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Ecological Significance and Selection of Candidate Assessment Endpoints

This Bulletin provides guidance to Superfund risk assessors and risk managers on planning ecological risk assessments (ERAs) at Superfund sites. This guidance is based on the experience of the Regional Biological Technical Advisory Groups (BTAGs). Following the concepts advocated in this Bulletin should result in ERAs that will meet the needs of Superfund program.

IN THIS BULLETIN

Background

In a 1994 OSWER Directive (No. 9285.7-17), Assistant Administrator Elliott Laws stressed the importance of protecting ecological receptors at Superfund sites through the Ecological Risk Assessment (ERA) process. The purpose for conducting the ERA was described as characterizing threats from chemical contaminants to the environment and identifying clean-up levels that will protect the ecological receptors at risk. The information provided in the ERA and the Human Health Risk Assessment complete the Baseline Risk Assessment

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conducted during the Remedial Investigation. It is important to note that Superfund ERAs may be more focused than ERAs conducted by other programs, in that only chemical stressors are evaluated during the baseline risk assessment process. Superfund risk managers, however, do consider both chemical and non-chemical (e.g., habitat loss due to physical disturbances) stressors when selecting a remedial alternative that will be ecologically protective.

A critical element in the ERA process requires distinguishing important environmental responses to chemical releases from those that are inconsequential to the ecosystem in which the site resides: in other words, determining the **ecological significance** of past, current, or projected site-related effects. Failure to make this distinction may result in a risk assessment that brings little value to the decision-making process.

For the purpose of a Superfund ERA, investigations should focus on endpoints most likely to be affected given the fate and transport mechanisms of the contaminants involved, the ecotoxicological properties of the contaminants, the habitats at the site, and the potential ecological receptors. Additional endpoints may be added to assist in risk communication. The challenge then, for the risk assessor and the risk manager, is to structure the ERA in such a manner that potentially ecologically significant risks will be addressed.

Ecological Significance and The Ecological Risk Assessment Process

The Superfund program accepts the approach described in the *Framework for Ecological Risk Assessment* (EPA/630/R-92/001) as an appropriate conceptual model for the ERA process. Superfund-specific guidance is being prepared by both the Office of Emergency and Remedial Response (OERR) and some Regions that will complement this generic Agency Framework. However, the OERR guidance is a process document that does not address issues such as the ecological significance of an observed or expected effect. Due to inherent complexities in developing site-specific ERAs, risk managers (e.g., Remedial Project Managers and On-Scene Coordinators) should coordinate with Regional ecological risk assessment teams (BTAGs).

The issue of ecological significance must be addressed in at least two phases of the risk assessment process. First, during the Problem Formulation phase, the risk assessor and the risk manager should discuss and identify ecological attributes associated with the site that may function as *assessment endpoints*, which are defined as explicit expressions of the environmental value that is to be protected (EPA, 1992). During these planning discussions, it is important to keep in mind the objectives of the risk assessment and what it seeks to achieve. A pertinent question to ask at this juncture is how an assessment of the proposed ecological endpoints will help determine whether or not to remediate the site, and if so, to what level.

Ecological Significance must be addressed during two phases of a Superfund ERA:

- *Problem Formulation, and*
- *Risk Characterization.*

The issue of ecological significance arises again during the Risk Characterization step. At this time, the risk assessor presents the results of the assessment to the risk manager and the results are in turn presented to the general public. The risk assessor must provide an interpretation of the assessment in the context of the questions raised in the Problem Formulation: what is the nature of the risk (likelihood, duration and magnitude) to the receptor(s) represented by the assessment endpoint(s), what is the anticipated spatial/temporal extent of the threat(s), and at what chemical concentration would the contaminant(s) of concern no longer pose a threat.

Ecological Significance and Candidate Assessment Endpoint Selection

During Problem Formulation, the significance of adverse toxicological, biological, and ecological effects to receptors is considered as part of the process in the selection of assessment endpoints. The BTAG considers individual, population, and community level assessment endpoints appropriate at Superfund sites. Examples of receptors at these levels of organization include:

Individual Level

- Endangered or threatened species known to be present (e.g., bald eagle, spotted owl, gopher tortoise)

Population Level

- A sensitive fish population
- Bird populations exposed to contaminants of concern

Community Level -

- Distribution and abundance of:
  - fish and avian communities
  - benthic community
  - wetland plant community
  - soil invertebrate communities

This list does not encompass the complete array of potential ecological structural and functional attributes that could be assessed. Given the state of current ecosystem models and the relatively small physical size of most Superfund sites, however, the utility of ecosystem-type assessments is questionable for Superfund ERAs.

