ER 390 Final Project Report

Project Title:

Ecological Factors Contributing to the Growth of Reed Canarygrass *Phalaris arundinacea* at Swan Lake/Christmas Hill Nature Sanctuary, Saanich, British Columbia Prepared for the Restoration of Natural Systems Program

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Abstract

For nearly nine decades the non native variety of *Phalaris arundinacea*, Reed canarygrass, planted by farmers as livestock feed, has existed in the wetlands of Swan Lake Nature Sanctuary. The spread of this sun-loving, nutrient-absorbing invasive grass owes its success to a number of factors, some of which originate in the much larger Blenkinsop/Mount Douglas watershed, located several kilometres upstream from the sanctuary. These factors: climate, soil, water, light, nutrient-load, pollution and other chemical run-offs assure Reed canarygrass's capacity for increased growth in an already compromised wetland ecosystem. Throughout the calendar year of 2003 to 2004, in which an examination of the ecological factors contributing to the growth of Reed canarygrass was observed, recommendations for restoration are as follows: 1) do nothing, allowing "nature" to take its course, 2) do something: plant, burn, shade, flood, harvest, mulch, mow, graze, disk, hand-pull, and apply herbicides, and lastly, 3) a combination of 1 and 2. This project addresses environmental restoration issues beyond those previously examined for Swan Lake Nature Sanctuary. The overriding concern is the effect climate change will have on the region's threatened Garry oak ecosystem. Reed canarygrass will be impacted too by climate change; whether positively or negatively cannot be determined.
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Introduction

*Phalaris arundinacea*, a member of the Poaceae family is a robust perennial, able to grow to heights of two meters, possessing lengthy, scaly pinkish rhizomes and hollow stems. It thrives in wet places, such as ditches, marshy or depression-type areas, such as those at Swan Lake Nature Sanctuary and favours nutrient-rich soils. One aspect of its abundance is connected directly to its ability to grow well in regions of human or agricultural activity. This competitive non native species had been introduced from Eurasia in order to improve a higher yield for farming purposes. Consequently, Reed canarygrass is one invader of wetland communities that is able to create monotypic stands and eliminate many species (Maurer et al, 2003). For the remaining native plants and animals that reside at Swan Lake Nature Sanctuary of Saanich, British Columbia, on Vancouver Island, this is a daunting rival.

Prior to the 1900’s, the region, like much of southern Vancouver Island contained large stands of *Pseudotsuga menziesii* Douglas Fir, *Thuja plicata* Western Red cedar, *Arbutus menziesii* Arbutus, and the increasingly rare *Quercus garryana* Garry oak. This diverse ecosystem attracted large mammals, birds, reptiles and amphibians, fishes and numerous species of insects. Indigenous peoples managed the landscape around Swan Lake, utilizing selective burning practices and other forms of agriculture to enhance opportunities for a varied diet and trade options (Cannings and Cannings, 1996). This balance between human and animal interaction has been recorded as having taken place after the last glaciation on Vancouver Island of over 10,000 years ago (Henrich, 2003). The glacial process created the bowl-like depression that contains Swan Lake; a part of a much larger watershed system so favourable to native peoples and subsequent settlers to the Pacific Northwest, where weather conditions enabled crops of all varieties to take hold in the Mediterranean-type climate.
Swan Lake received its English name from a Mr. Swan, a geologist, who first surveyed the area in 1884. The new municipality of Saanich was established in 1906, but prior to this, Saanich’s first resort was built on Swan Lake, alongside of what today is known as the Galloping Goose Trail, but then, was part of a rail line that ran directly beside the entire watershed system (Saanich News, 1994).

Besides land clearing around the lake for farming, the Victoria Ice Company in the 1890’s, cut ice from Swan Lake in winter for use in cold storage (Saanich News, 1994). The Pendray family established a farm in 1916, clearing willows in the flood plain. They, along with other settlers planted Reed canarygrass as a feed crop for their dairy animals (Pendray, 2004). As well, a winery operating into the 1950’s and located upstream, dumped effluent "The river ran red" (Pendray, 2004) into Blenkinsop Creek, which then flowed into Swan Lake and beyond to Colquitz Creek and out into Portage Inlet (MacGillivray, 2003). Today, diners at "The Keg" on Quadra Street have no notion that “The Winery” once contributed pollution that killed fish and assisted in changing the nutrient and sediment loads in Swan Lake, so that today the lake is eutrophic and struggling to breathe.

