Environmental Complexity: Implications for the Regulated Public (Newsletter)*

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Natural ecosystems are very complex and highly variable over a range of temporal and spatial scales. Unfortunately, this complexity is not taught in schools and general knowledge of how ecosystems function tends to be low. One result is reducing this complexity to a single number representing a threshold between “good” and “bad” (or “desireable” and “unacceptable.”) This simplification to a single number (diversity or biotic integrity index, single-chemical element concentration) does not work. The equally complex economic environment is examined using a range of measurements (e.g., Gallop’s consumer-based measures of the US economy: Economic Confidence Index; Job Creation Index; and Average Consumer Spending) that have monthly and seasonal variations removed. Applying the same idea of multiple measures of a natural environment’s current and predicted future condition would benefit project proponents, regulators, and the public. Two benefits of a more technically sound and legally defensible approach to characterizing natural environments two stand out: eliminating the application of the precautionary principle by decision-makers who do not understand the science and risks of regulated activities, and replacing subjective concepts with quantitative measurements.

The precautionary principle arose from poor understanding of risks and their management. The most common definition of the principle applies to an action perceived as potentially harming the public or the natural environment. If there is no scientific evidence that harm *would not* occur, the action should be forbidden until those who advocate for it can prove no harm. There are too many fallacies with this principle to cover in a newsletter. The most important flaw in that it is impossible to prove a negative. Natural environments are so dynamic and variable that scientists cannot "prove" that a proposed action would have no "harm."

Environmental statutes are filled with subjective terms such as “harm,” “degrade,” and “significant.” Environmental statutes and regulations at all governmental levels are meant to answer a single question: will the proposed project (or continued operations of an existing one) alter some environmental aspect to an unacceptable state? Because certainty about future conditions is not possible, federal courts mandate regulatory agencies take a "hard look" at the likelihood of undesired changes to defined aspects of the natural environment. While "hard look" also is subjective the potential (or reality) of change can be objectively quantified using appropriate statistical models.

While recent spreadsheet versions have added statistical functions beyond descriptive ones (e.g., correlation, regression, confidence limits, and probability distributions) these are all based on hypothesis testing that produces the familiar p (probability) values of results being as, or more, extreme than the calculated value. The assumption in the package is that the data are suitable for these analyses; often they are not. More importantly, these models do not necessarily address the concerns of regulators and others. Other statistical approaches (likelihood and Bayesian) are frequently more appropriate than is the familiar frequentist approach.

Advanced statistical models appropriate for environmental data have been developed in the past couple of decades. They are extremely robust, meet the requirement of taking a hard look at the available data, and can effectively resolve environmental concerns of proposed and existing projects about water quality, fish, and wildlife. Every business requiring an environmental permit to operate should analyze its data using the most appropriate statistical model and have the results easily understood by non-technical decision-makers. Environmental data are as critical to companies as are financial and market data, particularly in the western US with a decade-long drought and concerns about sage-grouse, wolves, and salmonids.

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