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A candidate vegetation index of biological integrity based on species dominance and habitat fidelity

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ABSTRACT

Indices of biological integrity of wetlands based on vascular plants (VIBIs) have been developed in many areas of the USA and are used in some states to make critical management decisions. An underlying concept of all VIBIs is that they respond negatively to disturbance. The Ohio VIBI (OVIBI) is calculated from 10 metrics, which are different for each wetland vegetation class. We present a candidate vegetation index of biotic integrity based on floristic quality (VIBI-FQ) that requires only two metrics to calculate an overall score regardless of vegetation class. These metrics focus equally on the critical ecosystem elements of diversity and dominance as related to a species' degree of fidelity to habitat requirements. The indices were highly correlated but varied among vegetation classes. Both indices responded negatively with a published index of wetland disturbance in 261 Ohio wetlands. Unlike VIBI-FQ, however, errors in classifying wetland vegetation may lead to errors in calculating OVIBI scores. This is especially critical when assessing the ecological condition of rapidly developing ecosystems typically associated with wetland restoration and creation projects. Compared to OVIBI, the VIBI-FQ requires less field work, is much simpler to calculate and interpret, and can potentially be applied to all habitat types. This candidate index, which has been "standardized" across habitats, would make it easier to prioritize funding because it would score the "best" and "worst" of all habitats appropriately and allow for objective comparison across different vegetation classes.

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1. Introduction

Indices of biological integrity of the vascular plants of wetlands (VIBIs) have been developed in many areas of the USA (Mack and Kentula, 2010). Although they are used in assessing vegetation quality in vastly different floras and communities, an underlying working hypothesis for all VIBIs is that they respond negatively to disturbance (Mack, 2004a; Mack and Kentula, 2010). In some states, VIBIs are used to make critical management decisions, such as determining whether or not development can occur in wetlands and in the surrounding upland habitat. The VIBI developed for the state of Ohio (OVIBI), for example, is an integral part of the state's regulatory program (Mack, 2004a, 2007a; USEPA, 2006). The OVIBI has been calibrated to a wide variety of vegetation community types, hydrogeomorphic classes, and ecoregions across the state (Mack, 2007a,b,b). The OVIBI is used to determine the appropriate antidegradation category for an individual wetland when the score for Ohio Rapid Assessment Method (ORAM), the primary wetland characterization tool in the state, falls in the "gray zone" between two antidegradation categories (Mack, 2001). The OVIBI is also the primary tool used in Ohio for monitoring mitigation wetlands to determine if they are achieving the required level of ecological performance (Mack, 2004a, 2007a). Further, some of the metrics used to calculate OVIBI scores are directly related to standard performance goals prescribed for all wetland compensatory mitigation projects (Mack, 2004a, 2007a,b).

One of the metrics used to calculate OVIBI is the Floristic Quality Assessment Index (Lopez and Fennessy, 2002; Andreas et al., 2004). A key component of the FQAI is the "coefficient of conservatism," which describes a species' degree of fidelity to habitat requirements relative to other species in the flora. A shortcoming of FQAI as a "stand alone" index of vegetation quality is that it does not incorporate abundance or dominance of plant species. Although the OVIBI has been shown to be a useful index (e.g., Stapanian et al., 2013a,b,b) it has several properties that suggest improvement is warranted, especially when evaluating wetland restoration and creation projects. The OVIBI is calculated

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from 10 metrics which are different for emergent, forest, and shrub wetlands. Early stages of plant community development are extremely dynamic, as a site can transform from emergent to shrub to forest in a short period of time.

Correctly classifying the wetland's true plant community “end point” is difficult to do during these early stages of plant succession. Additionally, most sites evaluated historically by the Ohio Environmental Protection Agency’s (Ohio EPA’s) Wetland Ecology Group are natural wetlands that have been present on the landscape for several decades or longer. While the various metrics used in the OVIBI are strongly correlated to a human disturbance gradient (Mack, 2007a), it is unclear how individual metrics respond during the early stages of plant community development. Trying to interpret OVIBI scores generated for mitigation sites is problematic for this reason. Lastly, because the OVIBI is separately calibrated to a wide variety of vegetation community types, hydrogeomorphic classes, and ecoregions, comparing scores across various wetland types across the state is questionable. From a management perspective, this aspect of OVIBI makes it inadequate to objectively compare the overall ecological condition of sites from different communities targeted for preservation or enhancement. A statistical transformation of OVIBI (e.g., “normalizing” or adjusting for a single reference condition) would introduce bias and additional error. An index that can be directly comparable among sites with different vegetation types will facilitate wise allocation of resources for monitoring, protection, and permitting.

