Hazardous waste sites

Dear Sir: In "Weighing the Ecological Risk of Hazardous Waste Sites" (*ES&T*, March 1992, pp. 432–38), Suter and Loar argue for implementation of a new ecological risk assessment (ERA) approach. That new approach is a hybridization of three complementary but distinct ERA paradigms: the "traditional" (*1*) or administrative criterion paradigm, the media toxicity testing or bioassay paradigm, and the population epidemiology or biosurvey paradigm. Although often insufficient for ecological risk assessment individually, when formed into a ". . . braid of lines of evidence," they are capable of accurately assessing ecological risk using best professional judgment. Based on my experience in attempting to implement a similar approach at a DOE Superfund site, I must differ with the authors on several points.

First, the authors' approach, while perhaps new to the Superfund Program, is an extension of the approach the federal and state Clean Water Act (CWA) programs have developed for determining whether the uses of a water body have been impaired and whether the impairment is due to point or nonpoint source discharges or natural or man-induced irretrievable conditions (*2*). Narrative water quality criteria (WQC) are implemented using a combination of bioassay and biosurvey methods, while the numerical WQC are derived according to standardized procedures from laboratory toxicity testing data and implemented through chemical analysis. EPA is developing WQC-based numerical sediment quality criteria (*3*) intended to complement the biosurvey and bioassay methods which have been used to define apparent effects thresholds for freshwater and marine sediments for a decade or more (*4, 5*).

Second, I believe that the authors have underestimated the utility of media toxicity testing, incorrectly concluding that ". . . they do not indicate what components caused the toxicity, and they cannot be readily used for predictive assessments." EPA has developed a toxicity reduction evaluation (TRE) procedure for fractionating acutely toxic agents in wastewater according to their physical, chemical, and biological properties and identifying the chemical category to which each toxic fraction belongs (*6*). The procedure is now being extended to the chronic toxicity range and to ambient waters and sediment pore waters (personal communications, G.T. Ankley, EPA, Duluth, MN, May 1991; and C. Zarba, EPA, Washington, DC, April 1992). Moreover, serial dilution of representative ranges of contaminated media with corresponding reference site media makes possible the prediction of the toxicity threshold for each medium using standardized bioassays. If their short duration is a problem, media bioassays can be extended to span the reproductive cycle of the test organism. If the standard test organisms are less than perfect predictors of ecosystem response, species from functional categories at the lower trophic levels can be collected from the reference site for controlled toxicity testing in microcosm.

Third, the authors' list of deficiencies in the epidemiological approach is impressive. Neither the bioassay nor the administrative criterion approach, singly or combined, can correct all these deficiencies. Therefore, the "braid" is broken. Further, while biomarkers improve our ability to estimate "internal exposure," it is not possible to reconstruct the external exposure history of a receptor population without additional information that is not readily acquired, especially for terrestrial species.

The strength of the administrative criterion approach lies in its administrative expediency. All that is required are the mean, standard deviation, and ranges of concentrations of each toxicant encountered in each medium at the site and a corresponding medium quality criterion. If a duly promulgated medium quality criterion is unavailable, a criterion-equivalent concentration in the limiting medium can be back-calculated using literature-derived or site-specific food chain transfer coefficients, an approved reference dose, and appropriate exposure assumptions. If a reference dose for the species of interest is unavailable, one can be extrapolated for it from related species using application factors to account for potential interspecies differences in sensitivity. Where more than one contaminant is present, the quality criteria for each can be used in a concentration-addition or additivity model to estimate the combined toxic effects of all the contaminants present in each medium.

While, in theory, wildlife epidemiological studies can also be used as a reality check on the predictions of the administrative criterion and bioassay approaches, in practice they are expensive, time-consuming, and very often inconclusive. The authors' experience with the Oak Ridge Reservation's Biological Monitoring and Assessment Program (BMAP) underscores this point. These studies have been going on for more than half a decade at an unspecified cost that must run into the tens of millions of dollars. No responsible Superfund official would tolerate such delays and additional expense from Superfund contractors in producing the required risk assessment documentation preparatory to remedial action.

