Small White Lady's-slipper: Impacts of Fen Succession

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Abstract

*The small white lady's-slipper (*Cypripedium candidum*) is an endangered orchid that occurs in only four locations in Ontario, one of which is a small provincial nature reserve in southeastern Ontario. One of the primary threats facing this orchid is the loss of suitable habitat through woody species succession. This study aims to establish long-term monitoring plots to evaluate the effects of succession on this population. In the open fen habitat of the site, 23 transects were set up containing a total of 34 test plots and 20 control plots. Cover values of vegetation, water, and marl were obtained as well as demographic data on all of the orchids present. Currently, succession, as indicated by increased shrub cover, does not appear to be having a negative effect on the growth or flowering of the small white lady's-slipper. Further monitoring and research are suggested to better understand this species' microhabitat requirements.*

Keywords: *fen succession, flowering success, ground cover, population monitoring, small white lady's-slipper, species at risk.*

Introduction

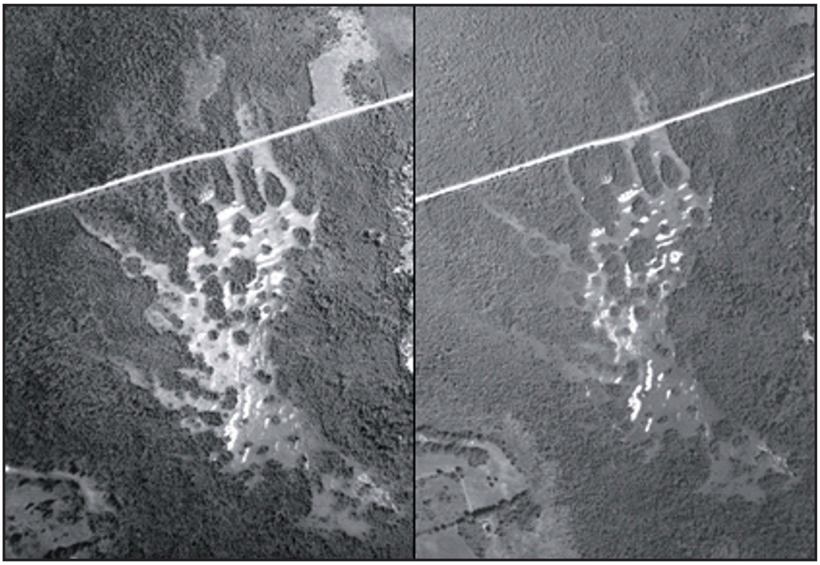
The small white lady's-slipper (*Cypripedium candidum*; SWLS) is a perennial orchid that is generally 20 to 36 cm tall (COSEWIC, 2000). This species typically flowers for 10 days in late May to early June (Bowles, 1983). Limited pollination from bees results in low fruit production (Catling and Knerer, 1980; Falb and Leopold, 1993); however, each fruit capsule that is produced can contain several thousand minute seeds (COSEWIC, 2000). Due to very slow seedling development from seed germination (Curtis, 1943), SWLS reproduces primarily vegetatively (Bowles, 1983). A ring of small, vegetative plants can often be seen growing out from the "mother plant" as a result of adventitious roots (Curtis, 1946; Carroll *et al.*, 1984).

SWLS is usually restricted to moist, calcareous soils and can be found in open prairie or fen communities. The primary limiting factors in its distribution are adequate moisture and light. The early senescence of this species allows it to better survive by withstanding late summer droughts and decreased light levels from competing vegetation (Bowles, 1983).

SWLS is listed as "Endangered" according to both the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and The Committee on the Status of Species at Risk in Ontario (COSSARO). Currently only ten sites in three areas in southern Ontario contain this species (COSEWIC, 2000).

One of the primary threats facing SWLS in Ontario is the loss of suitable habitat through woody species succession (Figure 1). The associated decreased light levels can reduce flowering success and vegetative growth (Falb and Leopold, 1993). This study aims to establish long-term monitoring plots that will allow for the evaluation of the effects of succession on the southeastern Ontario population of SWLS.

Figure 1. Successional changes of the study area between 1970 (left) and 2000 (right) aerial photographs. The bright white patches of marl and open water have decreased while the dull grey-coloured shrubs found between the "islands" have increased.



