Showy Lady’s Slipper (*Cypripedium reginae*) Orchid Census at Purdon Conservation Area 2023

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On behalf of the Ottawa Orchid Society

Abstract

The Purdon Conservation Area is home to a large population of showy lady’s slippers (*Cypripedium reginae*). Since 1985, the population has been censused four times, allowing to monitor the showy lady’s-slipper long-term population trend. The 2023 census counted a total of 6357 *Cypripedium reginae* stems, including seedlings, flowering, and vegetative stems. The population has experienced a significant drop from the previous count of 8020 stems in 2009. Moreover, we observe a continuous decline in the total number of stems since 1985. The causes of fluctuations in showy lady’s-slipper abundance are not clear but could include drought, herbivory, and pollinator limitation. Pursuing monitoring of the population and collecting information of the potential causes of fluctuations in orchid abundance will be crucial in determining the best conservation and management practices for the future.

Introduction

The Purdon Conservation Area is home to a large population of showy lady’s slippers (*Cypripedium reginae*) growing in a treed fen. The area, owned and managed by Mississippi Valley Conservation Authority, was first surveyed in 1985 by Mosquin to document the orchid abundance and location within the Purdon fen. A 4-hectare plot covering the orchid-rich area was subdivided into a grid of 15m × 15m squares to facilitate the survey. Approximately 16 000 orchid stems were counted, and the survey informed management guidelines (Mosquin 1986). Such guidelines included periodic thinning of White Cedar (*Thuja occidentalis*) and Tamarack (*Larix laricina*) to reduce excessive shading of the orchids, hand pollination of orchid flowers to increase seed production, and timing of field work to reduce damage to the orchids. The census was repeated in 1999, 2004, 2009, and 2023 by volunteers from the Ottawa and Kingston Orchid Societies, allowing to monitor the showy lady’s-slipper long-term population trend.

The showy lady’s-slipper is a perennial orchid forming large colonies in calcareous fens. Plants can be found in three different life stages: seedlings, non-reproductive adults, and reproductive adults. The plants can alternate between the reproductive and non-reproductive stages depending on the abiotic and biotic conditions. Plants can also enter an entirely below-ground dormant stage for one or multiple years (which we cannot count) that might be triggered by unfavorable conditions. The orchid is highly sensitive to soil humidity and minerals. Droughts can lead to population declines by reducing soil moisture and affecting mineral availability (Light 2001, Kéri et al. 2004). *Cypripedium reginae* is also affected by deer herbivory, as reported in previous censuses.

Materials and Methods

On July 29, 2023, about four weeks after flowering, 15 volunteers from the Ottawa Orchid Society counted orchids. The wetland is divided into a square grid of 102 squares marked out by PVC posts. Teams of 2-3 volunteers walked through the fen counting and recording the number of *Cypripedium reginae* stems that had flowered, non-flowering (vegetative) adult stems, seedling stems, and the total number of seed capsules in each square of the grid. Seedlings were defined as orchids having up to three leaves and very short stems (plants less than ~10 cm total height). Several other observations were also noted, including the type of tree cover, subjective light level, and the presence of other orchid species.

Results

The 2023 census counted a total of 6357 *Cypripedium reginae* stems, including seedlings, flowering, and vegetative stems, across 102 grid squares. Of these total stems, 3263 stems had flowered in 2023. This represents 51.3% of all stems, or 59.1 % of mature stems producing flowers. Despite the large number of flowers produced, only 111 flowers (3.4% of flowering stems) were successfully pollinated to produce fruits. About 838 stems were counted as seedlings, which represents 13.2% of total stems, although the distinction between a seedling and a very small mature plant is not always clear in the field. The remaining 2256 stems (35.5% of total) were mature vegetative stems that did not bear flowers.

For the first time, all the data from past censuses were compiled in one dataset, making it possible to map the abundance and change in orchids across space and through time. Figure 1 shows the changes of orchid numbers at Purdon Conservation area over the past 38 years.

