



# Ecosystem Management

*Ecosystem management (EM) promotes an integrated approach to environmental issues; its central goal is the protection of entire ecosystems. By focusing on an interdisciplinary solution to environmental challenges, EM can help to synthesize societal, economic, scientific, and governmental goals. Furthermore, as EM becomes part of the foundation of environmental legislation, it will support and enhance the growing societal drive to protect our environment.*

**A**t the end of the twentieth century, the U.S. President's Council on Sustainable Development stated that human survival may well depend on widespread acceptance of the principles of sustainable living and ecosystem management, a perspective articulated by former secretary of the interior (and council member) Bruce Babbitt (1999): "When we act locally, we must think globally. We must also think holistically, considering the relationship between Nature and the economic, cultural, and spiritual life of our communities and societies." The challenges are daunting due to threats from diverse factors such as an exponential increase in land use change and related ecosystem fragmentation, pests, pathogens, disease, light and chemical pollution, invasive species, and climate change.

Ecosystem management (EM) is one practice that is being implemented to address these challenges. It is an attempt to manage entire ecological systems rather than individual and fragmented components (Lindenmayer, Margules, and Botkin 2000). As the interdisciplinary science, monitoring, data documentation and sharing, and predictive modeling improve, the more likely that innovative EM practices will have greater success.

EM was initially an outgrowth of the U.S. Forest Service policy of multiple use, which promoted sustained yield management practices of national forests to encompass the

more holistic practice of sustaining ecosystem management (Jenson and Bourgeron 1991). The central object of EM is to sustain the integrity of ecosystems and their structure, processes, and functions as described by the American biologist and ecologist Eugene Odum (1956). He indicates that *structure* refers to species composition within communities and their distribution across attributes such as biomass, age class, reproduction, and mortality. *Process* describes elements that drive the system such as climatology, nutrient cycling, and species evolution and succession. Functional elements include habitat characterization and the role of the species and community in the food chain. At various stages, nutrient cycling processes such as uptake, decomposition, and mineralization are considered functional elements of ecosystems as well.

## An Interdisciplinary Approach

The growing influence of the interaction between society and natural resources is of vital importance (Campbell 2001). Human values and politics are at the center of social considerations concerning environmental conditions (Peine 2007). As succinctly expressed by the U. S. Geological Survey and U.S. Fish and Wildlife Service, an interdisciplinary approach to solving environmental problems is a true necessity.

Biologists and land managers have one overriding universal question they need answered: What specific lands do we need to restore, protect, and/or manage to most effectively achieve conservation objectives for X species or guilds of species? Our operational dilemma involves issues of scale both spatial and temporal and how we strategically plan and actually take on-the-ground action to achieve maximum results. The focus for this project will be how the socio-economic components of

this process of choosing a viable critical habitat and the necessary socio-economic components of the multidisciplinary process. (Peine et al. 2009)

EM emerged as a new paradigm for managing public and private lands. It combines the principles of ecosystem-level ecology and the policy requirements of managing public lands (Samson and Knopf 1996). By 1994, eighteen U. S. federal agencies had adopted some form of EM as a guiding policy (Cortner and Moote 1999). The environmentalist R. Edward Grumbine (1994) suggests five challenging principles of EM essential to sustaining ecological integrity: (1) maintain viable populations of native populations in situ, (2) represent within protected areas all native ecosystem types throughout their natural range, (3) maintain ecological and evolutionary processes, (4) manage over periods of time long enough to maintain the evolutionary potential of species and ecosystems, and (5) accommodate human use and occupancy.

