The Effects of Selective Cutting on the Growth of Native Orchids in a mature White Cedar Forest

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Acknowledgements:

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Purpose

Populations of native orchid species are thought to be in decline in Manitoba for many reasons, including man-made and natural disturbances. Native Orchid Conservation seeks to conserve populations of native orchids in the Sandilands area and elsewhere. The purpose of this five-year project was to study the effects of selective cutting of mature trees on native plant regeneration, especially native orchid species, and to see if this less intrusive method of harvesting might improve orchid growth. The study was carried out in a mature white-cedar forest in the Sandilands Provincial Forest about 100km east of Winnipeg. At the start of the project the site contained 14 native orchid species. Orchid populations in this forest seemed to be declining over the years as the forest matured and canopy-closure became extreme, and we wondered if selective cutting would increase orchid growth by improving light-levels. Then in 1997, this forest was accidentally selectively cut on the west side of the bush-road. Manitoba Forestry granted permission to have the east side of the bush-road selectively cut in March of 1998 as well. Thus, by removing some more of the larger cedar trees and letting in more light, the potential research area was enlarged (image04, image05, image06, image07, image08, image09). We subsequently set up research plots at the site in 1999 to monitor understory plant growth (image10 and image11).

We would have liked to carefully select which trees were to be removed, in order to apply different treatments to our research plots, and no treatment to our control plots. However in this case we had a chance to do a study in a forest that had already been partially cut and that contained large numbers of many different species of native orchids. We took advantage of the opportunity, even though it meant that some aspects of the desired protocol could not be followed.

Method

The study area is located north of Fireguard #29 (Old Dawson Trail) and consists of two approximately 2-acre sites, on either side of an old bush-road. In June of 1999, we selected 24 plots, each 5m x 5m, that reflected four different light-treatments (levels of canopy-closure): complete shade, heavy shade, moderate shade, and light to no shade. Twenty of the plots were chosen so that each would contain at least one orchid. The other four plots, known as T-plots, were chosen, one from each level of canopy-closure; these T-plots are unusual only in that they contained no orchids. Within each plot, five sub-plots, each 0.5m x 0.5m, were randomly selected and marked. A map showing the arrangement of plots is Appendix-A.

In each entire plot: every tree, meaning a woody plant of more than 15cm in diameter and 4m in height, was identified and its diameter at breast-height was recorded; every tree-seedling identified and counted; the percent-cover was estimated for each shrub species; the percent-cover was also recorded for each of: grass, moss and debris.

Within each sub-plot: every plant was identified, and counted by species.

Every orchid was marked with a metal tag, both inside the plots and elsewhere in the 4-acre study area; approximately 400 orchid plants were tagged. Note that we quickly gave up on this attempt to follow the growth of individual plants, because our metal tags too often disappeared.

No fertilizers, water, or other growth-enhancers were added. Once the plots were set up they were not manipulated in any way.

Light-level readings (image12) were to be taken every two years, at 3 times during the growing season, on a clear sunny day close to April 21, June 21, and August 21; with 3 readings on each of those days, at about 10:20am, 1:20pm (solar noon) and 4:20pm; and since visiting all 24 plots takes about 40 minutes, the readings were begun at 10am, 1pm, 4pm.

Orchid growth was monitored in the plots from June 1999 to August 2003. An annual orchid-count was carried out around August 15, where each orchid in each plot was identified, and its stem-height, number and size of leaves, and number of flowers and seed-capsules, were recorded (image18). Appendix-E and Appendix-F show some of the orchid-count data. Unusual conditions in the plots, like standing water, were noted at this time. As well, each plot and each sub-plot was photographed at this time (image13).

Plots were also visited at other times: in April to repair flagging tape (image15); in May to monitor numbers of *Calypso bulbosa* (because usually no trace of this orchid can be found in August); and in June, to observe the flowering of other orchid species. (Appendix-H summarizes these activities for some years.)

In 2003, the canopy-closure was re-estimated in each plot using several methods: taking a wide-angle photograph with camera facing up (image24), using a spherical densiometer (image19), as well as by-eye; and the new estimates were compared to the 1999 by-eye estimate.

Observations

Estimating canopy-closure:

We did not own a light-meter and had to borrow one; it was not always available when we needed it, so we took readings less often than we would have liked. The initial design called for light-level readings in years 1, 3 and 5, presumably in order to show how the canopy-closure changed over the 5-year period. However, given the minor change to the canopy in a mere 5-year period, and given the erratic nature of light-level readings, together with our small number of such readings, we have abandoned the idea of using these readings to show changes in light-levels over time.

Once we think of the canopy-closure being essentially constant over our time-period, then we regard our lux-readings as one reasonably good measurement of that canopy-closure (seeAppendix-B).

We also have 2 complete sets of "by-eye" estimates of canopy-closure for each plot, one set from 1999, and the other from 2003. We have another set of estimates done with a spherical-densiometer in 2003 (image19). At each plot, readings were taken in the 4 cardinal directions (image20, image21, image22, image23). And we have another set obtained by taking a wide-angle photograph with camera at ground-level facing up (image24 and image25), then analyzing these photographs with a computer-program (image26 and image27); these were done on a cloudy day in 2003.