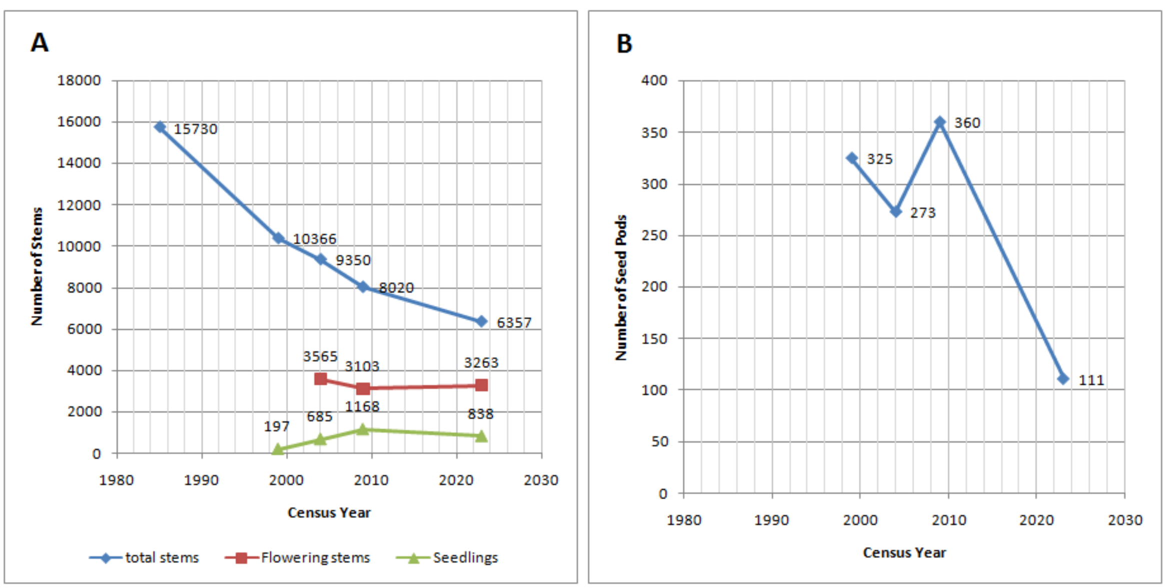

Figure 1. (A) Number of *Cypripedium reginae* stems (total stems, flowering stems, and seedling stems); and (B) number of *C. reginae* seed capsules at the Purdon Conservation Area from 1985 to 2023. Seedlings and seed capsules were only counted since 1999, while flowering stems were counted since 2004.

While an exhaustive search was not conducted, five other orchid species were observed, and their approximate populations were estimated and mapped for the first time. These include about 60 individuals of *Epipactis helleborine*, about 20 *Liparis loeselii*, about 30 *Platanthera* *aquilonis*, at least 6 *Platanthera dilatata*, and at least 13 *Spiranthes romanzoffiana*. While the orchid *Malaxis monophyllos* has been reported from this site once before, it was not observed during this census.

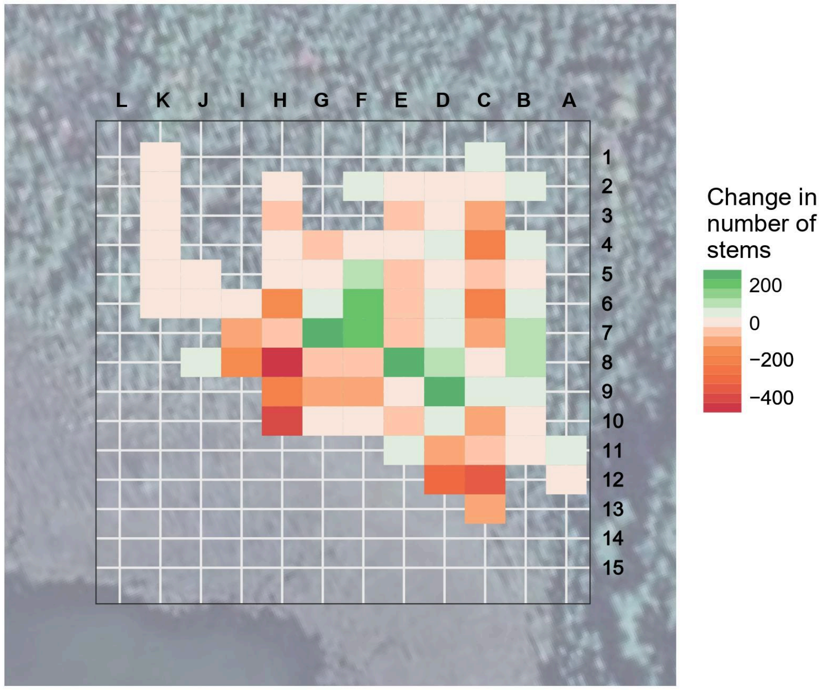

Figure 2. Change in the number of *Cypripedium reginae* stems between 1999 and 2023 in 15m × 15m squares covering the surveyed area at the Purdon Conservation Area. Values are provided only for squares censused both in 1999 and 2023.

Discussion

Several orchid censuses have been conducted at the Purdon Conservation Area since 1985. The *Cypripedium reginae* population has experienced a significant drop from the previous count of 8020 stems in 2009. We observe a continuous decline in the total number of stems, which consistently follows an exponential decay curve from 15730 stems in 1985 to just 6357 in 2023. While the 2023 census did not cover as much area as previous ones, the remaining uncounted squares on the periphery of the colony are unlikely to hold significant numbers of orchids because they have shown few or no orchids in the past.

