Leaf Litter Breakdown as a Functional Assessment Tool for Appalachian Coal Mine Stream Restorations

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ABSTRACT

Stream restoration is a standard means of compensatory mitigation, a requirement of the Clean Water Act [section 404], intended to produce ecological benefits to offset those lost due to mining impacts. Although assessment of stream restorations has historically focused on structural measures of stream condition such as physicochemical and biotic metrics, recent guidance from USEPA requires direct measurement of both structure *and* function to assess the efficacy of stream restoration efforts. Functional metrics are derived from serial measurements representing dynamic processes occurring through time rather than at discreet points, and are expressed as rates. Leaf litter breakdown provides a relative index of an important energetic function over fairly long intervals (typically ≤1 yr), and does not require exceedingly expensive equipment or technical expertise. To address the needs of regulators, industry, and stream restoration professionals, we are measuring breakdown rates of *Quercus alba* leaves for eight first and second order mining-impacted stream restorations in the coalfield region of southwestern Virginia, evaluating those rates through comparisons to four minimally impacted reference streams, and determining relationships of physicochemical factors with those rates. Coarse-mesh and fine-mesh bags were loaded with 6.5 g (±0.01 g) of *Q. alba* leaves, and 288 of each type were deployed in study streams in December 2010. Bags were retrieved in triplicate monthly through April 2011, and bi-monthly thereafter through October 2011. After washing, mean percent ash-free dry mass remaining was determined, and an exponential decay model was used to determine breakdown rates (day^{-1} and $degree\text{-}day^{-1}$). Mean coarse-mesh breakdown in forested reference streams (0.023 ±0.003 d^{-1}) was nearly twice as fast as that measured in mined streams (0.012 ± 0.005 d^{-1}). Similarly, mean fine-mesh breakdown in mined streams (0.007 ±0.003 d^{-1}) was approximately half the rate measured in forested reference streams (0.013 ±0.003 d^{-1}). Median breakdown rates were significantly different between stream type for both coarse-mesh [$z = 2.63$; $p = 0.0085$] and fine-mesh [$z = 2.12$; $p = 0.0338$]. Comparison of breakdown rates from fine-mesh, designed to exclude benthic macroinvertebrates, and coarse-mesh bags will provide insight into the influence of the benthic macroinvertebrate assemblage on leaf litter breakdown relative to that of microbial and physicochemical factors alone. Additionally, we anticipate that relating leaf litter breakdown with structural factors will help guide future stream reconstruction efforts and aid development of functional assessment protocols. This study is being augmented with an additional season of observations with final retrieval projected for September 2012.

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