Preface[1]

Soil biology should be a conscious consideration in forest management. Yet, it is not. Historically, managers of western forests have focused on harvesting methods, regeneration practices, vegetation control, and means of protecting their stands from fire and pests. Management has centered on the stand, with emphasis on efficient wood production and extraction. More recently, attention has turned to broader issues and the management and sustenance of whole ecosystems (Sierra Nevada Ecosystem Project 1996). On both public and private lands, scientists, planners, managers, and the general public are weighing other values along with the sustained production of wood. Increasingly, attention is turning to streamside protection, wildlife habitat, and the development of plant communities and forest structures mimicking late seral stages of forest succession. "Restoration ecology" has come into vogue, and a cottage industry has emerged to certify what is, and is not, "sustainable forestry."

Despite this broadening view of forest ecosystem management, the soil often is overlooked or remains an afterthought for many "ecosystemologists." Even within the field of forest soils research, certain aspects of soil science have drawn more attention than others of similar significance (Powers 1987, Stone 1987). True strides have been made in our understanding of how nutritional and physical properties of forest soils are affected by forest management. But our appreciation of the diversity, function, and importance of forest soil biology seems rooted in generalities, overlooked and misunderstood by well-meaning people who treat the soil ecosystem as a "black box" (Tate 1995).

Plant production is the source of organic carbon that drives ecosystem processes including soil genesis. But the transport and transformation of organic carbon in plant detritus is entirely due to the work of soil organisms—a silent community, which, because it literally is underfoot and out of sight, seems equally out of mind. In fact, plant detritus is the immediate currency for litter and topsoil fauna, which, through chewing and mixing, alter the surface area of fresh materials and to some degree, their chemistry. In turn, faunal feces become substrate for smaller soil invertebrates as well as fungi and bacteria that reduce them further, releasing plant nutrients, creating soil humus, continuing soil development. *Figure 1* illustrates the general pathway of forest detritus in the food web of soil organisms.

The significance of soil fauna to soil properties important to management has been previously described (Hole 1981). Ecological functions of soil fauna and other biota include mounding, mixing, void creation and filling, formation and destruction of natural soil aggregates, and the production of special products that range from soil-binding polysaccharides to edible mushrooms. Such activities affect water and air movement, nutrient cycling and availability, and soil aggregation and stability. Eight biologically mediated processes by which this occurs (Tate 1987) are:

- Catabolism of colloidal soil organic matter
- Modification of soil pH

[1] An abbreviated version of this paper was presented at the California Forest Soils Council Conference on Forest Soils Biology and Forest Management, February 23-24, 1996, Sacramento, California.

- Synthesis of chelators
- Alteration of soil redox potential
- Oxidation or reduction of soil cations and anions
- Synthesis of polysaccharides
- Physical shredding of organic debris
- Production of cell or mycelial biomass.

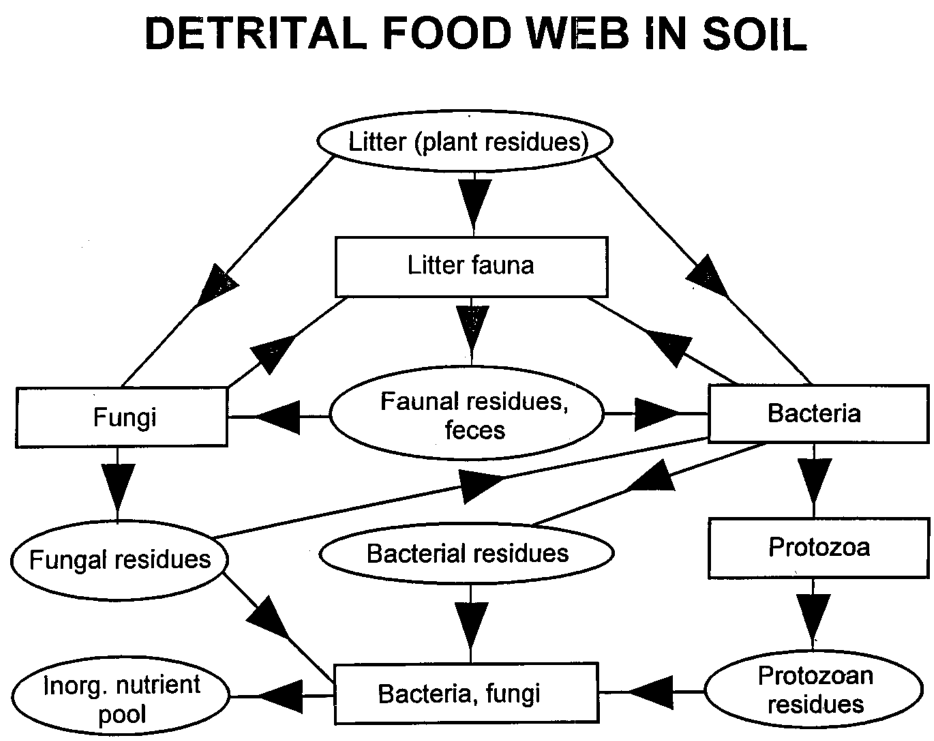

Figure 1—Simplified flow of organic matter in the detrital food web of forests (Richards 1974).

