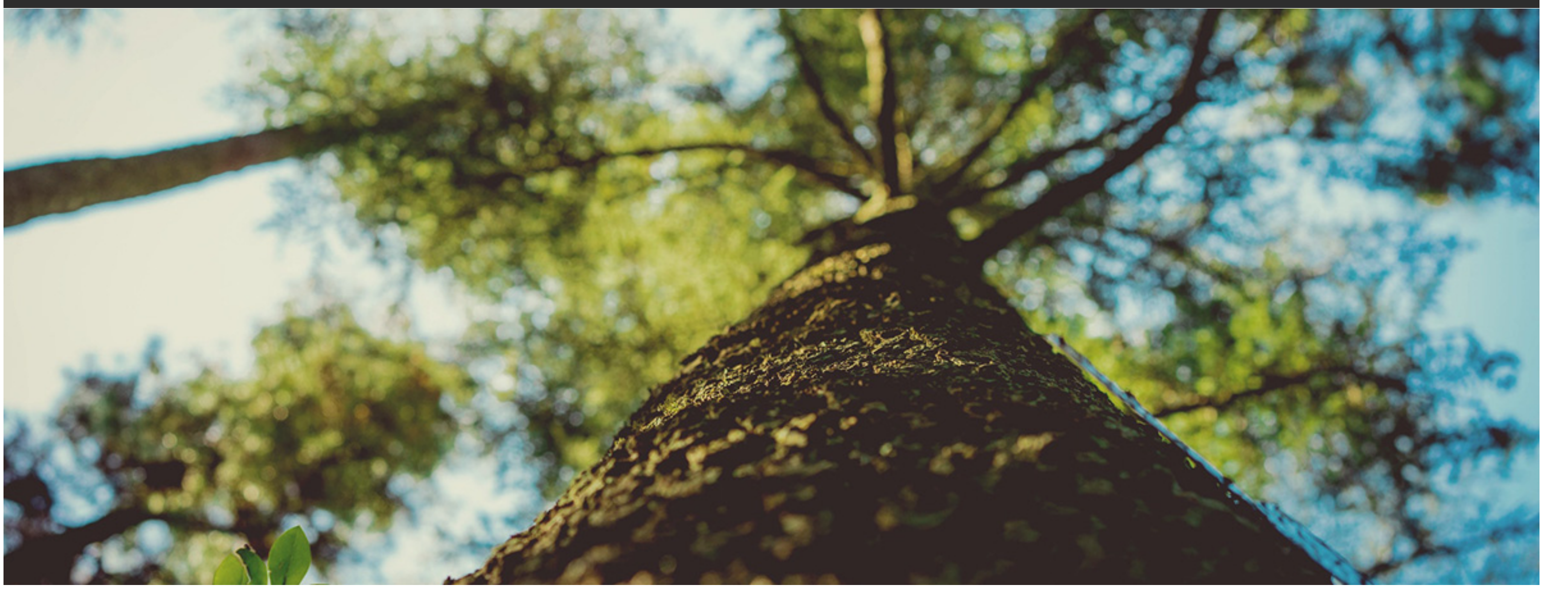
Basing an Environmental Expert Opinion on 'Multiple Lines of Evidence'



Experts in the environmental field often say that they base their opinions on "multiple lines of evidence." Is that good enough?

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For example, the federal regulations governing cost-benefit assessment of Clean Air Act regulations call for evaluation of lines of evidence in scientific literature. see 40 C.F.R. Section 83.1 (definition of systematic review process). An application for approval of an alternative liner system for control of a coal combustion residual disposal unit must evaluate certain enumerated "lines of evidence." Indeed, one might say that the process of "all appropriate inquiry" to establish the innocent purchaser and bona fide prospective purchaser defenses under the Comprehensive Environmental Response, Compensation and Liability Act, see 40 C.F.R. pt. 312, ultimately turns on the evaluation of "multiple lines of evidence." And, of course, lawyers in the field have seen many submissions to regulators and, indeed, expert reports in litigation citing not any particular scientific methodology, but instead "multiple lines of evidence."

Some time ago at a ballgame (the reader may want to pause here to remember with fondness going to ballgames) I made some bantering comment to an environmental scientist (who may, actually have been my host) that when an opposing expert bases an opinion on "multiple lines of evidence" he or she admits weakness in the support for the opinion. Revenge is a dish best served cold, and she (the scientist) contrived to get me to agree these years later to speak on the question to a hostile audience, and I am here recording those thoughts.

Legal research suggests that the intellectual basis of "multiple lines of evidence" for environmental or occupational health propositions is the President's Address delivered by Sir Austin Bradford Hill to the Section of Occupational Medicine of the Royal Society of Medicine. Hill, "The Environment and Disease: Association or Causation," 58(5) Proc. R. Soc. Med. 295 (May 1965).

