Volunteer Monitoring of Forest Restoration

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Abstract

Forest restoration projects are common on the Southern Ontario landscape, but very little monitoring is done at these sites. As a result, very little is known about the overall benefits of this restoration work or about the relative merits of different restoration techniques. This paper describes a toolbox of straightforward methods that might be used by volunteers to evaluate the progress of forest restoration projects. The effectiveness of these methods was determined by evaluating three forest restorations exhibiting different levels of progress. The vegetation, soils, landscape ecology, and faunal use of each of the restoration sites were compared with a reference forest. The results showed that this suite of methods can be used to differentiate between levels of restoration progress. In the second phase of the work, trials were run with students. Generally, they found the methods easy to use and, with good training, produced useful results. This study has shown that a restoration site can be readily characterised by inexperienced workers using these methods.

Keywords: *forest restoration, Southern Ontario, volunteers, methods, assessment.*

Introduction

Little remains of the original forest that covered the landscape of southwestern Ontario prior to European settlement (Larson *et al.*, 1999). That which is left is fragmented and unable to provide the level of ecosystem services that are required by the growing population in this area of the country. Services like water purification, air filtering, erosion resistance, soil building, and the provision of wildlife habitat are greatly compromised (Groffman *et al.*, 2004; Riley and Mohr, 1994).

Fortunately, there are many people in private and public life who are concerned about this issue. Conservation of the remnant habitats by private stewardship and the protection of public lands is growing (Fraser and Neary, 2004). At the same time, many professionals and volunteers are involved in restoring forested lands, either through active planting programmes, or by encouraging natural regeneration.

Unfortunately, very little monitoring of projects occurs after the planting is done (Stanturf *et al.*, 2001). Knowledge that might potentially be gained from these efforts and expenditures is lost. We need to answer such questions as: How well are these restorations succeeding? And which restoration techniques are the most cost effective?

In this study, we tried to identify indicators that might be used by volunteers to monitor the progress of forest restoration projects. We chose methods that require little training but that yield quantitative as well as qualitative information and are robust enough that they can be used by people with many different levels of experience and still give results that are reproducible. The question we are asking is: Can untrained workers involved in conservation and restoration distinguish between different levels of restoration progress using these indicators?

The Methods and Associated Indicators

Methods were chosen not only for their simplicity of use, but also for their acceptance in the practices of forestry (e.g., Larson *et al.*, 1999), vegetation ecology (e.g., Kent and Coker, 1992; Krebs, 1989), and soil science (e.g., United States Department of Agriculture, 1999; Ontario Centre for Soil Resource Evaluation, 1993). It was also important that the chosen indicators gave information relevant to forest restoration science (Lee *et al.*, 1998; Reay and Norton, 1999; Bormann and Likens, 1979). It is recommended that relevant information about the surrounding landscape (landscape ecology) and faunal use be included to round out the discussion about potential restoration progress (Huxel and Hastings, 1999; Forman and Godron, 1986). The methods that were chosen are listed in Table 1 along with the indicators that they provide.

This suite of methods was first tested by evaluating restoration sites of varying levels of progress. The first question asked was: Is the group of chosen

Table 1. Monitoring methods and indicators chosen for testing

Method	**Indicator**
Point centred quarter method for woody vegetation	Similarity coefficient
	Population densities
	Percent exotics
	Relative frequencies (of species)
Quadrat method for herbaceous vegetation	Similarity coefficient
	Population densities
	Relative frequencies (of species)
	Percent exotics
Soil auger sampling method	Soil texture and moisture regime
pH	Evolution of pH as forest soil develops, quantify difference between restoration and reference
Nitrate	Levels of available nitrate in soil
Soil dry bulk density	Soil porosity, development of forest floor
Slake test	Erosion resistance – indicates degree to which restoration is achieving this most basic of ecosystem functions
Soil infiltration rate	Soil porosity, development of erosion resistance
Earthworms	Presence of exotic species in soil Potential for restoration to move in different direction
Geographical context research	Surrounding landscape, landscape ecology
Observations of fauna using site	Faunal use, status of habitat function