In 1995, an interagency task force defined ecosystem management, saying, “The goal of the ecosystem approach is to restore and sustain the health, productivity, and biological diversity of ecosystems and the overall quality of life through a natural resource management approach that is fully integrated with social and economic goals” (IEMTF 1995). Extensive legislation in the United States providing key statutes for the practice of EM was passed in the 1960s through the early 1980s. Some notable examples include the Land and Water Conservation Fund Act of 1964; Wild and Scenic Rivers Act of 1968; National Environmental Policy Act (NEPA) of 1969, which established the U.S. Environmental Protection Agency (EPA) and a Council on Environmental Quality; the Clean Air Act (CAA) of 1970; the Water Pollution Control Act Amendments of 1972; the Endangered Species Act (ESA) of 1973; the Safe Drinking Water Act of 1974; the Resource Conservation and Recovery Act of 1976; the Water Pollution Control Act Amendments of 1977, which became known as the Clean Water Act; and the Comprehensive Environmental Response, Compensation, and Liability Act, commonly known as the Superfund Act of 1980. These laws regulated toxic substances, pesticides, and ocean dumping, and protected wildlife, wilderness, and wild and scenic rivers. Moreover, the laws provide

for pollution research, standard setting, monitoring, and enforcement. The creation of these laws led to a major shift in the environmental movement. Groups such as the Sierra Club shifted focus from local issues to becoming a lobby in Washington. New groups, for example, the Natural Resources Defense Council and Environmental Defense Fund, arose to influence politics as well (Buttel and Larson 1980).

## Challenges and Barriers

While EM scientific management practices support governmental and legal responses to ecosystem degradation, challenges are still evolving. Laws that incorporate single-medium or single species management have been very effective in some cases (Houck 1997), however, legal mandates that encourage and incorporate a more integrated approach are “necessary to sustain ecosystem composition, structure, and function” (Christensen et al. 1996). On a national level, there are a number of obstacles to the development and the

implementation of EM-based laws,

including scientific, institutional, jurisdictional, bureaucratic, and political barriers. In the United States, the political influence of large industries has a significant impact on the development of the nation’s environmental laws and regulations (Spence 2005), a situation that also applies regarding legislative or regulatory proposals that adopt EM principles.

For example, due to extensive lobbying by the coal and power industries, U.S. environmental laws have not

fully addressed the harms to the environment associated with the production and use of coal. Accordingly, despite the existing legal framework of the Clean Water Act (CWA), mountaintop removal for coal production is allowed in the Appalachian Mountains, and there currently are no regulations to control toxic waste from coal-fired power plant.

Nor did the Clean Air Act of 1970 require unmodified existing coal-fired plants to adhere to emission-control standards. Many of these plants still operate today with limited regulatory control of their emissions (Manuel 2009).

These barriers to EM legal responses increase exponentially when attempting to manage transnational ecosystems. As the climate change issue so perfectly illustrates, even near scientific consensus has not generated a political consensus on the appropriate international, intergovernmental approach. In the early 1990s, a large list of Nobel



Prize winners and National Academy of Sciences members signed an appeal stating that “there is broad agreement within the scientific community that amplification of the Earth’s natural greenhouse effect by the buildup of various gases introduced by human activity has the potential to produce dramatic changes in climate” (IPCC 1992). Over 190 countries representing more than 60 percent of the world’s emissions have committed to the groundbreaking U.N. Framework Convention on Climate Change (UNFCCC) and the binding obligations in the Kyoto Protocol thereto, including the European Union, Australia, Canada, and Japan. But the nations responsible for the remaining 40 percent of the world’s emissions have refused to make the commitment (UNFCCC 1992).

## A National Success

The many barriers to EM influence over legislation, however, have been successfully overcome in the development of a number of significant national and international legal instruments. Consider, for example, the U.S. Endangered Species Act (ESA), regarded by some as one of the first and most successful examples of legislation that implements EM-styled management (Houck 1997). The U.S. Congress passed the ESA in 1973 as amended, which provides broad protection for species of fish, wildlife, and plants that are listed as threatened or endangered in the United States and elsewhere. Protections for listing species include the design and implementation of recovery plans and the designation of critical habitat.