Decomposition of plant residues illustrates the relevance of soil biota in an important process. Sterilization/inoculation techniques and mesh-size screening treatments have demonstrated clearly the effectiveness of organisms of differing size on litter breakdown. For example, Vossbrinck and others (1979) have shown that excluding soil mesofauna (organisms between 0.2 mm and 1 cm in size)--thereby creating a purely fungal and bacterial system—reduces the decomposition of grassland litter by 50 percent (*fig. 2*). Such work also shows that decomposition still proceeds in the absence of meso- and macrofauna, but it proceeds much more slowly. The consequence is residue buildup, surface thermal insulation, and lessened nutrient availability.

One test of true understanding by a scientific discipline is the ability to answer the question "What does it mean?" True understanding extends beyond such questions as "What exists?" (simple taxonomic survey), and "How does it function?"

(observations of behavior under controlled conditions). Important as these questions are, we must also address the question "What is its significance to human endeavor?" If human endeavor—forest management, in this case—is associated with a lessened abundance of a soil organism, *what is the significance of lower abundance*?

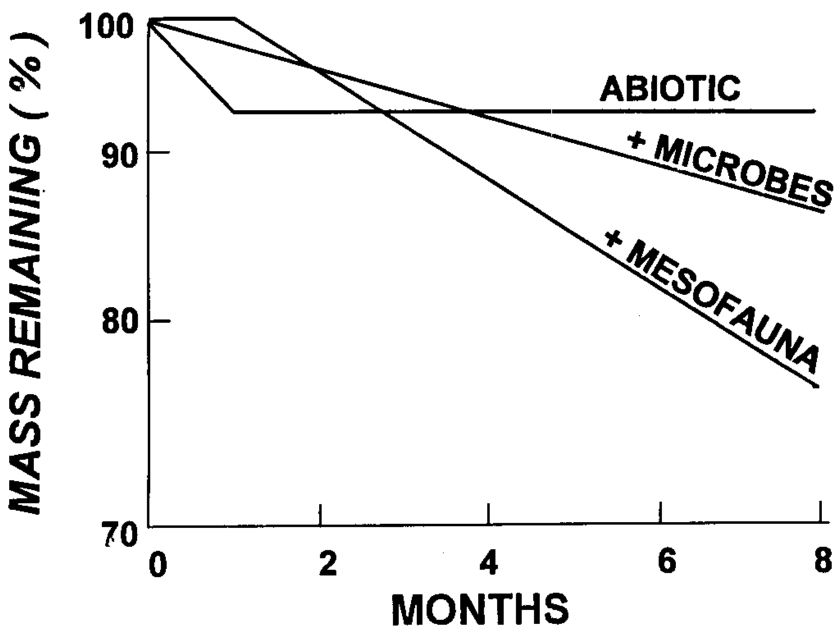

Figure 2—Eight-month trend in decomposition (mass loss) of grass residues by abiotic and biotic agents of decomposition (Vossbrinck and others 1979). Initial mass loss due to abiotic factors is the physical leaching of water soluble compounds.

Often we assume that if an organism behaves in a way that seems beneficial to things that humans value, then reduced abundance of that organism means a loss of that which is valued. Pankhurst (1997) cites evidence that beyond a certain minimum diversity of soil organisms, most species probably have redundant ecosystem functions. But Pankhurst also adds that redundancy may impart greater resistance to a loss of function caused by disturbance. Therefore, a profound question is "What is the minimum diversity needed to assure that important processes will continue to function in the face of forest management disturbances?" Does a measurable decline in the number of soil organisms mean a significant loss of function? What is the difference between statistical significance, biological significance, and practical significance? If changes triggered by forest management do occur, how long do they last? Do we underestimate (or overestimate) the resiliency of soil ecosystems?

These are the sorts of questions addressed in the pages that follow. Sometimes, data are available to support a conclusion. Other times, deductive reasoning can provide valuable insight. For other questions, only relevant factors can be discussed in the absence of quantitative data. As you read these proceedings, we ask that you raise these questions, as well:

- What are the roles of soil organisms in the function of managed forest ecosystems?
- Is there a perfect soil organism or suite of organisms?
- How stable are biotic soil populations or communities over time and how resilient are they to management disturbances?
- What is myth, what is fact, and what is speculation?

We organized this symposium not simply to summarize what already is known in the broad field of soil biology. Other symposia and volumes (Hatfield and Stewart 1994, Pankhurst and others 1997, Ritz and others 1994) have done this. Rather, we invited key research specialists to address questions of soil biology that may have great consequences for forest management.

Robert F. Powers
Donald L. Hauxwell
Gary M. Nakamura
Technical Editors[2]

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[2] Science Team Leader, Pacific Southwest Research Station, USDA Forest Service, Redding, CA 96001; Professor, Department of Natural Resources Planning and Interpretation, Humboldt State University, Arcata, CA 95521; and Forestry Specialist, Cooperative Extension, University of California, Redding, CA 96002.

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