indicators capable of distinguishing between good and poor levels of progress? Sites were chosen based on discussions with restoration practitioners (P. Gagnon, M.E. Gartshore, P. Carson, D. Holmes, J. Oliver, and D. Wynia, pers. comm. 2003). Three sites were chosen: one that was agreed by all to be showing good progress; one that was felt to be showing moderately good progress because it received mixed reviews from the restorationists; and a third that was agreed by all to be doing quite poorly. Each restoration site was compared to a reference forest community. Sample data from two sites are discussed here, these being the sites considered to show good and poor progress. Discussion of these two sites is considered sufficient for the purpose of this paper.

In a second phase of the study, two groups of high school students enrolled in environmental studies were asked to evaluate forest restorations on Conservation Authority lands using three of the key methods from the above listed group. The questions asked in this phase of the work were: After a short training session, do inexperienced workers find the methods easy to use? And what is the quality of results obtained by inexperienced workers?

Study Sites

Phase I: Testing indicators

Two of the restoration sites studied in Phase I of this work are sections of the Charles Sauriol Memorial Forest (CSMF), a conservation area located adjacent to Backus Woods in Haldimand, Norfolk County, Ontario (Figure 1), where various styles of forest restoration are being tested by the Long Point Region Conservation Authority. The sections that we evaluated lie side by side in the CSMF and both were planted with a generic mix of Carolinian Forest species (J. Oliver, 2003, pers. comm.; Long Point Region CA, 1993).

These restorations were 11 and 12 years old at the time of evaluation in 2003. The first section, labelled CSA in this paper, was described by the group of restoration practitioners as showing moderately good progress; while the second, labelled CSB, was thought to be progressing poorly. The reference community that was used as a target against which to measure restoration progress for these two sites is located in Backus Woods, within a kilometre of the restoration sites. It was chosen as the reference community because red oak (*Quercus rubra*), a major component in the restoration planting, is one of the dominant species.

Phase II: Use of indicators by high school students

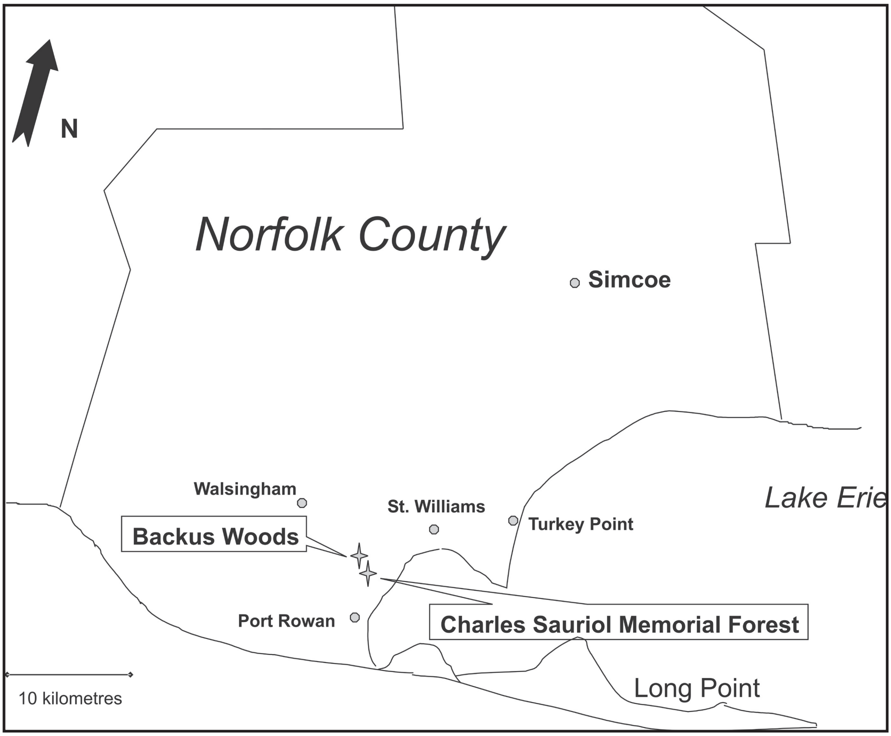
The restoration sites evaluated by the students in Phase II were both on Grand River Conservation Authority land. Kiera's Forest, a 2 ha site at the Guelph Lake Conservation Area, was first planted in 2001 with a mix of trees and a few shrubs (D. Schneider, 2004, pers. comm.). The Nith River site near Paris, Ontario, was direct-seeded in June 2003 with oak and hickory seeds and a mix of native forbs (M. E. Gartshore, 2003, pers. comm.).

