

# Introduction

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When a physician gives an annual physical, he or she generally makes the major judgment of the patient's health on the basis of functional attributes: blood pressure, heart rate, and the performance of the kidneys as demonstrated by the quality of the urine. Structural attributes, such as skin and eye condition, structural features demonstrated by X-rays, and other characteristics are also given attention. When environmental health is being determined, structural attributes based on "critter counting" are generally the most important determinants. Functional attributes of natural systems, such as energy transfer, nutrient spiraling, or rate of carbon fixation, are generally not nearly as prominent in regulatory measures to protect indigenous biota. This indicates that, where ecosystem health is concerned, we are more interested in the condition than in performance. We want to be sure that threatened and endangered species remain. The Europeans, with their saprobian system, extrapolate from the presence of certain organisms to the overall ecosystem condition. However, a species may be present, but only in marginal condition or functioning poorly. If enough species are functioning poorly, the ecosystem function will deteriorate as well. Moreover, performance is an integrating function, which is to say that, if any one of a number of components is malfunctioning, the entire system may perform poorly, whereas the presence or absence of species is a less integrated assessment. Of course, if the system is malfunctioning, one must make a detailed examination to determine why, which is precisely what a physician does if some of the characteristics assessed during the annual physical are outside normal boundaries. This means that, from a cost-effectiveness standpoint, if everything is going well and one measures a single integrated function that reflects the well-being of a variety of components, no further testing is necessary. If it is necessary, naturally the cost has increased.

Although this is written as if structure and function were dichotomous choices, it was done for illustration rather than as a recommendation that one approach be substituted for the other. My own feeling is that multiple lines of evidence are needed in a desirable management and regulatory approach when assessing the well-being of a complex system. The point is that, while we have structural and functional components in good balance for annual physicals of human beings, we have not yet achieved what appears to be a desirable balance for assessment of environmental or ecological health. Part of the reason is that ecologists have focused on species presence or absence rather than on ecosystem function, although this has changed in recent years. Initially, the methodology for structural assessment was more readily available than that for functional assessment of ecosystems.

The purpose of this book is to provide some illustrations of various types of functional measurements and how they might be used. This is by no means an exhaustive compilation—which would require a volume an order of magnitude larger—but rather an illustrative selection so that readers of ASTM publications can see what is available and how it might be used. It is quite likely that, with the advent of mesocosm testing for predicting the effects of pesticides on ecosystems in the United States, functional attributes will receive much more attention than they have in the past. These tests are strikingly more expensive than single-species toxicity tests involving lethality, reproductive success, and the like, and, therefore, any integrating function that can increase the information value while simultaneously keeping the cost constant or reducing the cost is well worth considering. This is a newly developing field and is still in the exploratory stage. There is no large body of standard methods presently available. However, some of the methods in this publication may, with modifications, be quite suitable for utilization as stan-

dard methods after a sufficient number of professionals have used them and their weaknesses and strengths have become better known.

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