
Preface

The Earth's biosphere—that thin envelope of life permeating the planet's hydrosphere, the lowermost part of its atmosphere, and a small uppermost volume of its lithosphere—is of surprisingly ancient origin: the first simple organisms appeared nearly four billion years ago (the planet itself was formed about 4.6 billion years ago), metazoan life (the first multicellular organisms belonging to the kingdom of animals) is more than half a billion years old, and complex terrestrial ecosystems have been around for more than 300 million years. Many species have exerted enormous influence on the biosphere's character and productivity, none more so than (on the opposite ends of the size spectrum) oceanic cyanobacteria and the large trees of the tropical, temperate, and boreal forests. But no species has been able to transform the Earth in such a multitude of ways and on such a scale as *Homo sapiens*—and most of these transformations can be traced to purposeful harvesting or destruction of the planet's mass of living organisms and reduction, as well as improvement, of their productivity.

These transformations long predate the historical period that began about five millennia ago and was preceded by millennia of gradual domestication of wild plant and animal species and by the evolution of sedentary agriculture. Humans eventually created entirely new landscapes of densely populated areas through intensive agriculture, industrialization, and urbanization. These processes reached an unprecedented intensity and extent beginning in the latter half of the nineteenth century as industrialization was accompanied by improved food supplies, greater personal consumption, expanded trade, and a doubling of the global population in 100 years (from nearly 1.3 billion in 1850 to 2.5 billion in 1950), followed by a 2.4-fold increase (to six billion) by the year 2000. Fossil fuels have energized this latest, industrial and postindustrial stage of human evolution, whose accomplishments would have been impossible without tapping an expanding array of other mineral resources or deploying many remarkable technical innovations.

But the metabolic imperatives of human existence remain unchanged, and harvesting phytomass for food is still the quintessential activity of modern civilization. What has changed is the overall supply and the variety and quality of typical diets: increasing populations and improved standards of living have meant greater harvests of the Earth's primary production, digestible photosynthates suitable for consuming directly as food crops or indirectly (after feed crops and natural vegetation are consumed by domesticated or wild vertebrates) as the milk, eggs, and meat of terrestrial animals or as the highly nutritious tissues of aquatic invertebrates, fishes, and mammals. Harvests of woody phytomass were initially undertaken to feed the hominin fires and make simple weapons. Sedentary cultures had a much greater demand for firewood (they burned crop residues, too), as well as for wood as a principal construction material. Industrialization increased such demands, and acquiring wood for pulp has been the third major motivation for tree harvests since the latter half of the nineteenth century.

The demand for food could not be met just by increasing yields but required the substantial conversion of forests, grasslands, and wetlands to new cropland. This led to a net loss of phytomass stores as well as to losses of overall primary production; in turn, some of the best agricultural lands were lost to expanding cities and industrial and transportation infrastructures. Similar losses of potential productivity have followed as substantial areas of natural ecosystems have been converted to pastures or affected by the grazing of domesticated herbivores, and as secondary tree growth or inferior woodlands replaced original forests.

Food, feed, fiber, and wood are the key phytomass categories that must be harvested to meet basic human needs. Harvests of furs, ornamental and medicinal plants, and companion animals may be important for their impact on particular ecosystems and species, but their overall removal has been (in mass terms) much smaller than the aggregate of many uncertainties that complicate the quantification of phytomass belonging to the four principal categories. The steeply ascending phase of phytomass harvests has yet to reach its peak, but I do not forecast when it may do so. Instead, I will review the entire spectrum of harvests and present the best possible quantifications of past and current global removals and losses as a way to assess the evolution and extent of human claims on the biosphere. Although some of the claims can be appraised with satisfactory accuracy, in many other cases phytomass accounting can do no better than suggest the correct orders of magnitude. But even that is useful, as our actions should be guided by the best available quantifications rather than by strong but unfounded qualitative preferences or wishes.