Results and Discussion

Phase I: evaluation of methods

A subset of the results for CSA and CSB is included here. Neither had many trees over 10 cm dbh, so in order to compare vegetation structure between

Figure 1. Map showing locations of Backus Woods and the Charles Sauriol Memorial Forest Conservation Area.



the restoration and reference sites, Table 2 shows the relative density of all trees over 2 cm dbh in the two restorations compared to mature trees in the forest. Table 3 illustrates the species overlap between each of the two restoration sites and the reference community in Backus Woods.

From Table 2 we can see that the population density of trees over 2 cm dbh in CSA is significantly greater than that of the mature trees in Backus Woods, while CSB has a significantly lower density of young trees than either. The same holds true for the tree seedling population densities. Visual

Table 2. Structural vegetation indicators

Indicators	BWR	CSA	CSB
Population density (stems/ha) Trees over 2 cm dbh in restorations vs BWR trees over 10 cm dbh	354	539	262
Population density (stems/ha) Tree seedlings under 0.5 m	1850	960	555
Canopy cover (average %)	83	25	7

observation of the two sites, as represented by the relative canopy cover on the three sites, confirms that there are relatively few healthy hardwood saplings remaining on CSB; it appears that the majority of the site is covered in old-field vegetation. On the other hand, CSA is about 50 % covered with groves of healthy young trees interspersed with meadows of old-field vegetation.

Table 3 illustrates the overlap of species between the restoration sites and the reference. By this indicator, CSA and CSB appear to be showing similar progress. Both show an equally low overlap of species with the Backus Woods reference forest. This is due to the fact that the mix of species planted at these sites was not modelled after a specific vegetation community in Backus Woods, but rather after a generic 'Carolinian Forest'. The data for KSF, the restoration site which showed the best progress in our study, is shown in Table 3 for comparison purposes. The restoration done at KSF included a mix of species that was based on a target community located directly beside the restoration site (M. E. Gartshore, 2003, pers. comm.).

Table 3. Species overlap between restoration and reference

Character	Jaccard Similarity Coefficient[1]
CSA - Woody	0.22
CSB – Woody	0.20
KSF – Woody	0.48

[1]SJ = a/a+b+c where a is the number of species in common between the two sites, b is the number of species on the reference not found in restoration, and c is the number of species in the restoration not found in the reference.

Phase II: trials of methods with inexperienced workers

In order to determine if the chosen methods were suitable for use by people with very little training and experience, two trials were run with students enrolled in environmental studies at high school. We were also interested to find out whether these inexperienced workers could produce useful information about the progress of restoration work.

The first trial was run with a class of students from Paris High School taking part in the Canadian Environmental Leadership Programme (CELP). These students spend at least one year of their curriculum focusing on environmental subjects. They were able to devote a full school day to the monitoring work, which translated into 2.5 hours in the field and one hour in the classroom.