Because of its natural bowl formation and age, Swan Lake has been filling with sediments from sewage for decades. Certain plants find Swan Lake an optimum environment for accelerated growth, leading to a high macrophytic production rate. These emergent plant species are gradually replaced by wetland and terrestrial varieties, like Reed canarygrass, creating swamp-like conditions, which fluctuate with dry and flood seasons.
Although the loss of lake area and volume is a natural occurrence, due to high nutrient loads, there is a low area to volume ratio; hence the problem of too many nutrients, which favours Reed canarygrass growth (Zaccarelli, 1975, Dauganet et al, 1999).

My research indicates that there are several ecological factors contributing to the growth of Reed canarygrass at Swan Lake: climate change, soil conditions, water quality and quantity, lighting conditions, vegetation, and human activity. Each one of these factors, with climate change being the most crucial element will be examined throughout this paper and recommendations for restoration will be presented.

**Methodology**

**Field Trips**

In an environmental restoration course of 2003, I collected data pertaining to Reed canarygrass at Swan Lake by plotting out four sites. I utilized the following methods to collect this data based upon my personal interest in wetlands and a desire to work in an out-of-doors climate. My first step was to visit the McPherson Library at the University of Victoria to obtain an aerial map of the Swan Lake region. I made personal contact with William MacGillivray, Site Manager for Swan Lake and other staff in order to gather historical and recent information on issues relevant to the Sanctuary. I met with MacGillivray on six occasions during the summer of 2003 during which time I randomly selected four plots, which were mapped using a combination of air photo interpretation and ground truthing.
To define the soils around Swan Lake, Jungen's 1985 publication provided invaluable information regarding soil description. I referred to the Manual for Describing Ecosystems (Meidenger, 1998), to detail the four plots, which include utilizing the Ground Inspection Forms (GIF) to identify ecosystems.

A Garmin Global Positioning System was used to record the elevation and geographical units. Slope and aspect measurements were recorded using a clinometer and compass. Plant specimens were identified on site using Plants of Coastal British Columbia (Pojar et al, 1994). Local botanist, educator, naturalist and paleoenthusiast, Thor Henrich was on site to assist with plant identification. Staff at the Swan Lake Nature Sanctuary also assisted in identifying flora and fauna.

Another series of field trips included bank stabilization along Blenkinsop Creek, which is a part of the Swan Lake watershed. During these excursions, I made observations regarding the agricultural lands surrounding Blenkinsop Creek, noting how water is used and diverted from the creek itself. These field trips occurred during the summer and fall months of 2002 and 2003.

Literature, Personal Communication Research

I researched biological and historical information through a number of scientific articles located at the University of Victoria’s McPherson Library. The History of Saanich was researched through the Saanich Municipal and Provincial archives, as well as archived material found at Swan Lake Nature Sanctuary. Personal communication with archivists, civil engineers, naturalists, ecologists, botanists, geographers, historians, and Reed canary grass restoration ecologists, wetlands biologists, the staff of Swan Lake, ministry officials or designates,
municipal environmental managers, members of Ducks Unlimited, an aquatic ecologist and numerous Swan Lake Nature Sanctuary volunteers had been conducted via e-mail, phone messages and onsite visits.

John Pendray, son of one of the original farmers to the area graciously answered my questions about his life growing up around Swan Lake. Mr. Pendray confirmed that his father planted Reed canarygrass as a feed crop for his cows. Consultation with Dr. Don Eastman, Faculty Director of the Restoration of Natural Systems of the University of Victoria occurred throughout the 2003-04 year, in which this paper was completed.