Most notably, a complete collapse of the orchid subpopulations in grid squares nearest the Purdon Lake was observed since 1985. These squares once contained the highest densities of orchids and the bulk of the population. The treeline has receded around the *C. reginae* population, and these squares now bear dead cedar trees (*Thuja occidentalis*), with grasses and small bushes now dominating the plant community. It is possible that this rapid change in habitat at the periphery of the population is partly responsible for the population decline that we observe at the Purdon Conservation Area. This being said, this trend has not necessarily been consistent since 1985. In the 1999 report, Light noted that, since the 1985 census, numbers of plants around and outside the edge of the population boundary had increased while it had decreased in the core of the population, the opposite of what we observed between 1999 and 2023. It is therefore unclear whether the decline in *C. reginae* abundance at the Purdon fen is the result of natural fluctuations in subpopulations' abundance–some increasing and other decreasing–or a more permanent trend. At least the fact that the grid squares in which we observed the strongest decline in abundance now bear dead trees suggests that subpopulations in those squares will take time to recover if their decline is the result of change in habitat.

The previous censuses and experiments conducted at the Purdon Conservation Area, as well as in other *C. reginae* populations, provide important insights on the potential causes for fluctuations in *C. reginae* abundance. Both at the Purdon fen and in other locations, precipitation seems to be an important driver of population health and abundance: droughts can reduce abundance and induce dormancy, while excessive wetness can delay flowering and could be detrimental to the plants (Mosquin 1986, Light 2001, Kéri et al. 2004). In the 2004 report, Light noted that the Purdon fen has experienced multiple droughts since 1991, leading to the fen becoming progressively drier. The Ottawa region has experienced similar droughts in the last decade (see precipitation data from Environment and Climate Change Canada). Such extreme climatic events can exert considerable stress on plant populations and can contribute to shifts in plant community composition. It is therefore possible that repeated droughts have contributed to the population trend that we observe at the fen since 1985.

In addition to changes in habitat and climate, orchid populations are affected by multiple biotic factors, some of which have been exacerbated by recent human activities. For example, deer damage was observed on a considerable portion of *C. reginae* stems in this census and in previous ones. Deer abundance has drastically increased in the last decades in many places in eastern North America due to the removal of its principal predators. This has impacted the populations of many understory plant species, and could be detrimental to orchid populations as well (Gregg, 2004). This being said, the high variability in subpopulation trends among grid squares that we observed–from a drastic decrease to a sharp increase in abundance–suggests that other factors are at play (if deer were the main driver of orchid population decline, we would expect the trend to be relatively consistent between subpopulations). The impact of deer herbivory could be investigated with little impact on the orchid population by installing deer exclusion fences around a subset of the monitored subpopulations.

Orchids are often highly dependent on relationships with mycorrhizal fungi. In turn, these fungi rely on diverse trees, shrubs, and understory plants as their primary source of carbon. Previous observations have suggested that thinning trees near clumps of *C. reginae* individuals might be beneficial for the orchids by increasing light availability, and thinning has been included as part of the management practices at the fen. However, later investigations have shown little association between light level and *C. reginae* abundance. In 2023, we have again found only a very weak relationship between subjective light level (assessed by volunteers) and orchid abundance. Considering the often observed association between *C. reginae* and cedar trees, it is not clear whether the benefits of increased light availability to orchids by thinning trees outweigh the costs in terms of reduced nutrient availability to their fungal partners. The fact that we observed strong declines in orchid abundance in grid squares in which cedar trees have recently died seem to support this idea. Keeping trees healthy could therefore be part of good management practices at the fen. Monitoring and comparing thinned and control areas should be helpful in informing best management practices for the future.

While the overall number of *C. reginae* stems has decreased since 2004, the number of flowering stems and seedlings remained fairly constant (no data on these plant stages were collected prior to 2004). These two growth stages are important indicators of the population's health: flowering individuals are the only ones contributing to the next generation, while seedling abundance is an indicator of recruitment of new individuals to the population. This suggests that despite a considerable reduction in *C. reginae*'s overall abundance at the Purdon Conservation Area, the population's ability to produce new individuals is mostly unchanged (Although we observed low fruit production in 2023). Effectively, this means that the population has the potential to bounce back. It is important to note that, although seemingly alarming, fluctuations in abundance are common in plant populations. We cannot currently tell whether the population will continue to decline or bounce back. Pursuing monitoring of the population and collecting information of the potential causes of fluctuations in orchid abundance will be crucial in determining the best conservation and management practices for the future.

Future Directions

For now, mostly subjective information on habitat composition has been collected during the censuses at Purdon, but it has still proven very informative. Monitoring more thoroughly the plant community composition and general conditions (e.g., humidity, light, herbivory) of at least a subset of the censused grid squares could be particularly helpful in better understanding the causes of fluctuations in orchid abundance at Purdon. Specifically, it could help isolate habitat characteristics shared among grid squares experiencing strong decline in orchid abundance.

