Ecological Risk Assessment*

SETACTIP*

*technical issue paper

Purpose: SETAC is a professional society with worldwide membership from academia, government, business, and nongovernmental organizations. TIPs provide a credible and balanced scientific discussion of important environmental issues.

In recent years, ecological risk assessment (ERA) has emerged as an important part of environmental protection programs. The following discussion provides a brief overview of ERA issues.

What is ecological risk assessment?

ERA is the practice of determining the nature and likelihood of effects of our actions on animals, plants, and the environment. (In Europe, the term "Environmental Risk Assessment" is often used.)

Ecological risk assessments deal with human-caused changes that alter important features of ecological systems such as lakes, streams, forests, or watersheds. When we introduce a new chemical (such as a pesticide to a wheat field), accidentally import a new species (such as a foreign insect), or change a landscape (such as draining or filling a wetland), scientists often assess how much damage those actions may have on the plants or animals in the area. Ecological risks may be local—a hazardous waste site. The risks may be regional—the Chesapeake Bay, the Black Forest, or the Great Barrier Reef. The risks may be global—atmospheric transport of chemicals or global warming. Ecological risks may involve a specific type of plant or animal (a bass), a community of organisms (the fish in a lake), or an ecosystem (all of the biological and physical components of the lake).

What is ERA used for?

Industry, government agencies, policy makers, citizens, and legislators use ERA to support environmental management decisions.

ERA helps organize information and contributes to informed decisions. It is a useful risk management tool that

- highlights the greatest risks, which is helpful for allocating limited resources;
- allows decision makers to ask "what if" questions regarding the consequences of potential management actions;
- facilitates explicit identification of environmental values of concern; and
- identifies critical knowledge gaps, thereby helping to prioritize future research needs.

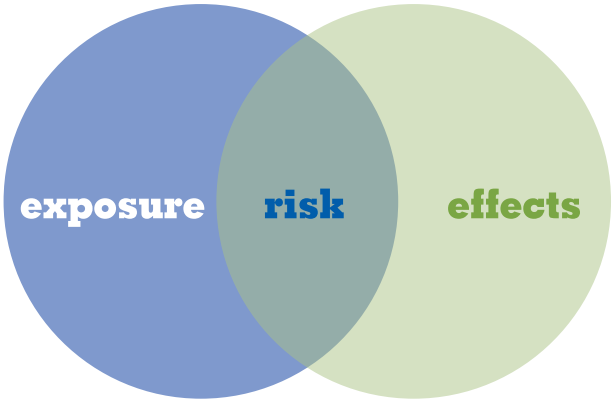
ERA can be used to evaluate relative benefits of different clean-up options at hazardous waste sites, screen new chemicals prior to their commercial production, evaluate the risks that imported agricultural products may introduce exotic agricultural pests, or determine the threats to valued ecological resources in a watershed.

What are ERA's basic concepts?

Ecological risks are 1) estimated from the relationship between exposure and effects and 2) made with varying degrees of uncertainty.

ERAs evaluate two basic elements: exposure and effects.

1) Exposure is the interaction of stressors with receptors. Measures of exposure can include concentrations of contaminants or physical changes in habitat.
2) The analysis of effects evaluates changes in the nature and magnitude of effects as exposure changes.



Integrating exposure and effects information leads to an estimation of risk, the likelihood that adverse effects will result from exposure.

Approaches for evaluating exposure and effects include, for example, measuring chemical releases, predicting with models the environmental fate and effects of chemicals even before they are manufactured, and testing effects of these chemicals in a laboratory. Exposure and effects must be considered together because they are both important in estimating risk. When the potential for exposure and effects is low, the risk will be low. When both are high, the risk will be high. Whatever the approach, the goal is to use all available information to characterize exposure and effects and to integrate them into an understanding of ecological risks.

Because of the complexity of nature, risk assessment will include some degree of uncertainty. Although we can reduce some components of uncertainty by gathering additional data, we can only estimate other components due to their inherent variability (such as rainfall and temperature variations). While it is important for risk managers to understand the impact of natural variability and uncertainty on the conclusions of the risk assessment, making a risk management decision does not require the absence of uncertainty. In fact, an attempt is made to quantify and communicate uncertainty when conducting and reporting ERAs so that the best decisions can be made with our current state of knowledge.