**Results and Interpretation**

**Location and Climate**

Swan Lake Nature Sanctuary is part of a much vaster watershed system which originates several kilometers to the northeast in an area known as The Blenkinsop Valley. This valley is situated at the base of Mount Douglas Park on its southwest side. Because this valley and the Greater Victoria region lie within the rainshadow of the Olympic Mountain Range of Washington State, it's location and climate reflect a Mediterranean-type landscape. The entire region and indeed, that of the southern tip of Vancouver Island, British Columbia, is noted for its Garry oak ecosystems, which are reflected at Swan Lake's position: Northing s- 472548, Easting's -5368214. This position identifies a Garry oak (*Quercus garryana*), Arbutus (*Menziesii*) ecosystem as "red-listed." (British Columbia Conservation Data Center, 2004). Rare indeed.
The drainage basin has a calculated area of 2513 acres (108 hectares) with 801 acres (324 hectares) compromising the smaller watershed of Blenkinsop Lake (Zaccarelli, 1975). From Mount Douglas Park, waters flow southwest toward the controlled-drained Blenkinsop Lake. The waters continue underneath the Quadra/Mackenzie street intersection's concrete culvert, then along Blenkinsop Creek, into Swan Lake, then outflows from Swan Creek, onto Colquitz Creek and eventually drains into its final destination of the marine environment of Portage Inlet. These tidal waters link up with the Strait of Juan de Fuca and the Pacific Ocean. (Figure1) (Appendix A)

The uniqueness of Swan Lake Nature Sanctuary is in its location within a rare and increasingly endangered Garry oak savannah. Climate, therefore plays a significant role in the growth of Reed canarygrass. During times of flooding (the average annual rainfall is 831 mm.) the lake’s depth can increase a metre and a half above its average of three metres (Zaccarelli, 1975). Conversely, during times of drought (July and August) only 5% of the average rainfall occurs in Swan Lake, when water levels can dip below 4.6 metres at its centre. Reed canarygrass can tolerate depths of .3 metres for up to two years at lake edges (Antieau, 1999). Consequently, four plots were chosen: two within the floodplain, one within a willowstand, and a final one within a maintained site (grass trimmed by Saanich Municipal Staff). These plots are numbered accordingly. (Appendix B)
Figure 1 Aerial Photo of Swan Lake Year 1975
Soils

During the Pleistocene era Vancouver Island had been modified by glaciation. Approximately 18,000 to 19,000 years ago, this ice sheet crossed the southeastern part of Vancouver Island (Alley and Chatwin, 1975). The area within Swan Lake is predominately the result of glaciation and consists of surficial deposits. Jungen (1985), describes and maps soils found on Southern Vancouver Island. Field data gathered indicate marine deposits are found at Swan Lake. In general terms these marine deposits have been formed by the washing action of waves upon preexisting surface materials exposed by emergence after glaciation (Jungen, 1985). Of the four plots completed, two contained marine deposits of a silty consistency and two sites of a clayey type (Eastman and Grant, 2004).

Water

Swan Lake Nature Sanctuary is a focal point primarily due to its water, which acts as a conduit for the watershed located upstream. The conduction of water begins as run off at the base of Mount Douglas Park and gathers momentum, becoming Blenkinsop or Lost Lake (due to the fact that the "lake" would disappear during the dry, summer months), which then flows into Blenkinsop Creek. The creek is dammed at the southerly outflow of a large agricultural site, where it continues onwards into Swan Lake, becoming a shallow water/ fresh water marsh as described by Zoltai and Vitt, 1995. (Figure 2)
The impact of water flow and factors contributing to the growth of Reed canarygrass are directly linked. During times of heavy rain fall, this "dam" makes do (somewhat), until there is a particularly intense rain fall period, when the overflow waters pass through unobstructed. If these waters were to be held back, the resulting flooding would negatively impact a "turf farm" located in the Blenkinsop Valley, along with numerous other business ventures dependent upon these waters.