The red wolf (*Canis rufus*) was one of the first and most highly threatened species addressed by the then new ESA legislation. It once ranged throughout the southeastern United States. Indiscriminate killing, bounties, and habitat destruction were the initial drivers of population decline. Further disruption related to timber harvesting, mining, and agriculture forced red wolves into the open, thereby increasing contact with humans and livestock while creating favorable conditions for invasive coyotes (*Canis latrans*). As the number of wolves decreased, coyotes moved in, and extensive crossbreeding occurred. A government predator-control program exacerbated an already dire situation for the wolves. The U.S. Fish and Wildlife Service (FWS) first officially recognized the taxon as endangered in 1967, and the species was extinct in the wild by 1980. With the enactment of the ESA, an ambitious recovery plan—arguably the most complex ever—was initiated. The first step was to establish a foundation breeding stock based on only fourteen individuals with adequate taxonomic purity, captured from the wild (Norwack 1992). After decades of captive breeding, red wolves were released experimentally on Bull Island of Cape Romain National Wildlife Refuge in South Carolina. Currently, red wolves successfully exist in

eastern North Carolina, in an area in which there are three national wildlife refuges.

## An International Success

Internationally, there are a number of legal instruments that incorporate principles of EM, including the Convention on Biological Diversity and its Cartagena Protocol, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, the Convention on Migratory Species, the Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat, the U.N. Convention to Combat Desertification, the UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage, the U.N. Convention on the Law of the Sea, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, and the Vienna Convention to Protect the Ozone Layer with its Montreal Protocol.

One very successful example of a collaborative legal regime that addresses the management of a specific transboundary ecosystem resource pertains to the Great Lakes Basin. The Great Lakes are the largest surface freshwater system on Earth, containing approximately 84 percent of North America’s surface freshwater and 21 percent of the world’s supply. The basin is located in heavily industrialized areas of both the United States and Canada, and nearly 25 percent of Canadian and 7 percent of U.S. agricultural production are part of the basin’s ecosystem (Karkkainen 2004). The Great Lakes marine ecosystem is subject to a number of environmental stressors, including toxic and nutrient pollution, both solid and atmospheric; city and agricultural waste; industrial discharges and disposal-site leachate; declining fisheries, wetlands loss, and habitat destruction; and alteration of natural stream flows.

The venerable 1909 Boundary Waters Treaty and the Great Lakes Water Quality Agreement are the primary legal instruments governing the basin’s international management programs. While the United States and Canada negotiated the first Great Lakes Water Quality Agreement in 1972 based upon conventional pollution control strategies, the 1978 and 1987 revisions to the agreement explicitly adopted an integrated ecosystem management approach. Within the United States, there are more than 140 different federal programs that fund and implement the Great Lakes management activities, including, for example, the Bi-national Toxics Strategy, Lakewide Area Management Plans, and Remedial Action Plans for designated priority areas. Governance of the Great Lakes Basin is shared across national, state, and local borders and involves various federal agencies in both the United States and Canada, eight U.S. states, two Canadian provinces, a series of binational nongovernmental and intergovernmental bodies,

major ports and municipalities throughout the region, tribal nations in the United States and in Canada, local and regional nongovernmental organizations (NGOs), businesses and trade interests, and the scientific community. Despite its complexity, this structure has been cited as the “premier example of successful transboundary collaboration in joint management of a freshwater aquatic ecosystem” (Karkkainen 2004).

## Another Industrial Revolution

On a final and positive note, there is a growing societal awareness of environmental degradation and a commitment toward long-term stewardship and restoration (Steinberg 2009). EM-based initiatives are occurring not only nationally and internationally, but also at regional, state, and local levels and are being developed with the involvement of business groups, environmental and other NGOs, scientists, and individual landowner citizens as well as supranational, national, and subnational governmental and management organizations. The challenge is to consolidate policy, science, and political commitment. The economist, author, and social critic Jeremy Rifkin suggests that “we are on the cusp of another historic convergence of energy and communication—a third industrial revolution—that could extend empathic sensibility to the biosphere itself and all of life on Earth” (Rifkin 2010). Legal structures that adopt EM principles could serve to encourage the development and success of innovative ecosystem programs and to extend empathic sensibilities to fragile ecosystems globally.

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See also Clean Air Act; Clean Water Act; Convention on Biological Diversity; Convention on International Trade in Endangered Species; Convention on Wetlands; Endangered Species Act; Forest Reserve Act; Lacey Act; Land Use—Regulation and Zoning; National Environmental Policy Act; *Silent Spring*; Wilderness Act

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## TREATIES / RESOLUTIONS / CONVENTIONS

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