Ecological Indicators 83 (2017) 227–231

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

Short communication

Floristic quality as an indicator of human disturbance in forested wetlands of northern New England

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ARTICLE INFO

Keywords:
Floristic quality assessment
Ecological integrity assessment
Forested wetland
Plant community condition
Ecological integrity
Human disturbance

ABSTRACT

Across the country, degradation of freshwater wetlands has prompted a need for science-based methods for assessing and monitoring wetland condition. Floristic Quality Assessment (FQA) is an assessment that measures the health of an ecosystem. FQA is based on resilience values called Coefficients of Conservatism (C-values), preassigned to each plant species. The method has proven to signal human disturbance in most wetland types, but is understudied in forested wetlands. We compared FQA scores and Ecological Integrity Assessment (EIA) scores (Level 2) of 11 red maple – *Sphagnum* basin swamps (RMSBS) of New Hampshire and 12 red maple swamps (RMS) of southern Maine to test the hypothesis that FQA signals human disturbance in forested wetlands. EIA did not distinguish RMSMS from RMS, however Mean C, Cover Weighted Mean C (wC), and FQI did. In RMSBS, wC showed the strongest positive correlation with EIA scores. In RMS, Mean C showed the strongest positive correlation with EIA scores. For all sites combined, wC and Mean C were significantly correlated with EIA scores. Meaningful relationships were not observed between FQI or wFQI and EIA scores. The results indicate that Mean C and wC offer a reliable metrics for the evaluation of forested wetlands in northern New England.

1. Introduction

Compliance with federal environmental laws such as the National Environmental Policy Act and the Clean Water Act require multi-metric methods for assessing and monitoring environmental quality. Science-based indicators are paramount to consistency and defensibility of any evaluation tool. Indicators should be applicable to any type of natural community, cost effective, and easy to apply. Floristic Quality Assessment (FQA), a plant based assessment tool that measures the health of an ecosystem, is based on resilience values called Coefficients of Conservatism (C-values), pre-assigned to each plant species. This tool has gained popularity over the last thirty years, however, its efficacy as a human disturbance indicator in forested wetlands had remained unclear. For example, some have suggested that FQA is potentially insensitive in forests because of the slow response of the canopy and shrub layers to environmental change (Nichols et al., 2006; U.S. Environmental Protection Agency, 2002). Additionally, multiple FQA indices have been developed over the years and a consensus on which is the most appropriate index has not been reached (Miller and Wardrop, 2006; Nichols et al., 2006). We compared four FQA indices to Ecological Integrity Assessment scores in thirty-seven forested wetlands of New Hampshire and Maine to investigate these uncertainties.

FQA's application to the full suite of natural community types is questionable, especially for forested wetlands, as indicated by Miller and Wardrop (2006). In Midwestern wetlands, where the majority of FQA application has occurred and for which the FQA was designed, shrub and canopy layers are not present (Mitsch and Gosselink, 2000). Some have suggested that FQA is potentially insensitive in forests because of the slow response of the canopy and shrub layers to environmental change (DeBerry, 2006; Nichols et al., 2006; U.S. Environmental Protection Agency, 2002). This could be due to ecological resilience and ecological inertia (Von Holle et al., 2003). Yet, others have suggested different FQA indices could be useful in forested areas (Miller and Wardrop, 2006; Nichols et al., 2006). To identify consistent and

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http://dx.doi.org/10.1016/j.ecolind.2017.08.010
Received 10 February 2017; Received in revised form 11 July 2017; Accepted 3 August 2017
Available online 14 August 2017
1470-160X/

defensible metrics for the assessment and monitoring strategies, further research in to the application of FQA in forested wetlands is necessary.

Existing methods that are inexpensive and can be completed within a single day, include the Method for Inventorying and Evaluating Wetlands in New Hampshire (Stone et al., 2013) for evaluating function, and the Level 2 Ecological Integrity Assessment (EIA), which evaluates condition (Faber-Langendeon and Nichols, 2014). However, such methods are largely based on qualitative judgment, and lack purely quantitative aspects that could produce more consistent results. For example, The EPA 2011 National Wetland Condition Assessment (NWCA) developed a Level 3 national Vegetation Multi-Metric Index (VMMI) that included the application of FQA to as a quantitative tool (USEPA, 2011). The Level 2 Ecological Integrity Assessment has been validated by an intensive and quantitative form of the method, the Level 3 Ecological Integrity Assessment in riparian shrublands of Colorado (Lemly and Rocchio, 2009). Therefore, the EIA serves as the most reliable Level 2 proxy to which FQA can be compared.

The goal of this study was to determine if FQA is a reliable method for assessing the natural quality of forested wetlands. Therefore, we compared FQA metrics to EIA metrics to determine their reliability as indicators of human disturbance in forested wetlands of northern New England. The analysis included 11 Red Maple −*Sphagnum* Basin Swamps in NH and 23 Red Maple Swamps in Maine.