Ideally, an index of vegetation quality should respond negatively to disturbance, reflect patterns among wetland vegetation community types (hereafter vegetation classes), and be robust enough to compare sites among different vegetation classes. For example, in Ohio true shrub wetlands are characterized by woody, obligate wetland species (i.e., species that nearly always occur in wetlands (Reed, 1988, 1997; Andreas et al., 2004) with comparatively high degrees of fidelity to habitat requirements (e.g., buttonbush

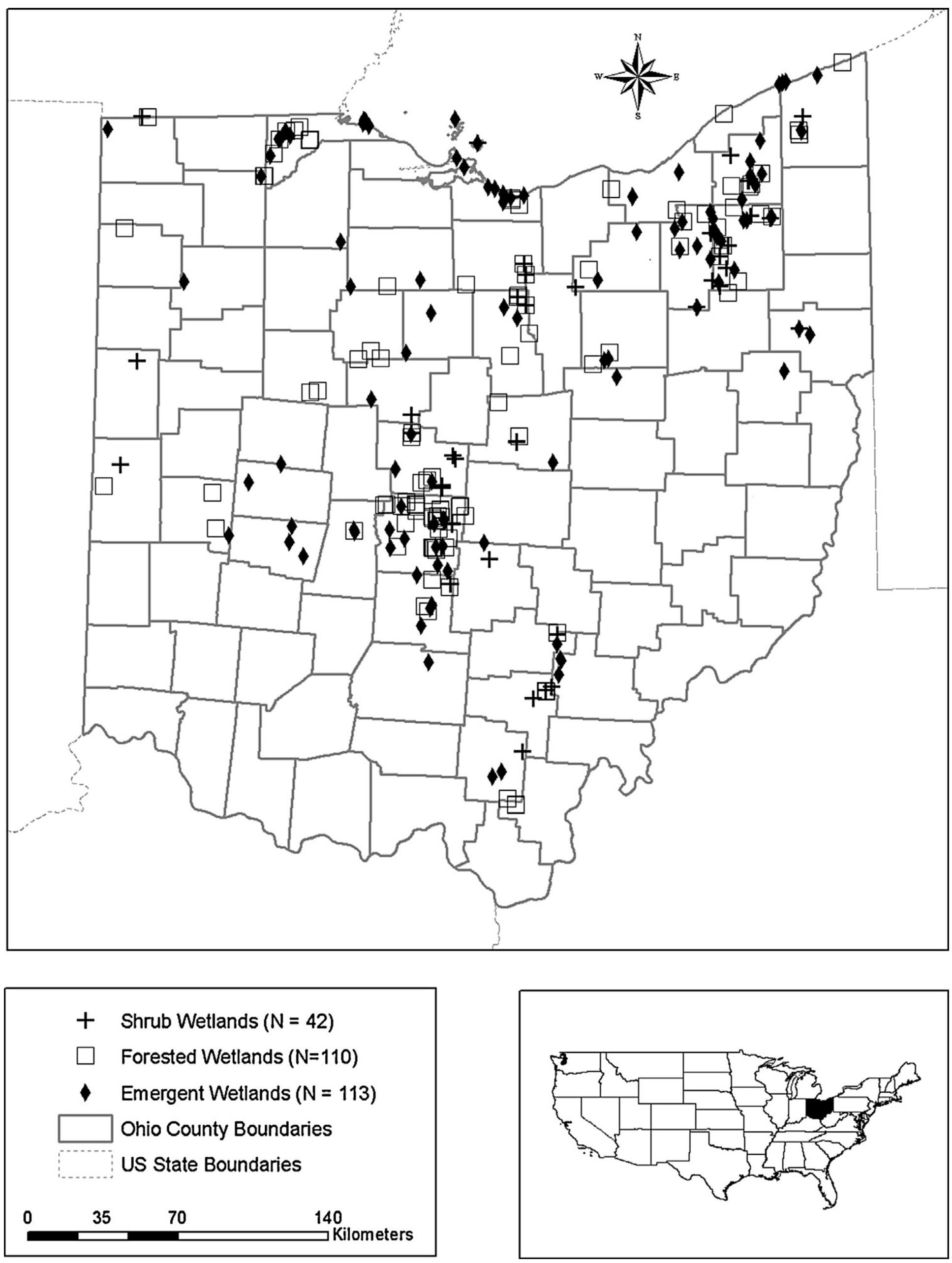

Fig. 1. Locations of wetlands assessed in Ohio, USA during 1999–2011.