**Figure 2 Blenkinsop Creek (Dam) 2004**
Consequently, huge volumes of water rush through a narrow passage, creating flash flood conditions along Blenkinsop Creek during the rainy season (Figure 3). Swan Lake Site Manager MacGillivray has indicated that Blenkinsop Creek has had numerous reconstruction projects over the years to accommodate possible flooding at Blenkinsop Lake, notably the meandering of Blenkinsop Creek in 2001-02. These reconstruction efforts are merely a band aid solution to a much larger issue; that of appeasing agricultural concerns over the nature sanctuary. As long as water flows in an orderly fashion, flooding of valuable growing lands is spared and Swan Lake takes up the slack.

Figure 3 Aerial Photo Swan Lake Flood 1978
Another important influence when regarding ecological factors and Reed canarygrass growth, is the type of water entering Swan Lake from upstream. Water has a direct bearing on the type and number of plants growing in and around the sanctuary. Run-off from fertilizers and other manufactured growth-enhancers have contributed to the excessive nutrient load (Figure 4) (Zaccarelli, 1975, Daugenet et al, 1999).

Figure 4 Blenkinsop Lake flood plain From Mount Douglas 2004
As well during this time the demand for residential housing has intensified within the entire watershed (Planning Department, Corporation of the District of Saanich, 1999). The municipality's response to the run-off from residential properties is to collect and divert waters (storm drain). But due to the increase of impervious layers this has become a strenuous task. Because of the unpredictability of water flow and human activity, there is still a concern of pollutants and unknown chemicals that could enter the water system and consequently, affect water quantity and quality.

The practice of draining water from Blenkinsop Lake for the purposes of agriculture and silviculture continues. A total of 14 water licenses exist on Blenkinsop Lake (Walter van Bruggen, Ministry of Water Land and Air Protection, 2003) Some of these licenses are issued for the purposes of agriculture, a turf-farm, nurseries, a driving range, and other ventures. The run-off produced by these businesses upstream and experienced downstream has created a near-perfect environment for Reed canarygrass growth (Figure 5). Its response to the excess nutrients is to explode into action; the more sediments, the better. "Bring it on, baby!" one could almost hear the rhizomes singing in the breeze. Authors Green and Galatowitsch (2001) have shown that nutrient addition increases the growth and spread of young *P. arundinacea* clones. When one visits Swan Lake, it would be virtually impossible not to notice Reed canarygrass growing in abundance.
Figure 5 Reed canarygrass at Swan Lake (2003).
Light

Swan Lake Nature Sanctuary experiences nearly 24 hours of light (Grant and Auld, 2004). This luminescence can be in the form of direct or indirect sunlight, along with the brightness of the municipal night lights of Saanich. Regardless of the darkness of the night (e.g. moonless evenings), these lights shine with an intensity seen to the farthest northeastern reaches of Swan Lake. The ecological impact on growth of Reed canarygrass is such that the grass is subjected to an abnormal quantity and quality of light, giving it another excellent growth opportunity.

Vegetation

During the month of October, 2003, four plots were examined for vegetation. Of the four, two consisted of tall shrub, three of flood plain and one of graminoid. The following list indicates the vegetation identified at the site, noting that seasonal plant variations occur.

<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Alisma plantago aquatica</em></td>
<td>Water-plantain</td>
</tr>
<tr>
<td><em>Cirsium arvense</em></td>
<td>Canada thistle</td>
</tr>
<tr>
<td><em>Cornus stolonera</em></td>
<td>Red osier dogwood</td>
</tr>
<tr>
<td><em>Crataegus douglasii</em></td>
<td>Black hawthorn</td>
</tr>
<tr>
<td><em>Glyceria eleta</em></td>
<td>Tall managrass</td>
</tr>
<tr>
<td><em>Hedera helix</em></td>
<td>English ivy</td>
</tr>
<tr>
<td><em>Heracleum lanatum</em></td>
<td>Cow-parsnip</td>
</tr>
<tr>
<td><em>Phalaris arundinacea</em></td>
<td>Reed canarygrass</td>
</tr>
<tr>
<td><em>Potentilla palustris</em></td>
<td>Marsh cinquefoil</td>
</tr>
<tr>
<td><em>Rubus discolor</em></td>
<td>Himalayan blackberry</td>
</tr>
<tr>
<td><em>Salix lucida</em></td>
<td>Pacific willow</td>
</tr>
<tr>
<td><em>Symphoricarpos albus</em></td>
<td>Common snowberry</td>
</tr>
<tr>
<td><em>Typha latifolia</em></td>
<td>Cattail</td>
</tr>
</tbody>
</table>
Fauna