2. Materials and methods

2.1. Study area

The study was conducted in the north-eastern United States within the states of New Hampshire and Maine (Fig. 1). The average temperature is approximately 4.4 °C and receives approximately 90 cm of precipitation on an annual basis (Keim and Rock, 2001). A historic trend in rapid afforestation lasted from the 1800s until the 1970s when it then reversed to a decline in forested cover (Foster and Aber, 2004; Olofsson et al., 2016). Today, the forested landscape is a mosaic of various stages of succession and represents a spectrum of altered hydrology and terrain, and increased anthropogenic stresses that are expected to continue as population increases.

2.2. Natural communities

Functions and response to degradation varies by community type and therefore is most effectively assessed on at the level of natural community or system. Over the last twenty-five years, the New Hampshire Natural Heritage Bureau (NHB) has developed a classification of natural systems and communities at the state level based on plant species composition, vegetation structure, and specific combinations of physical attributes (Sperduto, 2011; Sperduto and Nichols, 2011). Similarly, the Maine Natural Areas Program (MNAP) has developed natural community classifications for the state of Maine (Gawler and Cutko, 2010). The classification systems were applied according to the state in which each site was located. Two similar types of natural communities were included in this assessment; Red Maple − *Sphagnum* Basin Swamps (RMSBS) as defined by the NHB classification system, and Red Maple Swamps (RMS) as defined by the MNAP classification system.

RMSBSs are a type of natural community that occurs within temperate peat swamp systems of NH (Sperduto, 2011). RMSBSs form in glacial outwash basins with limited drainage (Sperduto and Nichols, 2011). Nutrient influx to RMSBs is limited by the typically small size of their watersheds. RMSBSs occur on deep, organic soils in basins that are seasonally flooded. Saturated histosols or poorly to very poorly drained histic epipedons, are characteristic of these acidic and nutrient poor swamps (Sperduto and Nichols, 2011). Water levels fluctuate seasonally and lateral movement of water is minimal (Sperduto and Nichols, 2011). RMSBSs are dominated by the two acid tolerant species for which they are named: red maple (*Acer rubrum*) and peat mosses (*Sphagnum* spp.). Two dominant species commonly occur with yellow birch (*Betula alleghaniensis*), hemlock (*Tsuga canadensis*), and red spruce (*Picea rubens*) as sub-dominant species (Sperduto and Nichols, 2011). Individuals in the heath (Ericaceae) and holly (Aquifoliaceae) families typically dominate the shrub layer. Common herbs include cinnamon fern (*Osmundastrum cinnamomeum*), marsh fern (*Thelypteris palustris*), and genera of the sedge family (Cyperaceae).

RMSs, including Red Maple − Sensitive Fern Swamps, are common throughout southern Maine (Gawler and Cutko, 2010). They occur on mineral soils that remain saturated throughout the growing season, often in floodplains. Soils are typically thirty to sixty centimetres of

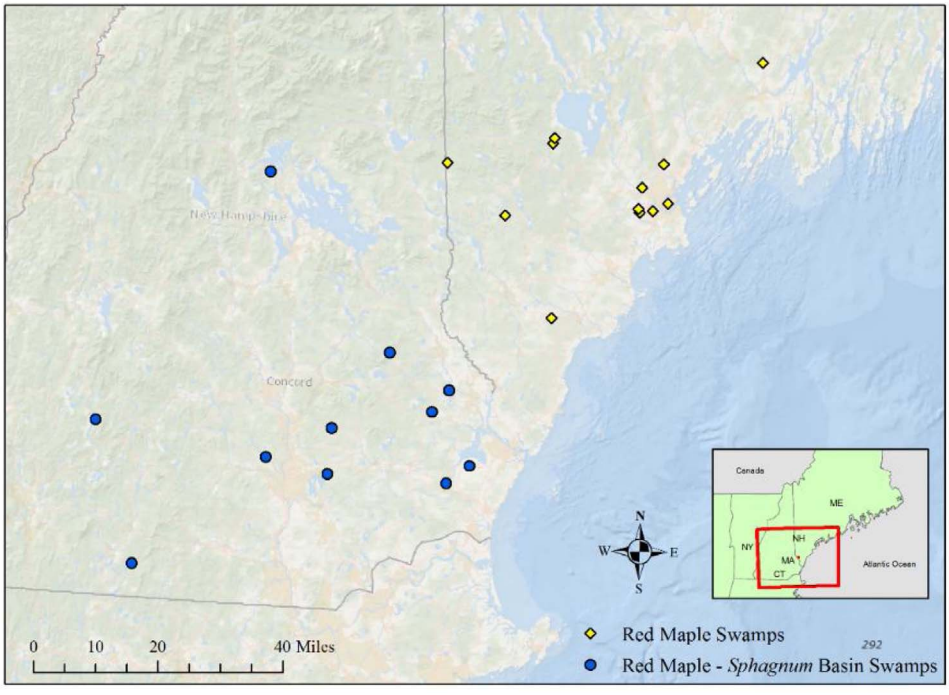

Fig. 1. Map of the study area in NH and ME showing the locations of the 23 surveyed sites. The location of the study area in northern New England is outlined within the map inset.