Deer have been identified as a potential cause of population decline at Purdon given the high rates of herbivory reported by volunteers, and it is known to have caused declines in other *C. reginae* populations (Gregg, 2004). Protecting orchids against deer is also relatively inexpensive and easy to implement using exclusion fences. Therefore, we believe that quantifying the impact of deer at Purdon would be very informative for future management practices. The impact of deer herbivory could be assessed first by recording the number of *C. reginae* stems damaged by deer (which has already been done to some extent in the past). Installing deer exclusion fences on a subset of the squares would allow to directly determine the influence of herbivory on population dynamics (see Gregg, 2004). Finally, using trail cameras would allow us to estimate deer abundance at Purdon.

Identifying which plant species form mycorrhizal associations with *C. reginae* would inform management practices, for example by identifying which tree species should not be cleared. This could be done by tracking the transfer of carbon isotopes between plant species (see McKendrick et al., 2000). More information could also be gathered by looking for positive associations between *C. reginae* and other plant species among squares, or by comparing squares in which different tree or shrub species have been cleared.

Each census conducted at Purdon has used somewhat different methods for counting orchids (for example, the number of flowering stems was not counted until 2004). A consistent method of counting is required for future censuses. Using a clear and detailed protocol that could be used during each future census would assure more consistent and reliable abundance data.

During the census, volunteers have noticed that some of the posts marking grid squares are mislabeled, while other posts have fallen over and been buried by vegetation. Some posts do not seem to line up with a perfect grid, making them difficult to find and causing confusion when recording data. Using GPS to locate grid markers, and re-labelling mislabeled or damaged ones may help future volunteers in collecting more reliable data, and ensuring that it can be compared with past census data.

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Appendix

In the following tables, quadrants are defined by the top-right corner post (eg. quadrant A1 is bordered by the posts A1, A2, B1, B2).

Table 1: Number of Flowering Stems per Quadrant 2023

	L	K	J	I	H	G	F	E	D	C	B	A
1		0	0	0	0		0	0	1	3	0	0
2		0	0		0		5	0	0	3	0	0
3		0	0		0			0	4	1	2	0
4		0	0		2	5	7	2	21	2	3	2
5		0	0		9	31	194	26	14	0	0	0
6		0	0	4	32	105	203	22	21	3	7	0
7				10	40	340	326	117	33	19	42	0
8			3	5	34	123	215	211	63	42	53	0
9					53	99	34	74	150	70	7	38
10					4	20	12	68	54	4	10	47
11								55	2	6	30	2
12									0	6		0
13										8		
14												
15												

Table 2: Number of Seed Capsules per Quadrant, 2023

	L	K	J	I	H	G	F	E	D	C	B	A
1		0	0	0	0		0	0	0	0	0	0
2		0	0		0		0	0	0	0	0	0
3		0	0		0			0	0	0	1	0
4		0	0		0	0	0	0	1	0	0	0
5		0	0		1	0	4	4	1	0	0	0
6		0	0	2	0	0	6	2	3	0	0	0
7				2	0	1	6	3	5	0	3	0
8			1	1	0	1	0	15	5	3	4	0
9					2	1	0	14	7	1	1	0
10					3	0	0	4	0	1	0	0
11								0	1	0	0	0
12									0	0		0
13										1		
14												
15												

Table 3: Number of Vegetative Stems per Quadrant, 2023

	L	K	J	I	H	G	F	E	D	C	B	A
1		0	0	0	0		0	0	1	7	0	0
2		0	0		0		14	0	8	4	3	0
3		0	0		0			3	4	10	8	3
4		0	0		0	13	13	7	10	10	4	6
5		0	0		1	32	59	25	20	8	0	0
6		0	0	4	18	43	84	14	32	0	18	1
7				11	37	170	127	49	45	25	40	0
8			8	11	24	69	140	90	29	44	49	0
9					20	50	46	41	84	31	23	32
10					6	6	70	50	27	8	29	43
11								94	0	8	102	6
12									0	16		1
13										8		
14												
15												

Table 4: Number of Seedling Stems per Quadrant, 2023

	L	K	J	I	H	G	F	E	D	C	B	A
1		0	0	0	0		0	0	0	0	0	0
2		0	0		0		1	0	0	0	0	0
3		0	0		0			0	0	0	1	0
4		0	0		0	2	4	4	8	0	1	0
5		0	0		0	12	36	13	5	1	0	1
6		0	0	2	3	2	10	4	12	0	5	1
7				0	11	16	45	10	6	2	1	0
8			29	0	2	7	59	28	30	29	5	0
9					3	38	82	21	49	34	8	2
10					0	7	17	8	28	4	11	15
11								28	12	20	19	2
12									1	8		0
13										13		
14												
15												