A number of rare species are known to occur in the South Vancouver Island/ Duncan Forest District. Many other rare species likely to occur at Swan Lake were not observed or recorded at the times this report was created. The British Columbia Conservation Data Center (BCCDC) identifies some of the following species at risk. The species observed are in too great a number to fully show in detail for this report but the table below gives an example of species observed at Swan Lake and within the watershed (Personal Communication with Swan Lake staff, 2003). Note: Red listing - threatened, Blue Listing - vulnerable

Table 1 Important Identified Wildlife Species Found at Swan Lake

<table>
<thead>
<tr>
<th>Species Name Birds</th>
<th>Common Name</th>
<th>BC Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tyto alba</td>
<td>Barn Owl</td>
<td>Blue</td>
</tr>
<tr>
<td>Melanerpes lewis</td>
<td>Lewis’Woodpecker</td>
<td>Red</td>
</tr>
<tr>
<td>Pooecetes gramineus affinis</td>
<td>Vesper sparrow</td>
<td>Red</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Species Name Butterflies</th>
<th>Common Name</th>
<th>BC Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plebejus saepiolus insulanis</td>
<td>Island blue</td>
<td>Red</td>
</tr>
<tr>
<td>Euphydryas editha taylor</td>
<td>Taylor’s checkerspot</td>
<td>Red</td>
</tr>
</tbody>
</table>
Discussion And Recommendations

*That land is a community is the basic concept of ecology, but that land is to be loved and respected is an extension of ethics... We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect. - Aldo Leopold*

The primary issue surrounding Reed canarygrass is whether or not one sees it as an aggressive invader or as a process of natural succession. Should people decide that Reed canary grass is merely another plant growing at the edges, then there is no need to consider restoring the area. If, however, one chooses to see the grass as taking over the remaining "nature space" of Swan Lake, then several recommendations for restoration could be considered.

For Swan Lake the following recommendations for restoration could be considered:

* flooding,
* hand-pulling,
* herbicide application,
* controlled burning,
* revegetation,
* climate control
Flooding

Flooding has been a factor in Swan Lake's historical record for several decades. The benefit to flooding this wetland for an extended period of time (up to five years), indicates that Reed canarygrass begins to essentially rot when emersed in a minimum depth of 2.5 metres (Reyes, 2004). The grass does not withstand continual "ponding" (Stannard and Crowder, 2001). Another advantage to flooding the area is that once extinguished, Reed canarygrass will be overtaken by native flora species or be revegetated by more suited plants, such as willow. The disadvantage to this method is that other invasive species could take hold and tip the scale towards another unfortunate cycle.

One natural application of controlled flooding is the introduction and settlement of *Castor canadensis*, or the beaver. This symbol of Canadian ingenuity is also noted for its capacity to build water-tight dam systems. A properly-placed dam site at Swan Lake, namely at the outflow of Swan Creek, would create increased depth to the lake and the surrounding flood plain, which is currently home to Reed canarygrass. If permitted to co-exist in harmony with its environment (including the nearby human inhabitants), then Swan Lake has a real chance of slowing down succession and its deadening effects. However, in reality, people and beavers do not always co-exist happily. Public awareness and education need to be encoded in the Sanctuary's protocols, so that *C. canadensis* and its family could be "adopted" and provided for by the local populace. If a beaver is not readily available to do the work of damming, then human involvement may be necessary at a greater cost. The essential elements remain the same, yet, again, public education needs to be acknowledged and supported.
Lastly, flooding offers the additional benefit of diluting nutrients and other noxious substances. This process would act as a flushing during the rainy season when additional waters could be siphoned off.

