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Short communication

A multiple watershed field test of hydrogeomorphic functional assessment of headwater streams—Variability in field measurements between independent teams

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ABSTRACT

Ephemeral and intermittent headwater streams are under increasing pressure from disturbance and development. Rapid, repeatable assessment techniques are needed in order to gauge the condition of these stream systems. Several attributes of these headwater streams constrain the use of the most widely used macroinvertebrate or water quality stream assessment techniques. The hydrogeomorphic (HGM) functional assessment is a reference-based alternative technique. To evaluate this alternative, repeated assessments were conducted in eight high-gradient headwaters in West Virginia by four independent teams. Across-site and measurement variance among teams was assessed using a coefficient of variation (CV, expressed as percent). A variability of >50% CV, which suggests less repeatable results, occurred in only 13.8% of measurements, primarily associated with 2 of the 9 variables examined (snag density and substrate size). Between site measurement variance was the greatest at more highly disturbed sample locations, particularly with regard to the large woody debris, tree species richness, and channel bank erosion variables. Variables with the lowest CV were tree diameter, detrital cover, canopy cover, and channel embeddedness. Based on these results, measurements included when applying HGM approach to these streams should focus on direct measurements or directed estimates that yield a large response range across a spectrum of sites while maintaining consistent repeatability among different teams, with special attention paid to their use in highly disturbed sites.

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1. Introduction

Ephemeral and intermittent headwater streams are a major component of the riverine landscape, frequently accounting for over half of total stream length in a catchment (Leopold et al., 1964). These streams only contain surface water during and immediately after precipitation events or during the rainy season. Headwater reaches have received limited legal protection despite extensive alteration due to logging, farming, mining, and development (Roy et al., 2009). However their abundance across the landscape and combined with the perception that 'dry' stream reaches provide little environmental benefit, has allowed their assessment and management to be overlooked. Recent work has confirmed that these streams provide multiple ecological functions and environmental benefits including transport of organic matter, sediment retention, compound transformation, temperature regulation, habitat (aquatic and riparian), and hydrologic regulation (Doppelt et al., 1993; Meyer and Wallace, 2001; Meyer et al., 2007; Wipfli et al., 2007).

Consequently, improved assessment techniques for headwater streams are needed because most traditional stream methods (i.e. benthic macroinvertebrate and water chemistry sampling) are often constrained to the narrow windows of time when water is present in the channel, making them impractical for year-round use. The hydrogeomorphic (HGM) approach is an alternative that focuses on measurements that can be taken regardless of the presence of water or time of year. HGM techniques typically include geomorphic, vegetation, and structural measurements that do not depend on the presence of water in the stream channel. HGM assessments have been applied to numerous wetland and stream types and form the basis for the stream classification and assessment methods presented here (Brinson, 1993, 1995; Wakeley and Smith, 2001; Rowe et al., 2009; Noble et al., 2010). The HGM methodology assesses a site in less than one day during any season of the year (wet or dry stream conditions). The outcomes of an assessment allow natural resource managers to make

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Table 1
Site ID, name, location, highest vegetative stratum, and condition.

Site ID	Name	County	Highest vegetative stratum	Condition—current and historical land usages
1	Beech Fork	Wayne	Tree	Historic agriculture/timber
2	Lingo	Wayne	Tree	Historic agriculture/timber
3	Energy	Wayne	Shrub	Recent timber/Mining
4	Logan	Logan	Tree	Historic agriculture/timber
5	Three-mile	Boone	Shrub	Mining
6	Kanawha	Kanawha	Tree	Suburban
7	Twenty-mile	Nicholas	Tree	Historic agriculture/timber
8	Stonewall	Lewis	Tree	Historic agriculture/timber

and document informed decisions concerning potential impacts of development projects and restoration efforts and have been approved for use by multiple Federal agencies (Federal Register, 1997).

In order to support application of the HGM methodology to headwater streams, inter-team variation is analyzed in the mountains of West Virginia. Over a 5-day period, pairs of evaluators independently visited the same eight headwater streams. Each teams collected measurements for the same eight variables (Noble et al., 2010). Results are compared across evaluation teams and sample sites.

2. Methods

2.1. Team composition

Four independent evaluation teams comprised two individuals each visited all eight sites between October 22 and 28, 2009. Although team members had varied professional and academic backgrounds (e.g., biology, environmental science, natural resource management), all had a minimum of a bachelor's degree, at least 2 years post-graduation experience in an environmental field, and none had used the HGM protocol before. Before visiting the field sites, the teams were allowed to review the HGM protocol and data sheets, and were able to ask questions during a half day workshop that included a field demonstration of the protocols. Following the workshop teams worked independently on the evaluations (i.e. only one team was present at a time and no on-site supervision or coaching occurred either during, or after, data collection).

