Atrazine is suddenly very much in the news. Today's New York Times features a major story about whether the EPA's current standard for acceptable levels of atrazine in drinking water is tight enough to protect human health. Yesterday's Peoria Journal carried a story about a class action lawsuit filed in Illinois state court against Syngenta, the primary manufacturer of atrazine. And NRDC has just issued a report accusing EPA of ignoring the atrazine problem (summary here, full text here).

Atrazine is a herbicide commonly used to keep corn fields, lawns, and golf courses free of broad-leaved weeds. It is reportedly the most widely used herbicide in the United States and, correspondingly, the most commonly detected pesticide in U.S. waters. EPA regulates atrazine under two laws, the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and the Safe Drinking Water Act. FIFRA sets the terms for sale and use of pesticides, and the SDWA sets targets for allowable contaminant levels in drinking water systems.

Atrazine regulation has been contentious for several years. Atrazine was first registered for use in the U.S. in 1958, at a time when FIFRA was concerned almost entirely with whether claims made for the effectiveness of pesticides were true, rather than with their incidental effects on health or the environment. In 1988, Congress amended FIFRA, directing EPA to reregister older pesticides under modern standards, which require that pesticides not cause any unreasonable adverse effects on the environment, further defined as any "unreasonable risk to man or the environment, taking into account the economic, social, and environmental costs and benefits" of their use. 7 U.S.C. 136(bb). Before EPA had reregistered atrazine, Congress in 1996 passed the Food Quality Protection Act, which required new safety findings for pesticide residues in food.

To comply with both of these laws, EPA undertook a human health and ecological risk assessment of atrazine.In 2003, it found that there were human "risks of concern" from drinking water, especially in the midwest, from occupational exposures, and from exposure to treated lawns. EPA concluded that the risks could be mitigated by adding restrictions to the labels and monitoring drinking water exposures. It concluded that atrazine was unlikely to be a human carcinogen, despite criticism from its own Scientific Advisory Panel, which thought the evidence did not justify that conclusion. Later, in response to a lawsuit brought by NRDC, EPA agreed to further study the potential association of atrazine with cancer. With respect to ecological risks, EPA found some risks to aquatic communities, but initially declined to consider potential endocrine disruptor effects on amphibians. A

2001 paper in the Proceedings of the National Academy of Sciences (abstract here, full text here for those with subscription access) had reported that low levels of atrazine interfered with development of the male sexual organs of frogs.

After wrangling with its Science Advisory Panel about what evidence it could consider, EPA wrote:

> The Agency's ecological risk assessment does not suggest that endocrine disruption, or potential effects on endocrine-mediated pathways, be regarded as an regulatory endpoint at this time. Nor does the Agency have evidence to state that there is no reliable evidence that atrazine causes endocrine effects in the environment.

It did commit to more analysis. After that analysis, EPA and the Science Advisory Panel agreed that there was enough evidence to justify a hypothesis that atrazine might have estrogenic effects on amphibians, but not enough to confirm or refute that hypothesis. Accordingly, EPA reaffirmed that the potential for atrazine to act as an endocrine disruptor did not justify any additional regulatory steps.

Finally, after a separate study of the cumulative effects of atrazine and other triazines, EPA found in 2006 that "there is a reasonable certainty that no harm will result to the general U.S. population, infants, children, or other major identifiable subgroups of consumers from aggregate exposure (from food, drinking water, and non-occupational sources) to cumulative residues of atrazine and the other chlorinated triazine pesticides." It therefore finalized the re-registration of atrazine. (EPA's decision documents on atrazine are here.)

The risk assessments supporting atrazine's reregistration have been sharply criticized. Washington Post writer Rick Weiss used the atrazine ecological risk assessment as a primary example of the ability of the Data Quality Act to suppress important regulatory information in a 2004 article.

Since that risk assessment, new concerns have been raised about the human health effects of atrazine in drinking water. Several studies have suggested an association between low levels of atrazine and low birth weight or birth defects. The ecological consequences of atrazine remain contested. A recent review (abstract; subscription required for full text access) inthe journal *Critical Reviews in Toxicology* concludes:

> Based on a weight of evidence analysis of all of the data, the central theory that environmentally relevant concentrations of atrazine affect reproduction and/or reproductive development in fish, amphibians, and reptiles is not supported by the vast majority of observations. . . . For other responses, such as immune function, stress endocrinology, parasitism, or population-level effects, there are no indications of effects or there is such a paucity of good data that definitive conclusions cannot be made.

That review, though, is unlikely to resolve the question, because its authors are supported by Syngenta, a company with a history of using its research funding to suppress data or interpretations unfavorable to its interests.

Two general lessons emerge from the atrazine saga.

First, regulators cannot rely on firms with a clear economic interest in the outcome as the primary source of information about the effects of their chemicals on people or the environment. In principle, scientific data-gathering is an objective process unaffected by bias. In reality, however, there is plenty of room for judgment in science, from the selection of research questions and methodologies to the interpretation of ambiguous data. There is lots of opportunity for unconscious bias, and dependence on a chemical manufacturer for funding could be a powerful source of such bias. Even if it does not affect the investigators (and there are surely factors, such as concern for professional reputation, pushing the other way), studies funded directly by a manufacturer exacerbate public distrust. (Wendy Wagner and David Michaels detailed the problems associated with regulatory reliance on privately produced research at 30 J. Am. L. & Medicine 119 (2004).)

There is no need for studies that give the appearance of bias. It is wholly appropriate that manufacturers should bear the financial costs of testing their chemicals for adverse effects. But they need not fund studies directly. Instead of demanding that manufacturers perform studies, EPA should demand that the manufacturers provide research funds, which EPA (or NIH or NSF, if they are thought to have greater expertise in the subject) could distribute through typical competitive processes.

Second, the benefits of pesticides have not been sufficiently scrutinized. The most striking assertion, to my mind, in the NRDC report, is that”atrazine provides, at

best, only minimal economic benefits to the farmers who use it." NRDC explains:

> The U.S. Department of Agriculture estimates a ban on atrazine would result in crop losses of only 1.19 percent and decrease corn acreage in production by just 2.35 percent. Italy and Germany (both of which banned atrazine nearly 20 years ago) have not seen any drop in corn productivity or total acreage of land in production for corn since their ban on atrazine was put in place, although this was due in part to the use of other hazardous pesticides. However, Integrated Pest Management techniques could help farmers eliminate the use of atrazine and control weeds while reducing their use of other dangerous chemicals.

That sort of analysis should play a much bigger role in EPA's FIFRA registration decisions than it currently does. While some environmental impacts would be "unreasonable" even if chemical use provided substantial economic benefits, any adverse effect should be enough to outweigh a minimal economic benefit. But EPA's FIFRA review process not only does not require a careful accounting of benefits, it does not even require proof of efficacy. See Mary Jane Angelo, Embracing Uncertainty, Complexity, and Change: An Eco-Pragmatic Reinvention of a First Generation Environmental Law, 33 Ecology L. Q. 105, 182 (2006).

The best outcome of the current focus on atrazine would be for EPA to take a hard look not only at its atrazine regulations, but more generally at its approach to pesticide regulation.

If you want to know about atrazine in surface waters in your neighborhood, the NRDC report has some maps, and the USGS has this map site.