The population of SWLS in the southeast zone of Ontario Parks was discovered in 1975, and in 1979 the population was estimated to be between 150 and 200 plants (COSEWIC, 2000). In 2003 a monitoring program was initiated by the southeast zone. A total of 638 plants were observed in four sections of the fen habitat. At this point, natural succession did not appear to be having a negative impact on the population (Solomon, 2003).

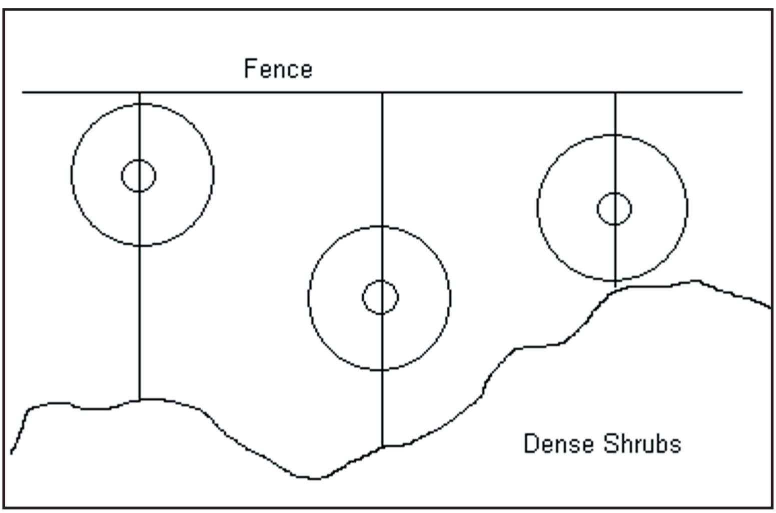
Methods

Study Design

Based on SWLS populations previously identified, transects were established at three locations of open fen habitat within the wetland. Fence posts and isolated trees were used as starting points of the 23 transects to facilitate relocating them in future years. All transects extended from the start point either true North or true South (declination 13° West) into the fen depending on which side of the road they were located on. The exception to this is transects 1 and 2 which run 167° from their starting points. The end point for each transect was determined when continuous, dense, high shrub cover was encountered because this is not SWLS habitat.

Each SWLS located within 1 m of the transect line became the centre point of a 1 m diameter circular test plot. This plot was nested inside a larger 5 m circular plot, allowing scale-dependent effects of habitat on SWLS to be detected (Figure 2). Plots did not overlap. A total of 34 test plots were established.

Figure 2. Diagrammatic view of plot layout along the transects.



The locations for the control plots were then randomly selected, ensuring no overlap among plots. Twenty control plots were established in this manner.

Data Collection

Within both the nested and 5 m plots, the relative percent cover was determined for each of seven cover types (Table 1). These included herbaceous plants, graminoids, low shrubs, high shrubs, bryophytes, water and marl. The low shrubs were considered to be all individual shrubs that measured less than 0.5 m in height; high shrubs were all shrubs taller than 0.5 m.

The total stems of SWLS within the test plots were counted. The number of clumps included in the plot was also noted. A clump was considered to be a grouping of individual plants of this species that were growing less than 15 cm from each other. Since this plant can reproduce vegetatively, measuring the number of clumps is a more accurate measure of the number of genetically distinct individuals occurring within the survey area. The number of stems flowering and general comments on the health of the plant were recorded.

One photo was taken facing north at every nested and 5 m plot. Every photo was taken from a height of 1.45 m and an angle of 45°. The camera was positioned 0.6 m from the nested plots and 1 m away from the 5 m plots.

Data Analysis

Fourteen of each of the control and test plots were selected using a random number generator. These 28 plots formed the basis of the statistical analysis of the cover data. The cover data was analyzed in SPSS using the non-parametric Mann-Whitney test (Zar, 1996). This test detects significant differ-

Table 1. Cover classes for ground cover monitoring.

Cover Class	Percent Cover
0	0%
1	0.01%
2	<1%
3	~1%
4	2-10%
5	11-25%
6	26-60%
7	>60%

ences in the medians of two populations based on ordinal data. The cover data for forbs, graminoids, marl, water, bryophytes, low shrubs, and high shrubs were compared between plot sizes and treatments. Only the low and high shrub cover are evaluated here (Table 2). The null hypothesis was that shrub cover is equal in both the control and test plots.