Appendix-C shows that these 5 different estimates do not altogether agree. Because of this lack of consensus, which may seem somewhat disturbing, we have simplified our approach regarding the different treatments, going from 4 different treatments down to 2. We are now dividing our plots into the 2 groups:
Control plots, or those largely unaffected by the tree-removal; and
Treated plots, or those receiving significantly more light as a result of cutting.

Now that we are dividing our plots into only 2 groups, we find that using all 5 sets of estimates, together with "majority wins" resolution, results in just one pair of plots being swapped, compared to a 2-group breakdown based purely on the original 1999 canopy-closure estimates.

Orchid Counts:

When you look at the yearly orchid counts (Appendix-F) you can see that counts fluctuated widely from year to year, and that the 2003 total turned out to be almost identical to the 1999 total. The fluctuation may have been partially due to heavy rains in July rotting the orchids some years and also because of increasing animal predation of flower spikes and seed capsules, especially by white-tailed deer. Heavy rains at blooming time may have also interfered with pollination. On the other hand, continued heavy rain in July may have stimulated orchid growth in some species. These factors may have affected the actual number of orchids and may certainly have affected the orchid counts done in August. On the other hand, orchid populations are known to fluctuate from year to year.

Orchid Species Diversity:

The kinds of orchids in the plots did change after the tree-removal. We noticed a marked decrease in Platanthera species like *P.orbiculata* and *P.hookeri* and an increase in Cypripediums like*C.pubescens*. Orchids, namely *Platanthera orbiculata* and *P.obtusata*, appeared in two of the T-plots where none had been in 1999. And *Goodyera repens*, a species not previously seen in the plots, appeared in large numbers in Plot#16 in 2001, possibly as a result of a disturbance caused by a large cedar falling down nearby in the winter of 1999-2000, or for some other reason. A few also appeared in Plots #3 and #5, also in 2001; perhaps increased light or precipitation were factors in stimulating their growth. *Amerorchis rotundifolia*, initially found in Plot#16, disappeared completely from the plots.

Other Plant Species:

The regeneration of other native plant species was also considered in the study. By comparing the photographs taken yearly in August from 1999 to 2003, gross changes in the plots were observed. Grass species appeared to overgrow a number of plots, along with bunchberry, Indian hemp, thistles, raspberry and poplar. Balsam-poplar seedlings grew very rapidly and twinflower seemed to disappear in some plots, but in shady plots change was much slower. For example, image28 is from 1999, and image29 is the same plot11 in 2003; also image30 from 1999, image31 from 2003, both show plot5; while image32 from 1999, image33 from 2003, show subplot-B7 within plot5. Fallen cedar logs rotted down very quickly, no doubt due to high temperature and humidity; in August the temperature was often around 32°C with a relative humidity of 92%. The process is obvious in photos of Plot #10, which contains a thriving group of*Calypso bulbosa*; the fallen log is clearly visible in the 1999 photo (image34), but by 2003 it has almost disappeared (image35). Calypso are often associated with rotten logs, which may explain why they are only found in this plot.

Future Observation Plans:

In June of 2004, we intend to repeat the detailed survey of all plants in the sub-plots (like the one we did in 1999), so we can see exactly how the species-mix has changed. At that time we will also measure and count the tree-seedlings, observe tree growth, and note the percent cover of shrubs, moss, grass etc. We will post the results of that survey on our website.

Discussion and Conclusions

We have insufficient data to make any firm conclusions at this time about the effects of selective cutting on the growth of native orchids. It is very difficult to distinguish the effects of selective cutting on orchid growth and survival, from other factors that could affect them, such as changes in precipitation amount and timing, increased animal predation and climate change. We looked at weather data published by Environment Canada (Appendix-G) and noticed marked variations in precipitation over the study period. We are also aware that native orchid populations tend to fluctuate from year to year. We speculated about what kinds of orchid seeds and protocorms are in the seed bank at this site and if that might help to explain the sudden emergence of orchid species such as *Goodyera repens*. It would be interesting to see if and how *A. rotundifolia* responds to continuing changed conditions both from the selective cutting and from climate change. Regarding other native plant species, it is clear already that increased light and thinning of the trees promoted the growth of grass and other opportunistic species like thistles and poplars not usually found in abundance in a white-cedar forest

One thing does seem clear: it is not possible to use the selective cutting method of tree harvesting as a method to set back plant succession incrementally. In selectively cutting a coniferous forest, the removal of the large trees disturbs the soil and opens up the canopy to increased light, thereby providing an opportunity for fast-growing, invasive species to colonize the site. Primary succession occurs when a site not previously influenced by a particular community is first colonized. However, in this case we have an example of secondary succession where vegetation was removed, but the well-developed soil, seeds and spores remain (M. Begon, et.al. 1996). Such disturbed sites are colonized by pioneer species with rapid dispersal mechanisms, or by seeds and other propagules present in the seed bank. The heavy branches of cedar trees in this mature forest may have held back many wind-blown seeds, but when the large trees were cut out, and other conditions became favourable, seeds dispersed by wind were able to come in and start growing in the site.