For Superfund ERAs, at the population level of organization, "life-table" parameters (e.g., mortality, fecundity, age class distributions) are recommended as appropriate measures of response. It is suggested that community assessment endpoints should focus on structural characteristics such as productivity and diversity.

Distinguishing potential and current adverse effects due to releases of contaminants from normal fluctuations in measurable population- and community-level parameters is the most contentious and complicating issue in the ERA. Natural variability (e.g., population fluctuations, changes in presence/absence of

During a Superfund ERA, natural variability inherent in the ecosystem at a site must be addressed as an uncertainty, and factored into the risk characterization.

species, abundance, diversity, biomass) is a factor that must be addressed when selecting assessment endpoints. Due to time constraints in the Superfund process, it is unlikely that site-specific studies will be conducted to determine natural variability inherent in populations associated with Superfund sites. Consideration of whether the observed or estimated effect is within the range of normal variability should be addressed as an uncertainty, and factored into the risk characterization.

Candidate assessment endpoints that are consistent with the Superfund ERA process include (but are not limited to) the following:

Population Level Assessment Endpoints

- Survival and reproduction of fish
- Survival, growth, and reproduction of fish-eating birds and mammals

Community Level Assessment Endpoints

- Stream benthic invertebrate species diversity and abundance
- Survival of soil invertebrates
- Productivity of wetland vegetation
- Maintenance of song-bird populations

Additionally, candidate assessment endpoints for endangered or threatened species, individuals, or populations should include impacts on the following:

- Physiological status
- Reproduction
- Growth
- Development
- Morbidity and mortality

Conclusion

Choosing from candidate endpoints is a challenging process that requires site-specific information on species, communities, and functions; the mode of action (both direct and indirect) of the released contaminants; and exposure and sensitivity of the response of the receptors. It is important that Superfund ERAs address risks that are ecologically significant and relevant to the site. Decisions to remediate sites based upon poorly-designed ERAs that do not clearly define site-specific needs are contradictory to the intent of CERCLA and compromise the integrity of the Superfund Program.

It may be argued that any discussion regarding the significance of an effect, the significance of a specific receptor, and the societal value of remediation all fall within the purview of risk management rather than risk assessment. While it is important to not allow the risk management process to force the assessment process in any predetermined direction (and thus compromise the integrity of the assessment), the risk assessor and risk manager must reach agreement on the issue of assessment endpoints prior to beginning any data

Regional BTAG Coordinators can work with Superfund RPMs and other project managers to select appropriate assessment endpoints for ERAs. This process will increase the chance that the ERA will address risks that are ecologically significant and relevant to the site.

collection activities to confirm the projected effects. When the results of the ERA are provided to the risk manager, the significance of the risks to the ecosystem should be discussed, and the role of societal value can then be weighed as an aspect of risk management. Without this coordination, there is no way to assure that the ERA will be useful to the risk management decision-making process.

The Regional BTAG Coordinators can work with the project manager to select the appropriate assessment endpoints for the ERA. Establishing explicit assessment endpoints very early in the process greatly increases the likelihood that a successful ERA will be accomplished.

Reference

U.S. Environmental Protection Agency, 1992. *Framework for Ecological Risk Assessment*. EPA/630/R-92/001. Risk Assessment Forum, U.S. Environmental Protection Agency, Washington, DC.

Glossary (adapted from EPA, 1992)

assessment endpoint - An explicit expression of the environmental value that is to be protected.

community - An assemblage of populations of different species within a specified location in space or time.

direct effect - An effect where the stressor acts on the ecological component of interest itself, not through effects on other components of the ecosystem (compare with definition for **indirect effect**).

ecological risk assessment - The process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors.

ecosystem - The biotic community and abiotic environment within a specified location in space and time.

exposure - Co-occurrence of or contact between a stressor and an ecological component.

indirect effect - An effect where the stressor acts on supporting components of the ecosystem, which in turn have an effect on the ecological component of interest.

measurement endpoint - A measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint. Measurement endpoints are often expressed as the statistical or arithmetic summaries of the observations that comprise the measurement.

population - An aggregate of individuals of a species within a specified location in space and time.

risk characterization - A phase of ecological risk assessment that integrates the results of the exposure and ecological effects analyses to evaluate the likelihood of adverse ecological effects associated with exposure to stressor. The ecological significance of the adverse effects is discussed, including consideration of the types and magnitudes of the effects, their spatial and temporal patterns, and the likelihood of recovery.

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

xenobiotic - A chemical or other stressor that does not occur naturally in the environment. Xenobiotics occur as a result of anthropogenic activities such as the application of pesticides and the discharge of industrial chemicals to air, land, or water.