Table 2. Variables tested and resulting statistics for each cover type using a Mann-Whitney test.

Cover Type	Sub-sample	Treatments Compared	Z – Score	P-value
Low Shrubs	**5 m**	**Test vs. Control**	**-2.924**	**0.0015**
Low Shrubs	**Nested**	**Test vs. Control**	**-1.835**	**0.0335**
Low Shrubs	**All**	**Test vs. Control**	**-3.274**	**0.0005**
Low Shrubs	Control	5 m vs. Nested	-1.084	0.139
Low Shrubs	**Test**	**5 m vs. Nested**	**-2.102**	**0.018**
Low Shrubs	All	5 m vs. Nested	-1.519	0.0645
High Shrubs	5 m	Test vs. Control	-0.519	0.302
High Shrubs	Nested	Control vs. Test	-0.960	0.1685
High Shrubs	All	Control vs. Test	-0.136	0.4455
High Shrubs	Control	5 m vs. Nested	-1.458	0.0725
High Shrubs	**Test**	**5 m vs. Nested**	**-2.987**	**0.0015**
High Shrubs	**All**	**5 m vs. Nested**	**-3.102**	**0.001**

Results and Discussion

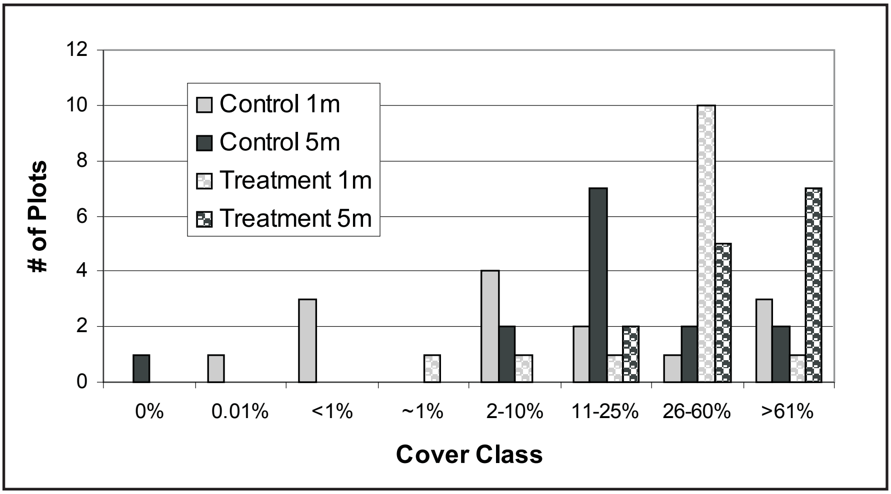
Several significant differences were found ($P<0.05$) within the low and high shrub cover types as are highlighted in bold in Table 2. The treatment listed first indicates greater cover present. The critical value for the z-score was 1.6449.

Low Shrubs

The entire site had an abundance of low shrub cover composed primarily of shrubby cinquefoil (*Potentilla fruticosa*) and some small tamarack (*Larix laricina*) and Eastern white cedar (*Thuja occidentalis*). For the low shrubs, the null hypothesis stating that shrub cover in test and control plots is equal should be rejected. Significantly more low shrub cover was found in the test plots compared to the control plots in both the 5 m and nested plots (Figure 3). However, the primary species, shrubby cinquefoil, occurs across many open habitats and is not an indicator of succession. The presence of this low shrub cover does not appear to be negatively impacting SWLS.

The placement of the plots may also be influencing some of the differences in low shrub cover. The method of randomizing the location of control plots caused more control plots to occur in the open area while the majority of test plots were found in the wetland edge areas. This distribution may be indicative of a preference of SWLS for edge habitats. The resulting placement of the nested plots on the edge of forested areas placed part of the 5 m plots directly in the dense shrub. This edge effect was more pronounced for the test plots with significantly more low shrub cover in the 5 m plots than the nested.