Hill addressed the policy problem of whether steps should be taken to ameliorate exposure to an environmental agent when evidence existed of an association—a correlation—between exposure and disease, but the evidence did not have the level of rigor one would expect from controlled laboratory experiments. His examples included (in 1965) evidence that smoking is associated with lung cancer, weaker evidence that smoking is associated with heart disease, and stronger evidence that work as a chimney sweep is associated with scrotal cancer. For none of those, at the time, had laboratory evidence been developed of biological mechanisms to explain the association, and therefore to allow a conclusion that smoking or chimney sweeping *caused* disease. The causal connection had not been subjected at that time to sufficiently rigorous scientific hypothesis testing.

The association/causation issue is, for us, an evidentiary one. Correlation does not imply causation, of course. If A and B are correlated, then: A causes B, B causes A, C causes both A and B but A and B are not related, or the observation of the correlation is random and not real. The scientific method would typically allow an expert to opine to a reasonable degree of scientific certainty as to which of those four possibilities was true.

If we are lucky, a judge or juror will have remembered high school science. That recollection probably associates scientific method with hypothesis testing. That is, in the cartoon version, a scientific methodology forms a hypothesis about some issue and subjects that hypothesis to experimental testing. If a powerful test cannot disconfirm the hypothesis, the scientist's confidence in the hypothesis increases. The important part of the methodology is that the experiment must be able to generate data that would cause the scientist to reject the hypothesis. An argument based upon "multiple lines of evidence," rather than hypothesis testing, looks more like the way one supports a historical or literary proposition.

In some circumstances, rigorous hypothesis testing in controlled experiments either cannot be, or has not been, conducted. Nevertheless, someone may have to make a practical decision: How much should an air emission or water discharge be controlled? How much cleanup is required? Which cleanup method would be appropriate?

Hill proposed what we would call nine lines of evidence that support or do not support an inference of causation from an observed association:

- strength of the association (that is, magnitude of the correlation);
- consistency of the association in different places, circumstances, and times;
- specificity of the association (that is, correlation of exposure with a particular outcome and not others, and of that exposure and not others with a particular outcome);
- temporality—that the exposure precede the outcome;
- biological gradient—more exposure leads to more outcome;

- plausibility—there is a reasonable hypothesis as to the mechanism of causation;
- coherence—the hypothesized mechanism is not contrary to what is otherwise known;
- experiment—even if not controlled, an observation that a change in exposure (such as implementation of a protective measure) reduced the outcome; and
- analogy—whether analogous agents are known to cause analogous outcomes.

Under Federal Rule of Evidence 702, as is familiar, an expert can testify to an opinion only if the expert's opinion will be helpful, the expert has based the opinion on sufficient facts, the expert has used reliable principles and methods, and the expert has reliably applied those principles and methods. Following *Daubert v. Merrell Dow Pharmaceuticals,* 509 U.S. 579 (1993), a federal court evaluates the reliability of the expert's methodology by inquiring into whether the methodology: is testable and tested, has been subjected to peer review, has a known or potential error rate at all and within acceptable bounds, has established standards and has widespread acceptance.

Those factors do not apply in a straightforward way to "multiple lines of evidence." However, courts do admit that testimony. For example, a district court erred when it excluded expert opinion that workplace exposure to benzene caused plaintiff's leukemia, because it "erred in reasoning that because no one line of evidence supported a reliable inference of causation, an inference based on the totality of the evidence was unreliable." See *Milward v. Acuity Specialty Products Group,* 639 F.3d 11, 23 (1st Cir. 2011). For that proposition, the court cited a Superfund case, *NutraSweet v. X-L Engineering*, 227 F.3d 776 (7th Cir. 2000), that allowed an opinion to be based in part on aerial photographs.

Pennsylvania courts apply the more restrictive *Frye* standard that requires an expert's methodology to be generally accepted. See, e.g., *Walsh v. BASF*, 234 A.3d 446 (Pa. 2020). In *Walsh*, the Supreme Court explicitly considered the Hill factors, and remanded to allow defendants in a case involving an allegation that pesticide exposure caused leukemia to renew their *Frye* motions.

But, of course, an opinion, even if admitted, must withstand cross-examination. While multiple lines of evidence may allow an expert to render an opinion to a reasonable degree of certainty when any one line would not, each line can be attacked individually. And sometimes, a court may find that multiple lines of evidence are not reliable. So, in a case involving claims of nutritional value of milk additives, the court wrote "randomized control trials … are considered the gold standard. Other lines of evidence … can be used to generate hypotheses, but experts in the field do not consider them to establish cause and effect relationships …" See *In re Horizon Organic Milk Plus DHA Litigation*, No. 12-MD-02324 (S.D. Fla. Apr. 28, 2014).

Finally, one has to guard against what might be called un-science in litigation. One may hold a conclusion in an environmental case in a way that cannot be disconfirmed. For example, parties and regulators in contamination cases may hold views of certain presumptive remedies that cannot be shaken. A hypothesis is not scientific unless it can be disproven. If the expert will discount any line of evidence that tends to undercut the hypothesis—that contaminated sediments should or should not be dredged, that "fracking" is or is not unusually risky, or more conventionally, that a spill from Facility A did or did not cause groundwater contamination under Facility B—then the expert's opinion is not scientific and not evidence.

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