2.2. Site selection

A study site was defined as the area within an 8 m buffer surrounding 90 linear meters of stream (720 m^2). The 8 headwater streams used in the evaluation were located in the western portion of West Virginia and were selected to have comparable location and site accessibility, >4% slope (high-gradient), a catchment size of <20 ha, and a headwater position (Fig. 1 and Table 1). Evaluation

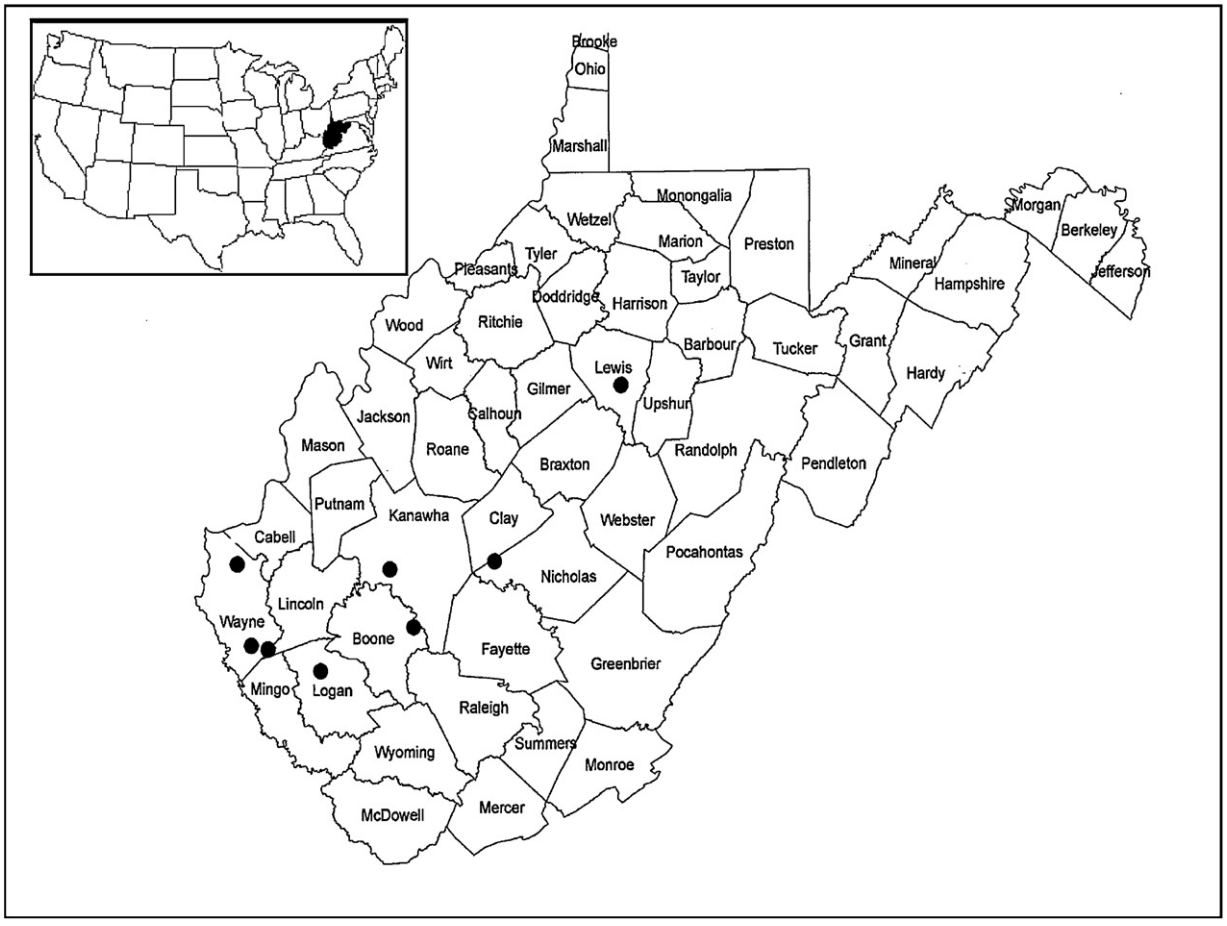

Fig. 1. Locations of the eight field sites by county in West Virginia, USA.