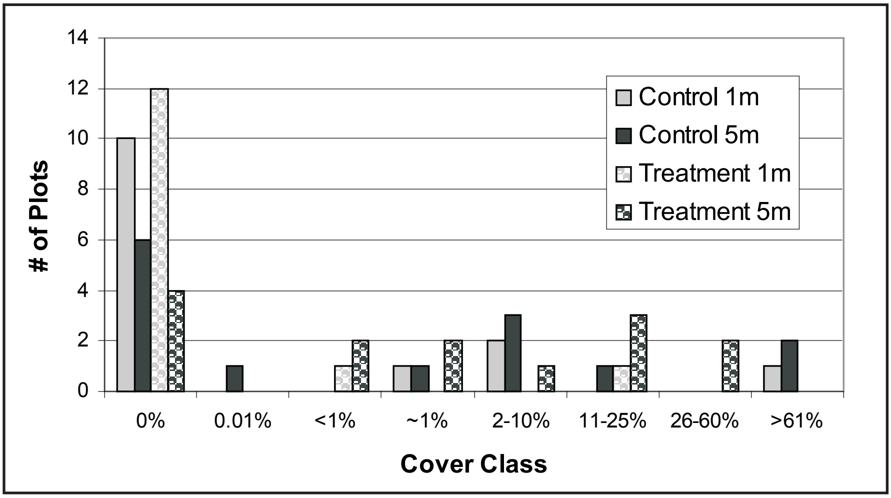
Figure 3. Low shrub cover class analysis in control and treatment plots.



High Shrubs

A total of 71% of the plots had 1% or less high shrub cover (Figure 4). This minimal level of cover may be a result of using height instead of growth form as the dividing line between low and high shrubs. Many of the species indicative of woody succession into the fen habitat (e.g., tamarack and Eastern white cedar) are present in both the low and high shrub cover classes due to their short height. No significant difference was found in the cover between the test and control plots, supporting the null hypothesis. Significantly more high shrub cover was found in the 5 m plots compared to the nested. As was considered for the low shrubs, this may be a result of many of the plots being on the edges of dense shrub cover.

Figure 4. High shrub cover class analysis in control and treatment plots.



Demographic Data

Demographic information on SWLS from all the experimental plots is summarized below (Table 3). These population numbers are a subsample of the entire population as this study only covered a portion of the known population extent. Almost 40% of the plants found had flowered this season. The flowering success has not changed since 2003 when there was found to be 38.87% of the SWLS flowering (Solomon, 2003). These values are comparable to the 36.5% reported in a New York fen (Falb and Leopold, 1993) and 39% in an Illinois fen (Bowles, 1983). In an 18-year study conducted by Curtis (1954) where SWLS was growing in optimal conditions in Wiscon-

Table 3. Individuals, clumps, and flowering of SWLS surveyed.

Individuals	# of individuals	183
	Average per nested plot	1.91
	Average per 5 m plot	5.08
Clumps	# of clumps	143
	Average per nested plot	1.45
	Average per 5 m plot	3.97
	Average individuals per clump	1.28
Flowers	# of flowers	72
	% of individuals flowering	39.34%

sin and Michigan, there was an average of 60% flowering success for each shoot. In Illinois a high of 91.5% flowering shoots was found in one population (Bowles, 1983). Since this study population is at the northern extent of its range, the current degree of flowering seems to be very good.

Recommendations

This study did not find that woody succession is adversely affecting the population of SWLS at this time; therefore, no specific management actions are needed. However, monitoring and assessment of this population should continue to detect any future disturbances to the populations.

- More control plots should be established to allow a larger sample size to be analysed in the future. The locations of the additional plots should be selected randomly but placed throughout the entire habitat area.
- Since the growth of individual stems from a clump can vary widely from year to year (Falb and Leopold, 1993), all of the established plots should be monitored each year for the next three years to provide a baseline for future comparisons of population change.
- The areas of past and current potential SWLS habitat should be accurately mapped to determine the degree of expansion of the shrubby islands into the open fen. The locations of the plots within the habitat should be overlaid to determine any movement in SWLS distribution over time.
- There appears to be an affinity of SWLS with wetland edge habitats although this has not been quantified. The distance and direction from each nested plot to the nearest densely shrubby island should be noted to determine if there is an association between SWLS and the edge of these areas.
- Light measurements of photosynthetically active radiation (PAR) should be taken over each flowering and non-flowering SWLS stem. These measurements will help to provide information on whether the success of SWLS is being affected by the predicted, decreased light levels from shrubby succession.

Acknowledgements

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