How is ERA done?

ERAs include the following:

1) Problem formulation: clearly defining the problem

2) Analysis: characterizing potential or existing exposure to stressors and their effects

3) Risk characterization: integrating and evaluating exposure and effects information.

Planning the assessment with the risk manager and communicating the risks to decision-makers are important parts of the process.

The diagram to the right, from the USEPA's Proposed Guidelines for Ecological Risk Assessment, illustrates one of ERA's strengths: a generally accepted standard framework.

How does ERA relate to decision-making?

Ecological risk assessment is one input to environmental management decisions. Other inputs include stakeholder concerns, availability of technical solutions, benefits, equity, costs, legal mandates, and political issues.

For example, a course of action that has the least ecological risk may be too expensive or not technologically feasible. Thus, while an ERA provides critical information to risk managers, it is only part of the whole environmental decision-making process.

What are ERAs designed to protect?

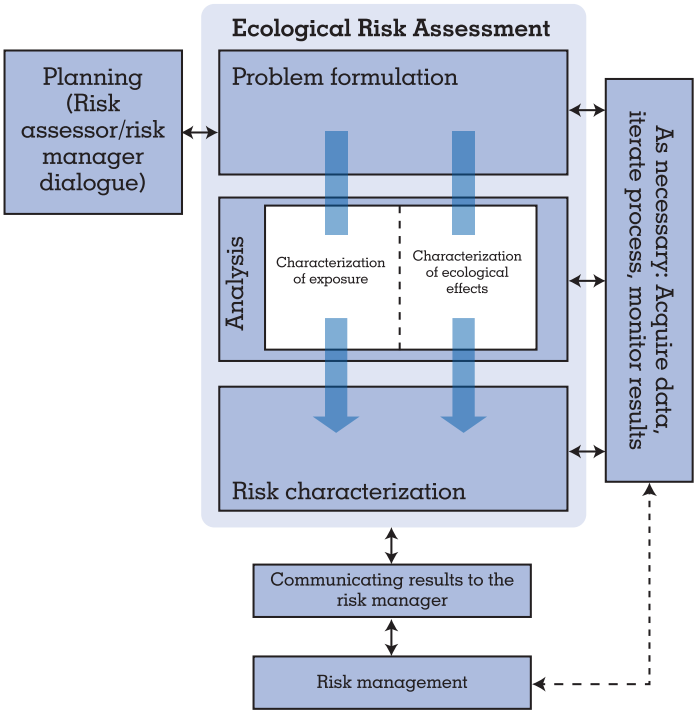
ERAs may address any of a variety of environmental properties ranging from the survival of individual members of an endangered species to the productivity of the community in a stream or the biological diversity of an entire region.

Although the risk assessment process is scientifically based, deciding what environmental properties we are concerned about requires input from stakeholders and includes considerations of ecological values as well as ecosystem-based science. In an initial planning process (problem formulation), risk managers and stakeholders may identify ecological concerns that have significant economic, social, or recreational value. The endpoints for the ERA should reflect these concerns while being ecologically relevant to the ecosystem they represent and being susceptible to the stressors of concern.

Won't protection of humans also result in protection of the environment?

Ecological receptors can receive more exposure to contaminants in the environment and can be more sensitive than humans.

Protecting against risks to human health will not necessarily protect the environment. People do not interact with their environment in identical ways to those of other organisms, so separate human health and ecological assessments generally are necessary. As an example, consider a hazardous chemical found in a wetland. A fence surrounding the wetland may be perfectly adequate to prevent human access.



From USEPA 1996.

However, birds, fish, and mammals using the wetland as a habitat and food resource receive much more exposure and may suffer toxic effects as a result. Finally, organisms differ in their susceptibilities to chemicals and other stressors, and protection of a single species does not ensure protection of other species.

How are ERA predictions useful?