**Hand Pulling**

While probably the most environmentally feasible recommendation for Reed canarygrass removal, hand pulling and replanting with other native plant species would also be the most labour-intensive. William MacGillivray has personally pulled Scotch broom *Cytisus scoparius* at the Swan Lake/Christmas Hill Nature Sanctuary for over 15 years and is still facing an uphill battle with this invasive plant! (MacGillivray, 2003). However, hand-pulling could be achieved during the off-growth season of Reed canarygrass when it is least likely to scatter seed and be carried on the pant legs of an unsuspecting restoration enthusiast to yet another location.

**Herbicide Application**

The benefits of herbicide application are based solely on cost: it is relatively inexpensive to purchase and can be applied directly onto Reed canarygrass. However, public perception around herbicide use has become more volatile in recent years and in particular when contemplated in a nature sanctuary. The correct herbicide for application needs to fully understood in terms of proper usage on Reed canarygrass. Stannard et al, (2001), indicate that herbicides can be critical in revegetation strategies and "properly applied herbicides will provide excellent control of reed canarygrass." For consideration of use in Swan Lake however, public support and knowledge would be key components as to whether herbicides could be applied at the sanctuary.
While agricultural and business interests continue to support the use of herbicides within the Blenkinsop Valley, a gradual public awareness is demanding more organically grown produce. These nurseries, sod farms, fruit and vegetable growers and surrounding residents are all learning about the benefits to alternative methods of growing what they need for personal or commercial-use. The resulting shift in behavior only assists the Sanctuary downstream.

**Controlled Burning**

Burning at Swan Lake is somewhat problematic in that its location directly across from not only residential housing, but municipal services buildings, would need to have wide public support. As well, recommendations for burning in a prescribed area needs to consider air quality, time of year and optimum conditions in order to be deemed successful. Antieau, (1999), indicates that the "dead culms and leaves from previous year's growth should be removed prior to starting a flaming regime to minimize the fire and smoke hazards and to create better flame access to emerging shoots." And, burning could take up to 10 to 15 years to be successful according to Reyes, 2004. Flaming, therefore, may be a more viable option than whole-scale burning, but must be considered carefully and take into consideration the time it would take to see results because this practice is more area specific and is quite small in scale.

**Revegetation**

Native willow. Why willow? Because willow has been growing successfully at Swan Lake prior to agricultural efforts, it offers many benefits to the sanctuary. Willow, being a faster and more competitive plant than slower growing tree species has the advantage of "kick starting" design succession (Antieau, 1999). A native species, Pacific willow has a vast root system,
which interweaves with each other, permeating moist spongy soils, creating a mangrove-like swamp environment. These rooty spaces permit other flora to take hold within a wetland ecosystem. Willow has deciduous properties, so it sheds leaves and smaller branches, depositing them into mat-like woody debris. Animals use the debris to build nests, hiding spaces and other airy shelters. In design succession, "early colonizers" can be selectively thinned a few years later, allowing for conifer planting. The benefit of this application is a weakening of Reed canarygrass growth due to a thinned deciduous canopy (Antieau, 1999)

Swan Lake would particularly benefit from increased willow planting mainly because willow "pole wood" can be planted directly into Reed canarygrass habitat. These poles are essentially gigantic live stakes or dormant hardwood cuttings. Pole wood in wetland and riparian restoration has shown promise in areas dominated by the aggressive grass, Reed canarygrass (Link, 1998). This is cost-effective, visually-appealing and relatively easy method has the added benefits of creating instant shading, causing competition to Reed canarygrass. Existing Pacific willow and another excellent native shrub, Red osier dogwood, Cornus stolonifera, could be utilized at Swan Lake.