Further, once the ERA-delayed final cleanup determination is made public, experts representing either the principally responsible parties (PRPs) or local, state, or national citizens or environmental groups could contest the expert opinions of the preparers, delaying cleanup still further. On the other hand, calculating risks and defining remediation objectives based on duly promulgated numerical media quality standards or using administratively approved media bioassays obviates the need for expert opinion. This increases the likelihood that the final cleanup decisions will not be changed, or, if challenged, that they will stand up in court.

Ultimately, since humans consistently undervalue nonhuman life, it is the protection of human health that will continue to predominate in Superfund site decisionmaking. Only where administratively protected species are present will remediation objectives generated by ERAs be likely to dictate site cleanup. Such species are usually at the top of the food chain and small in number. Under such circumstances, the "traditional" or administrative criterion approach is most applicable and the epidemiological approach least so. The time, expense, and legal vulnerability of the authors' approach militate against its use in routine Superfund remedial assessments.

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The authors reply:

Dear Sir: We will reply to each of Mr. Fink's three comments in turn.

First, we did not claim that the approach that we were presenting was completely novel. As Mr. Fink points out, the three types of data used in our approach are also used by the EPA Office of Water in the regulation of aqueous effluents. Our approach differs from theirs in the use of the data. The EPA treats single chemical toxicity data, effluent toxicity data, effluent toxicity data, and biological survey data as independent methods any one of which can be used to derive the terms of an NPDES permit (*1*). When more than one is used, the most conservative result is preferred (*1*). In contrast, we propose a weight of evidence approach.

Second, we did not intend to minimize the utility of media toxicity tests, but rather to indicate that they have limitations like all other data. Fractionation of effluents and testing of those fractions to identify toxic components is clearly feasible, but currently that approach is problematical for chronically toxic concentrations of chemicals in ambient water, sediments, and soils. Certainly, when testing of fractions is applicable it should be used. Our comment about the short duration and limited species complement of media toxicity tests referred to the standard EPA approved tests. We are not aware of any practical or accepted protocols for life cycle tests of fish or microcosm tests with ambient water. In any case, any feasible set of media toxicity tests could not contain all exposed species, life stages, conditions, or response variables. Therefore, they are never as realistic as biosurvey results.

Finally, Mr. Fink seems to argue that no ecological data are perfect, the use of administrative criteria is expedient, biological surveys must be as expensive and time consuming as the Oak Ridge BMAP program, any approach that explicitly incorporates expert judgment is subject to challenge, decisions will be dominated by human health risk assessments in any case, so rather than messing with ecological data we should simply base remedial actions on administrative criteria. We strongly disagree. Anyone who is experienced in ecological toxicology is aware that high-quality biotic communities often occur in areas where administrative criteria are violated, and that degradation may occur where no criteria are violated (*2*). Most toxic chemicals have no criteria, and currently no media other than water have criteria to protect nonhuman biota. If decisions are made only on the basis of criteria, billions of dollars may be wasted or unneeded remedial actions and many ecological effects will go undetected. The cost and duration of the BMAP program should not be considered representative of a biosurvey study for a typical waste site. BMAP serves multiple regulatory and management purposes and, as we indicated, monitors effects of hundreds of waste sites and point sources. More focused biosurvey studies can be relatively expedient and inexpensive (*1*). Further, if Mr. Fink believes that health risks will inevitably dominate remedial decisions, then ecological risk assessments of any sort are a waste of time. We believe that the EPA's recent forceful commitment to giving ecological risks equal weight is sincere (*3*).

Use of more than one line of evidence inevitably means that expert judgment will be used to interpret any apparent conflicts between the types of data. That should not be a reason to reject use of the best available data for performing ecological risk assessments that are scientifically defensible as well as administratively expedient. An epidemiological approach that uses laboratory toxicity data to interpret the causes of ecological effects in the field potentially provides such an approach.

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