Forest restoration or reforestation efforts often focus on a narrow set of relatively short-term objectives that are most easily assessed based on the return of forest structure. In the central Appalachian coalfields of the United States, for example, where surface mining has drastically disturbed ~600,000 ha of mixed hardwood forests since the 1800’s, current reforestation efforts focus on the rapid restoration of metrics like ground cover, stem density, or species diversity. As a result, decades of research in these systems have focused on the short-term goals of improved seedling survival and establishment. The Appalachian Regional Reforestation Initiative’s Forestry Reclamation Approach is one such technique that is currently promoted by the U.S. Office of Surface Mining Reclamation and Enforcement and many other regulatory agencies as an increasingly feasible and appealing option for reclaiming post-mining landscapes throughout the Appalachian region. Despite the success of such reforestation strategies, and their broad adoption and promotion, very little is actually known about the restoration of ecosystem function associated with these reforestation efforts. This study was initiated to characterize the linkages between the rates of development of forest structure and key functions associated with forest ecosystems. A chronosequence of four reclaimed and reforested stands (ages 5, 11, 21, and 30 years) and an unmined reference stand, representing the pre-mining forest condition, were identified in southwestern Virginia. Within each age cohort, three replicate stands were characterized for structural attributes including forest biomass, basal area, stem density, species composition, ecosystem organic carbon and nitrogen pools, and microbial biomass. Throughout the 2013 growing season, forest ecosystem functions such as soil greenhouse gas [i.e., carbon dioxide (CO2), nitrous oxide (N2O) and methane (CH4)] fluxes, nutrient supply/availability, and microbial activity were monitored. Results indicate that some ecosystem structural attributes (e.g., microbial biomass) rapidly return to the pre-mining condition, and that certain associated ecosystem functions (e.g., soil CO2 efflux and nitrogen cycling) correlate strongly with the return of forest structure. However, other ecosystem functions (e.g., soil CH4 consumption) were completely decoupled from forest structural development over the 30-year reclamation period. This research shows that while the restoration of some ecosystem functions can be tied to structural development, the return of forest structure does not necessarily imply the complete restoration of ecological function along the same time frame. Thus, restoration strategies that facilitate plant processes may be quite different than those required to restore the microbially mediated processes which are equally important to the restoration of functioning forest ecosystems.