In our opinion, five years of research is not enough to clearly understand what is going on. This would require a long-term study and monitoring of this forest for something like 20 years to see how it regenerates. Native Orchid Conservation volunteers intend to carry on monitoring this site as time, volunteers and funding permits. However, we can make some recommendations about how to proceed with a study of this type, based on our experience so far. We have included some of our data as appendices to this report, and we will be happy to make the rest of it available to others interested in carrying on with this project or a similar one. This report and our ongoing findings will appear on our website at www.nativeorchid.org.

Recommendations

Native orchid species in these plots should be monitored for many more years, in order to better understand the effect of selective cutting and the reasons for fluctuation in orchid numbers and species. It is difficult to distinguish the effects of selective cutting on orchid survival, from the many other causes that may affect their survival. This will require a long-term study. It might be instructive to correlate changes in orchid populations to precipitation, temperature, and perhaps nutrients, as well as to the availability of light. The following are some suggestions:

Plot Photography:

Photograph the plots at noon on a cloudy day for best results. Check the previous year's photo, and ensure the same orientation and lens-length is used. Use a scale object like a ruler in the photo and include a stake showing the plot-number or the sub-plot-id in each photo.

Orchid Counts:

Plots should be checked oftener than we did, perhaps as often as twice a month in May, June, July and August, so as not to miss any orchids that bloom and then disappear for one reason or another. Ideally there should be a full orchid count done around June 15 when the orchids are flowering, as well as on August 15, so that orchids like Corallorhiza and Calypso that tend to disappear later in the summer, are not missed. Caution must be exercised as the plots are often far too wet to access and stepping into the plots under such conditions to do the count could be harmful to the orchids as well.

Full Plant Survey:

Close monitoring of the plant growth in the plots is necessary. We recommend that the detailed survey of all plant species in the sub-plots be repeated in 2004, to show how the species-mix has changed. In the entire plots, the measuring and counting of trees, estimating percent cover of shrubs, moss, grass and debris, should be redone also, to show tree-growth and other changes to conditions in the plots.

Light-level readings:

It is difficult to obtain reliable light-level readings in this kind of mature coniferous forest. The slightest wind moving the branches changes the readings and they jump all over the place. An easy way to improve these readings would be to take several readings at different places in each plot and average them. Light readings should be taken on a clear, sunny day with no clouds or smoke in the air; this is not easy to achieve, especially in springtime. You would need to take many readings at many different times during the growing season and average them to get a more complete idea of the amount of light reaching the plots.

Densiometer readings:

Our experience leads us to believe that the spherical densiometer is no better than the human eye or wide-angle photography in estimating canopy-closure; and is subject to similar problems in that the reading can change dramatically upon a minor change in the orientation of the device. We have observed that our densiometer sometimes leads to over-emphasizing the effect of distant trees near the horizon, much as would the use of an overly-wide wide-angle or fisheye lens on a camera; though possibly this is due to the device being either off-level or incorrectly positioned with respect to the eye of the observer. See the observer-view photos attached to this report (image20, image21, image22, image23).

Each of our 4 methods added something to our understanding of how much light comes down to the plots through the forest canopy.

Plot markers:

It might be better to use a different method for marking the plots; possibly one that doesn't involve flagging tape. Our plots required frequent repair because of animal damage. The study area is visited regularly by deer, rabbits, wolves, bears, squirrels and birds. In 2003 a litter of wolf puppies chewed up all the flagging tape and removed stakes from our plots. It took us a day to repair the damage (image16 and image17).

A different size of plot might be considered; using larger but fewer plots would mean less work needed to maintain the markers.

We also found that using ordinary metal plant-tags to mark individual orchids did not work here. So many of our tags disappeared over the first summer that we had to abandon the idea of following the growth of individual plants. Birds or animals sometimes remove them, and may sometimes press them into the soft soil where they can't be seen.

Concluding recommendations:

From the perspective of a volunteer, non-profit organization this was a very demanding project. NOCI volunteers put in over 600 hours of fieldwork over the last 5 years. On the days when we did the orchid count and plot photography, in August, the temperature would be around 32°C and the humidity around 92%. These weather conditions combined with an abundance of biting insects made the work difficult. The analysis and interpretation of the data for this research is a complex and time-consuming task, which needs further work. We hope that some of our findings and recommendations based on our experience with this project may be helpful to others. We would also welcome suggestions from others who have experience with this kind of research as we could find very little information on the subject. We would like to see research on native orchids at this site continue for a longer term and would be happy to cooperate with others who are interested.

References

M. Begon et. al. 1996. *Ecology: Individuals, Populations and Communities, Third Edition*. Blackwell Science Ltd. Oxford.

Appendices - saved as separate files

Appendix A - Plot Map

Appendix B - Light-Level Readings

Appendix C - Canopy Closure Data

Appendix D - Orchid Codes

Appendix E - Orchid Inventory Data

Appendix F - Orchid Count Data

Appendix G - Weather Data

Appendix H - Activity Log for Year-3 through Year-5

Appendix I - Photographs - as thumbnails - not saved

Appendix J - Photographs - as full-sized photos