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WHY FORESTS PROVIDE THE BEST PROTECTION FOR WATER RESOURCES

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In *"Man and Nature,"* published in 1864[2] and widely regarded as the wellspring of the Conservation Movement, George Perkins Marsh (photo on following page) wrote ...*"With the disappearance of the forest all is changed."* Then and now, after a century of scientific research, this simple declarative statement confirms our intuitive sense that forests provide the best protection of water supplies and aquatic ecosystems. In contrast with developed areas, forests are remarkably efficient, low maintenance, solar-powered living filters.

Comparing the hydrologic characteristics of forests and developed areas highlights the sometimes subtle differences in vegetation, soil properties, and pathways of water flow that lead to substantial differences in streamflow and water quality. In forests, rain tumbles through the mature tree canopy, understory trees and shrubs, and herbaceous plants such as ferns before reaching the litter layer. Renewed by annual additions of leaves, twigs, and branches, the litter layer is: a natural mulch that limits evaporation, a shock absorber that protects soil pores, an insulator that inhibits soil freezing, and a slow-release source of nutrients to foster more plant growth and site protection. The underlying organic, mixed, and mineral layers (horizons) in forest soils can store and transmit large quantities of water. This water storage capacity and permeability — exceeded only by some hurricanes and rain-on-snow events — is developed over centuries by microbes, insects, earthworms, burrowing animals, and the extensive, deep, and perennial root systems of trees and shrubs. As a result of these ecological characteristics, overland flow and soil erosion are rarely, if ever, observed in forests.

Roofs, driveways, parking lots, and roads (impervious surfaces) in developed areas convert rain or snowmelt immediately and directly to stormwater. Ornamental trees, shrubs, and gardens cast some shade, use water, recycle nutrients, and intercept rain and snow in imitation of forests. Lawns (a monoculture of shallow-rooted grasses) also use water and nutrients but typically require irrigation, fertilizers, lime, and pesticides to maintain the color, density, and uniformity that most people desire. Mulching mowers leave grass clippings to form a thin thatch layer that is a laudable yet poor functional substitute for the litter layer in forests. Last but not

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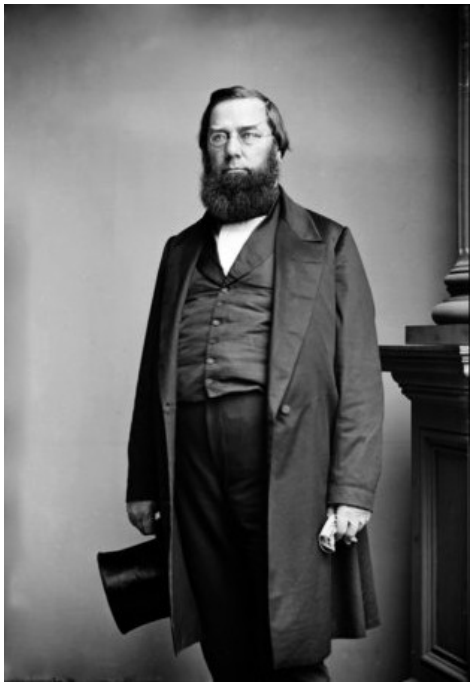
[2] Marsh, G.P. 1864. *Man and Nature* (reprinted 1965, Introduction by David Lowenthal), The Belknap Press of Harvard University Press, Cambridge, Massachusetts, 472 pp.

least, the excavation and grading associated with most construction projects decreases the ability of the soil to store and transmit water. Topsoil (a jumbled mixture of the original forest soil horizons) is bulldozed into piles before the subsoil is subjected to "cut and fill" earthwork. The topsoil is spread back over the site and seeded to grass at the end of the construction phase. The weight and vibration of the heavy machinery needed for this work causes soil compaction that often inhibits drainage and root growth. Water-logged soils in developed areas are subject to freezing that, in effect, temporarily converts them into impervious surfaces. With the disappearance of the forest much is changed and, as a result, overland flow, soil erosion and nonpoint source water pollution become commonplace events.

In sum, when forests are converted to residential, commercial, or industrial land uses high flows increase, low flows decrease (…or go to zero), and the response time to rain or snowmelt may decrease substantially. These changes in streamflow and water quality occur because water that once percolated *through* the leaf litter and forest soils now flows *over* compacted soils and impervious surfaces. Overland flow (stormwater) lifts and carries soil particles, nutrients, and other pollutants (e.g., pet waste, motor oil, metals, etc.) downstream – to public water supply intakes, recreation areas, and estuaries. Subsurface flow that once took days or weeks (even months) is replaced by overland flow that occurs in minutes or hours. Obviously, this reduces the contact time with plants, soil microbes, and organic matter and the opportunity for what remains of the forest filter to work on our behalf.

The conversion of forest land to developed areas replaces a stormwater and pollutant *sink* with a stormwater and pollutant *source.* This is the two-edged sword of suburban sprawl and forest fragmentation and the reason why a comprehensive approach to forest conservation and the revitalization of urban areas is at least as important today as it was a century ago.



Matthew Brady's portrait of George Perkins Marsh, Library of Congress