Climate
The final consideration for restoration of Swan Lake Nature Sanctuary is the most challenging. When we consider climate change or control, what we are really referring to is a need for the Western world to change behavior patterns that have been firmly engrained for over 100 years. As long as we continue to drive the vehicles we do, consume the goods and products at the rate we do and use fossil fuels to do so, we run the risk of increasing global temperatures (Strong, 2004).
The increased residential settlement in the entire Greater Victoria region and increased population in general has meant that local temperatures and weather patterns have gradually warmed over the past three decades and continues to rise. The summers are hotter and drier, the winters have less snowfall and at times, less rainfall. Restoration consultant David Polster (2004), does not see this as such a negative event. A warmer climate offers the Garry oak ecosystem a future, as long as the remaining environment is protected and supported with plantings and monitoring over the coming years.

Summary

Poor Swan Lake! People have been abusing it for decades. It has been a source or recipient of ice making, ice skating, horse racing (in winter), fishing, septic drainage, effluent from wine tailings, herbicide-dumping from agriculture upstream, garbage dumping and animal harassing and killing. Just recently, a beaver trying to establish a home, setup on Swan Lake for a mere few weeks before its nascent dam was mysteriously destroyed over one weekend. Whether the act of naive vandals or one intent on purposeful destruction, the actions of humans on animal populations is one of uneasy tension. People want nature in their backyard, but not too close to live and let live, it seems. Even though the lake was named for a Swan, there used to be the actual bird nesting on its waters. But, no more.

In the nearly 30 years since Zaccarelli’s report, much has been accomplished to deal with encroaching urbanization on a rural environment. Public awareness through programs initiated by individuals and societies and endorsed by the Municipality of Saanich have included:
Naturescape, a program to encourage natural spaces within a residential setting, a heritage tree-identification and maintenance program, an annual tree-planting day, held each September, the completion and maintenance of the Galloping Goose/Lochside Regional Trail system, the Garry Oak Environmental Recovery Team, water restrictions and proper-use campaigns, "brown lawn vs. green lawn" education efforts, recycling and proper disposal programs and "Think Global, Buy Local" campaigns.

As with any recommendation, the measure of its success can only be determined through continuous and supported monitoring. This role is one actively taken on by the staff and volunteers at Swan Lake in the forms of "broom pulls," bird counts, water sampling, youth-focussed nature programs, and an annual fossil fair. Climate control begins on an individual basis and once embraced becomes part of the collective knowledge. Swan Lake Nature Sanctuary is one unique place where urban and rural can co-exist in harmony and the factors contributing to the growth of Reed canarygrass can be limited or even reduced with public education and a little love and respect.
Acknowledgments

I would like to thank the following people for their assistance: the staff at Swan Lake/Christmas Hill Nature Sanctuary for granting me permission to study the area in and around Swan Lake, the Henrich family for all of their support, my partner Ann Auld for assisting me with this project (and putting up with my ...), fellow students who had come out to assist with the collection of field data, and finally, the staff of the University of Victoria Restoration of Natural Systems program. To Don Eastman and Peggy Faulds, many thanks for your guidance and understanding.
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Appendix C: Historical & Recent Pictures
Ecological Factors contributing to the growth of *Phalaris arundinacea* at Swan Lake/Christmas Hill Nature Sanctuary, Saanich, British Columbia.

Aerial Photo of Swan Lake Year 1928
Ecological Factors contributing to the growth of *Phalaris arundinacea* at Swan Lake/Christmas Hill Nature Sanctuary, Saanich, British Columbia.

Aerial Photo of Swan Lake Year 1985
Ecological Factors contributing to the growth of *Phalaris arundinacea* at Swan Lake/Christmas Hill Nature Sanctuary, Saanich, British Columbia.

Blenkinsop Lake 2004

Blenkinsop Creek (Tunnel under Quadra Street) 2004
Ecological Factors contributing to the growth of *Phalaris arundinacea* at Swan Lake/Christmas Hill Nature Sanctuary, Saanich, British Columbia.

McLean Farm Christmas Hill in the background (1965)
Ecological Factors contributing to the growth of *Phalaris arundinacea* at Swan Lake/Christmas Hill Nature Sanctuary, Saanich, British Columbia.

Swan Lake 1913. Taken from Swan Lake Hotel - Looking towards the now existing Nature Sanctuary.