Box 2.1 The Difficulty of Assessing Ecosystems

It is enormously challenging to measure the overall condition or health of an ecosystem. The ecosystem "indicators" most readily available, and that have shaped our current understanding of ecosystems, are far from complete. Each provides only a partial description of the bigger picture, like the parable of the five blind men giving different descriptions of the same elephant because each can feel only a small part of the whole animal. These indicators include:

- *pressures* on ecosystems, including such factors as population growth, increased resource consumption, pollution, and overharvesting;
- *extent* of ecosystems—their physical size, shape, location, and distribution; and
- *production* or output of various economically important goods by the system, such as crops, timber, or fish.

Each of these indicators is important, but collectively they provide only a narrow view of ecosystem condition and how well ecosystems are being managed. Indicators of pressure, for example, reveal little about the actual health of the system. With proper management, an ecosystem can withstand significant pressures without losing productivity. Indeed, some agroecosystems have withstood the pressure of intensive cultivation for generations, but have sustained productivity with the help of organic fertilizers and crop rotation. And although growing populations may increase pressures on forests or fisheries, examples abound of community-based management systems that maintained the productivity of ecosystems even in the face of significant population growth.

Similarly, changes in ecosystem extent—such as loss of forests and expansion of agriculture—may indicate that the form of land use and the predominant vegetation have changed, but don't reveal how well the remaining forest or agroecosystem is functioning. And information about the production or output of various ecosystem goods and services doesn't provide a complete picture because production information is rarely available for nonmarketed commodities such as water filtration or storm protection; and the nonmarketed commodities are sometimes the most valuable services ecosystems provide.

Most important, none of these traditional indicators provides information about the underlying capacity of ecosystems to continue to supply their life-sustaining goods and services. The history of the world's fisheries illustrates this problem well. Routinely in fisheries around the world, overfished stocks have collapsed after several years or decades of bountiful harvests. The high production in the good years thus revealed nothing about the health of the fishery; it merely foreshadowed the exhaustion of the resource. Similarly, food production statistics don't reveal evidence of the degradation of agroecosystems that might result from excessive soil erosion or nutrient depletion, since some degradation can be offset by increased fertilization and new crop varieties. With time, though, the diminished capacity of the agricultural lands will increase production costs and may ultimately take land out of production.

Indicators of ecosystem capacity are not easy to obtain. Such indicators must probe the underlying biological state of the ecosystem, including physical factors such as soil fertility or water's dissolved oxygen content that lie at the base of the ecosystem's ability to function. For example, data about the size and structure of some marine fish stocks are available. When these basic population data are combined with knowledge of breeding cycles, the availability of basic nutrients, and large-scale ocean trends like El Niño, the result can lead to an estimate of the maximum sustainable yield for the monitored fish stocks—in other words, the maximum amount of fish that can be harvested without risking depletion of the resource. If calculated carefully, this represents a true measure of the ecosystem's capacity to sustainably produce fish.

Unfortunately, the basic biological data needed to judge ecosystem capacity are often available only for limited areas or species. Even when these data are available, the complex interactions between the elements of the ecosystem and how they affect ecosystem capacity are often unclear. Capacity indicators thus represent the frontier of ecosystem assessment and one of its most problematic aspects.