Efficiency of mitigation wetland vegetation sampling

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Introduction

Human modification of the landscape has resulted in extensive national wetland loss, especially in the Midwest. As wetlands are lost so are many valued ecosystem services they provide. Resulting from Section 404 of the Clean Water Act compensatory mitigation, the restoration or creation of wetlands, has become a prevalent practice in the United States in an attempt to alleviate ongoing, unavoidable loss of wetland ecosystem acreage and function and consequently maintain the integrity of the nation's waters (1).

Administered by the US Army Corps of Engineers (USACE), the mitigation permitting process establishes "performance criteria" a mitigation site must meet to be deemed a success. Performance criteria almost always include measures of vegetation such as percent cover, species richness, and occasionally coefficients of conservatism all of which can be obtained using Floristic Quality Assessment (FQA), a valuable vegetation assessment method gaining popularity in the Midwest (2).

In order to validate a site's progression toward compliance with performance criteria, the USACE obtains periodic monitoring reports from responsible mitigation consultants. These reports may contain the only data available documenting the condition of many mitigation wetlands; thus, it is imperative that the sampling protocol used is adequate to detect meaningful biological variation (1). In the USACE districts encompassing and near the study sites, mitigation consultants are required to provide a minimum of 2-4 1.0m^2 samples of quantifiable herbaceous vegetation when monitoring sites comparable to those used in this study (Hasty, Ritchie, Snyder, personal communication). It is believed by some that this sampling protocol is insufficient for providing scientifically valuable information regarding the condition of mitigation wetlands.

The purpose of this study is two-fold: to demonstrate the floristic quality of the sampled mitigation wetlands in northeastern Indiana; and using parameters obtained from FQA, to demonstrate the degree of statistical confidence for varying intensities of sampling schemes through the use of a Monte Carlo randomization technique.

Materials & Methods

Study Sites:

Two mitigation wetlands in Allen County, Indiana of typical mitigation size and vegetative structure were selected (3). Both wetlands were released from monitoring after the 2003 season by the USACE following the typical five year monitoring period. One mitigation, Site A, totaled 1.18 acres and was divided by a narrow berm so as to form two distinct basins. For the purpose of this study each basin was treated as an individual site, site A1 and site A2. Site B totaled 0.43 acres.

Sampling Protocol:

Nested 0.25m^2 & 1.0m^2 quadrats at site B.

Sampling was conducted late June – early July 2005. Nested 0.25m^2 and 1.0m^2 quadrats were used to sample vegetation every 6m along a regularized grid having square elements of 3m x 3m. Approximately 100 samples were collected at each site. For each quadrat percent cover per species present was recorded.

Data Analysis:

A standard transect FQA was performed using Floristic Quality Assessment Computer Program to calculate the mean coefficient of conservatism (MC) and Floristic Quality Index (FQI) of each site at the transect (site) and quadrat level (4).

A Monte Carlo randomization technique was used to examine three FQA derived variables at the quadrat level: percent cover, species richness, and MC for each of the three sites. Each Monte Carlo simulation consisted of 1000 iterations with sub-sampling for each trial being taken from the quadrat data collected in the field. One simulation was conducted for a sample size of 3, 6, 12, 18, 24, 36, and 48 quadrats for each variable and each quadrat size tested. The mean of all quadrats for a variable for each quadrat size was treated as the true site value. For each simulation the number of iterations falling within ±5%, ±10%, and ±15% of the site mean were determined for the variables of percent cover and species richness. For the MC variable, the iterations per simulation within the values of ±0.1 and ±0.2 units of the MC were determined.

Results

FQA:

MC values for the three sites were relatively low ranging from 1.8 to 2.7 indicating a dominance of species characteristically tolerant of disturbed habitats. Species diversity was unexpectedly high for site B (Table 1).

Site	Total MC	Total FQI	Species Richness
A1	2.6	17.8	47
A2	2.7	16.7	39
B	1.8	14.1	72

Table 1. *MC and FQI values including total species (native and adventive) and the total number of species observed at each site.*

Monte Carlo Analyses:

Using a 1.0m^2 quadrat and a sample size of 3 at site A1, parameters encountered in local mitigation monitoring reports, at a 5% precision level we would find our confidence level to merely be at a value approximating 20% for percent cover and species richness; at a precision of 10% we would have approximately 40% confidence in the data collected and 65% confidence at a precision of 15% (Fig. 1).

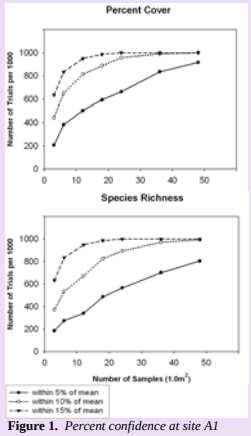

Figure 1. *Percent confidence at site A1 for varying sample sizes at a precision of 5%, 10%, and 15% of the site mean percent cover and species per quadrat.*

We can attain 95% confidence with 10% precision using approximately 24 samples for percent cover and a sample size of 36 for species richness. If we are to consider a precision level of 15%, it would be necessary to attain a minimum sample of 12 quadrats for either variable (Fig 1).

The site A1 MC data examined at a precision of ±0.2 units of the site mean shows 95% confidence can be achieved with approximately 24 samples using a 1.0m2 quadrat (Fig. 2).

The results for site A1 were intermediate of the other sites. The number of quadrats necessary for 95% confidence at 10% and ±0.2 units precision levels for site A2 varied from a minimum of 18 to 48 samples, whereas site B varied from a minimum or 12 to 30 samples using a 1.0m^2 quadrat (Fig. 3).

Data collected with a 0.25m^2 quadrat resulted in slightly lower confidence levels for percent cover and species richness. MC results were nearly identical for the two sizes.

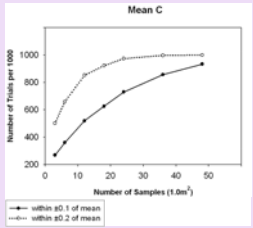

Figure 2. *Percent confidence at site A1 for varying sample sizes at a precision of ±0.1 and ±0.2 C units of the site MC.*

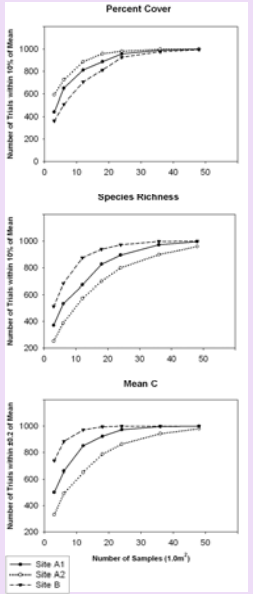

Figure 3. *Percent confidence for varying sample sizes at 10% and ±0.2 units precision at sites A1, A2, and B.*

Conclusions

The floristic quality, MC and FQI values, of the three Indiana mitigation wetland sites is comparable to results found for similar areas in other regions (5).

The low degree of confidence present in data from sample sizes such as 2, 3, or 6 clearly suggests that such sample sizes are inadequate to obtain consistently reliable data for quantitative parameters established as performance criteria.

The smaller 0.25m^2 sampling unit may potentially be more time efficient. Further investigation is needed.

It is not until we begin to collect reliable information that we can begin to assess the conditional state of mitigation wetlands and obtain a greater understanding of the measure of success of these constructed ecosystems.

Literature Cited

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Background picture: Mimulus ringens L. (Allegheny monkeyflower)