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The Case for Ecosystem Services as Toxicological End Points

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WHAT ARE ECOSYSTEM SERVICES?

Ecosystem services are defined as those ecosystem functions perceived as beneficial to human society. Ecosystem functions have existed as long as life on earth, but ecosystem services are those functions of interest to human society. Services may be shared by numerous species other than humans, but this commentary focuses on human society's interests because many humans may not be as attuned to the needs of other species as they are to their own. Examples of ecosystem services are capture of sunlight for the production of food and fiber, maintenance of the atmospheric gas balance, and the breakdown of wastes and recycling of useful components. Collectively, ecosystem services constitute the life support system of humans.

Ecosystem services can be measured at widely varying spatial and temporal scales. However, the scale chosen should match the inherent scale of the problems. Many pollution problems have inherently large spatial scales. For example, the Arctic haze is caused by industrial smog, even though the Arctic is not a major source of such emissions (Kerr 1979). Spencer and Cliath (1990) have tracked the movement of pesticides from the soil to the atmosphere, where they are capable of transport over vast distances. The Chernobyl reactor disaster spread radioactive contaminants over an entire continent (IAEA, 1991).

ECOSYSTEM SERVICES AND TOXICOLOGY

Toxicity tests must reflect the importance of large scales in evaluating pollution problems, including the problem of cumulative impact, i.e., the potential for what appear to be small-scale environmental impacts becoming important on a large scale when multiple impacts are repeated over a large area (Hunsaker *et al*, 1990; Suter, 1990). In particular, ecosystem services should be considered as toxicological end points for the following reasons:

1. Ecosystems services, because they are perceived as valuable, potentially provide end points for toxicity tests that are both socially and biologically relevant.

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