The restoration project that they evaluated was seeded in June of 2003 with acorns, hickory nuts, and other tree seeds on Grand River Conservation Authority land near the Nith River. In October of that same year, the first author measured the population of tree seedlings with an assistant using 2 m x 2 m quadrats set randomly along a transect. In June of 2004, the CELP students did a similar assessment. The students were given a 20-minute introduction to the method, including plant identification, and plant keys were distributed. They were asked to identify 7 trees and about 20 plants to the species level and to count stems in the quadrats except where coverage was higher than ten percent. We then compared the results obtained by the students and the researchers.

A subset of the results is shown in Table 4. There is very little correlation between the results that the students obtained and those of the researchers. Although the students found the quadrat method itself reasonably easy to learn and put into practice, they were not able to produce results which approached those of the researchers in terms of accuracy. Even if the results are analysed at the presence/absence and generic level, they do not appear to be very accurate.

A second trial using the point quarter method was run with high school students attending the Guelph Nature Centre for classes in environmental science. These students had only one 50-minute class period in which to do the work. They were given a 20-minute training session on the method, and then 30 minutes to work in groups of three or four. Each group measured the trees and shrubs for one point. The restoration site had been planted in 2001 and 2002 with a mix of young hardwoods and conifers of varying sizes. It is located at the Guelph Lake Conservation Area, Guelph, Ontario.

Table 4. Vegetation survey of Nith River Restoration Site.

Species	**Individuals/ha Researchers October 2003**	**Individuals/ha CELP June 2004**
Bitternut Hickory (*Carya cordiformis*)	3875	1250
Red Oak (*Quercus rubra*)	3375	11578 (incl. *Q. velutina*)
Black Oak (*Quercus velutina*)	2375	0

Because there were enough students, they were able to measure woody species at five points, and the results were sufficient to evaluate young tree, seedling and shrub populations. The statistical scatter in the results was similar to that for the researchers in their work at the Charles Sauriol Memorial Forest, and the students obtained a value for the tree population density which was comparable to the number obtained from the planting plan for the site (Table 5) (Schneider, 2001). The population densities for shrubs and seedlings did not approach those of the planting plan very closely, but this could have been due to mortality and the difficulty of finding the seedlings in the waist-high old-field vegetation which covered the restoration site.

Table 5. Results from Student Evaluation of Kiera's Forest

Indicator	Student Results	Comparator
Trees > 0.5 m (stems/ha)	161	137 (from planting plan)
Scatter in data	203 %	80-260% (researchers)

Overall, it was felt that this exercise showed that with a small amount of good training, and some reasonable supervision and access to knowledgeable help, students are able to produce valid monitoring outcomes.

Conclusions

In this work we found that the methods were easy to use and provided a wealth of qualitative and quantitative data for the evaluation of forest restoration progress. Only a small subset of the results are given here, but a full discussion can be found in May (2004). Some of the indicators, such as herbaceous population densities and soil dry bulk density, do not give useful information in the early stages of site development. However, as the restored forest starts to mature and the canopy closes, these measurements will give quantitative evidence of site development. In the early stages of restoration progress, a few, simple-to-use methods can give comprehensive information about the progress of forest restoration projects.

The question of whether the indicators can differentiate between good, moderate, and poor restoration progress has also been answered briefly in this paper. A much more thorough discussion of this subject is given elsewhere (May, 2004).

The trials with inexperienced high school students demonstrated that workers with very little background knowledge find these methods easy to use. However, since the group with better training produced more valid results, it can be concluded that a certain minimum amount of training is required for inexperienced workers to produce useful data. It is our expectation that naturalists' groups, with their mix of interested and knowledgeable people, or summer employees with a good grounding in environmental studies, would find these methods simple to use for rapid data gathering and, with a minimum of training in the methods, would be able to produce good data.

Further investigation is needed to determine whether volunteer groups would be willing to spend the time required to analyse the data collected using this set of methods. Nevertheless, we believe that this work has shown that groups of inexperienced workers who are interested in conservation and restoration can, with a small amount of training and practice, provide useful data on restoration projects that would otherwise not be monitored due to lack of funds or lack of time.

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