Although there are various sources of uncertainty in ERA, we can predict many effects with confidence. Even when uncertainties are high, risk assessments with proper scientific review and consensus provide the best summary of the state of knowledge.

ERA results are most useful when risk managers clearly communicate the risks and decisions to the public. An ERA should

- summarize results so that the public can understand them,
- distinguish scientific conclusions from policy judgments,
- describe major differences of opinion on scientific issues or alternative conclusions that readers can draw from the data, and
- explain major assumptions and uncertainties.

How complex are ERAs?

ERAs may involve the effects of multiple stressors on ecosystems containing numerous species that are interlinked and dependent on a range of processes.

Because of the complexity and variability of nature, the initial scoping phase of an ERA (problem formulation) is critical to providing a focus for the assessment. However, ERAs need not be complex or lengthy, they only need to define the risks with the degree of certainty required to support a risk management decision.

What is the future of ERA?

Anticipated improvements in ERA will include development of standard tools and approaches and more effective links to risk management. Increasingly, ERA will address issues concerning its application in the management of land and natural resources.

Some challenges facing ERA include the following:

- Integrating the concerns of stakeholders and risk managers with the scientific knowledge of risk assessors
- Conducting risk assessments that encompass large areas and involve multiple stressors
- Moving beyond effects on individual organisms and species to predicting changes in populations and ecosystems
- Communicating ecological risks to stakeholders.

While improving the science behind ERA will always be desirable, ERA is now and will continue to be a valuable tool supporting scientifically sound environmental decision-making.

Where is there more information about ERA?

While there are many excellent sources for ERA information, the following resources will help in further understanding the issue.

- [USEPA] U.S. Environmental Protection Agency. 1996. Proposed Guidelines for Ecological Risk Assessment. *Federal Register* 61:47552-47631. This document can also be found at: http://www.epa.gov/ORD/WebPubs/ecorisk.
- [USEPA] U.S. Environmental Protection Agency. 1992. Framework for Ecological Risk Assessment. EPA/630/R-92/001. Risk Assessment Forum, Washington, DC.
- Suter II GW. 1993. Ecological risk assessment. Boca Raton FL: Lewis. 550 p.

Ecological risk assessment terms

endpoint: A characteristic of the environment that is evaluated or measured in an assessment.

receptor: A plant, animal, community of organisms, or ecosystem that is exposed to stressors in the environment.

risk assessor: An individual or team with the appropriate training and range of expertise necessary to conduct a risk assessment.

risk management: The process of determining appropriate actions in response to an identified risk.

risk manager: An individual, team, or organization with responsibility for or authority to take action in response to an identified risk.

stakeholder: Any individual, team or organization interested in or affected by the outcome of a risk assessment.

stressor: Any physical, chemical, or biological entity that can induce an adverse response.

uncertainty: A lack of confidence in the prediction of a risk assessment that may result from natural variability in natural processes, imperfect or incomplete knowledge, or errors in conducting an assessment.

About this document

When referring to this text, please use the following citation:

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Society of Environmental Toxicology and Chemistry

In the 1970s, no forum existed for interdisciplinary communication among environmental scientists—biologists, chemists, toxicologists—and others interested in environmental issues such as managers and engineers. The Society of Environmental Toxicology and Chemistry (SETAC) was founded in 1979 to fill the void. Based on the growth in membership, annual meeting attendance, and publications, the forum was needed.

Like many other professional societies, SETAC publishes an esteemed scientific journal (*Environmental Toxicology & Chemistry*) and convenes an annual meeting replete with state-of-the-science poster and platform presentations. Because of its multidisciplinary approach, however, the scope of the science of SETAC is much broader in concept and application than that of many other societies.

SETAC is concerned about global environmental issues. Its members are committed to good science worldwide, to timely and effective communication of research, and to interactions among professionals so that enhanced knowledge and increased personal exchanges occur. Sister organizations in Europe (1989), Asia/Pacific (1997), and Latin America (1999) have been formed, and the nonprofit SETAC Foundation for Environmental Education was founded in North America in 1990. International acceptance of the SETAC model continues with widespread interest in Russia and Africa.

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