years from now), and (4) do not ascertain and incorporate a desired future condition. An advantage of the proposed three-dimensional ranking system is that it does include these points. However, it does not explicitly consider the rarity of an ecosystem or its resilience, which are included in some other ecological ranking schemes.

The proposed ranking system provides a framework for involving EPA, partner agencies, and stakeholders in determining threats to ecosystems at risk and determining priorities for agency response. The details of both ecosystem delineation and the three-dimensional ranking system must be developed and refined through testing in the field.

Conclusions

An ecosystem approach to environmental protection by the EPA or other agencies will require new thinking about how ecosystems are defined, and how problems and solutions are framed. In summary:

- Ecosystems are places, large and small, nested in a spatial, temporal, and functional hierarchy.
- Ecosystem delineations must be scientifically defensible and administratively practical.
- Boundaries for ecosystems are climatic factors and landscape features.
- Ecosystem delineations should emphasize functionality.
- Ecosystem scale has implications for monitoring methods.
- Category of threat, level of threat, and "distance" from desired future condition can be combined to rank ecosystems at risk.
- Ranks should be based on a review of quantitative information by a scientific panel with stakeholder participation.
- Ranks are determined using negotiated consensus and summing values from the three ranking dimensions.
- Ranks can be used to plan and prioritize EPA action for ecosystems at risk.

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