UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program
Student Research Report

An Examination of Animal Food Sources in Totem Residences
as they contribute to UBC Community Biodiversity Green Corridor Landscape

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University of British Columbia
APBI 497B
Themes: Biodiversity, Food, Land
November 17, 2017

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SEEDS: Mapping Animal Food Sources- UBC, Totem Residences
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Acknowledgements

I gratefully acknowledge that the land on which we gather at UBC-Vancouver is the unceded traditional territories of the Coast Salish peoples, including the territories of the xʷməθkwəy̓əm (Musqueam), Skwxwú7mesh (Squamish), Stó:lō and Səl̓ílwətaʔ/Selilwitulh (Tsleil-Waututh) Nations.

I would also like to extend my most sincere thanks to everyone who has contributed to the success of the Seeds Mapping Food Sources project. It is our hope that the findings of this report will serve to improve the biodiversity of the UBC Green Corridor project enabling species at risk to thrive and regain Totem wetlands.

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Abstract

The purpose of this study is to continue the University of British Columbia Biodiversity Green Corridor project located within Totem Residence area. Specifically, to provide four species at risk, through knowledge of their habitat and food sources with those advantages necessary to thrive yearlong in this area. Understanding habitat quality and food sources for animals and birds is crucial for landscape architects and managers. For managers to understand where the distribution of food sources for species at risk are located, the quality of food sources and identification of species must first be measured. The scope of this project allowed for this student to photograph Totem food sources whilst on other occasions join a walk of this grid with UBC Birding Club members identifying those birds and mammals at risk. Once those species were identified these photographs were loaded onto Google Maps which then could be downloaded into KML network links. Next these files can be opened in Google Earth by Landscape Architects to view the map. In addition, UBC landscape design maps from 1960s to present day, identified those plants that had been planted within the grid area. The student then compared with what had existed with what this student found on her ecological studies. One plant invasive species was discovered, the yellow flag iris which the client, landscape architect explained will be removed from the last remaining wetland area beside Totem forest.

Introduction

This project is part of a larger series of student led research projects pertaining to the Biodiversity Project. The goal of this “Biodiversity Project” is to create a series of student research projects to feed into an exciting new online resource that will integrate campus-specific biodiversity research across different faculties and disciplines and apply the findings to the campus as a living lab project. The online resource will make research and projects done by students more accessible to clients and faculty, informing decision making in planning, landscaping, operations, policy and development plans on campus.

Previous SEEDS projects, (Dyck, et al., 2016) have investigated and mapped habitats, trees, birds, pollinators, and native plants. However, there is currently a gap in understanding how the flora of the campus act as food sources to certain campus species throughout the year, and which ones play critical ecological roles. Knowing what these critical food sources are, where they are on campus, and which ones are missing, would not only guide current landscape operations, but also inform future development of the campus with respect to plant, shrub, and tree selection.

Habitat quality as defined by Hall et al. (1997) in *the Habitat Concept and a Plea for Standard Terminology,* is the ability of the environment to provide conditions appropriate for individual and population to persist. The authors sought to provide standards, and they defined habitat as,

> the resources and conditions present in an area that produce occupancy-including survival and reproduction by a given organism, (p.175).

Working within an operational terminology using concepts that are measurable and accurate, this student aims to build on standardized habitat terminology. In doing so my aim is to make meaningful statements to advance science building on landscape ecology.

Landscape ecology has been defined in several different ways (Risser et al. 1984, Urban et al. 1987, Turner 1989, Pickett and Cadenasso 1995, Turner et al. 2001), but shared among definitions is the explicit focus on the importance of spatial heterogeneity for ecological processes. Spatial heterogeneity refers to the uneven distribution of various concentrations of each species within an area. A landscape with a mix of concentrations of multiple species of plants or animals (biological), filling its area is said to have species richness. The way to discern species richness is simply to count the number of species whilst species diversity takes into account not only species richness but also species evenness. Moreover, when it comes to assessing avian habitat, Johnson, (2007) in *Measuring Habitat Quali*ty, cautions that drawbacks exist when researchers only use plant distribution to reveal habitat quality before establishing how well a given system adheres to patterns of ideal habitat selection by animals, (p.496).

This student was simply asked to photograph and count the number of plants in her given Totem Residences area that she identified as a food source for the four species at risk. The way forward for research considerations by Landscape Architects then would be to digitize these photographs on Google Maps to compare what flora and fauna originally was in these areas from 1967 to 2010 with that of future studies. Landscape Architects then, utilize mapped inventory of habitats through the production of visual digitized files as they are mapped into ArcGIS systems for future research.

Totem residences were built in three phases from the 1960s to 2011. The first phase was Dene House in 1966, Kwakiutl in 1967, and lastly, Hem'lesam in 2010. Advancing operational terminology of landscape ecology, this student compared the 1960s to 2011 landscape planting plans with what she counted and photographed whilst on her bird count walk, (Appendix 1).

Lastly, the student notified the landscape architect there are invasive species of *Iris pseudacorus* (yellow flag iris) within the marsh area across from Kwakiutl. This is the area directly beside Totem forest. The client replied he would instruct his staff to remove *Iris pseudacorus* because it chokes out avian nesting sites of sedges, reeds, and grass.

Literature Review

Through a discussion with Mr. Varner and the University of British Columbia Bird Club, four species at risk were identified: *Tamiasciurus douglasii*, (Douglas Squirrel), *Calypte anna* (Anna's Hummingbird), *Bombus occidentalis*, (Western Bumblebee) and *Hirundo rustica*, (Barn Swallow). Although on the Western Bumblebee and Barn Swallow are listed on the Canadian Species at risk registry, discussions with University of British Columbia's Birding Club members and Mr. Gill outline the need for yearlong food sources to sustain this population during cold winter months. On 29th September, 2017, a bird count was conducted in Totem Residence grid with the UBC's Birding Club members and myself during which we counted *Tamiasciurus douglasii*, *Calypte anna*, and *Bombus occidentalis*, (Appendix 2). Mr. Varner explained that the *Hirundo rustica* have been seen eating insects within Totem. This species mainly nest at Gage Residence.

During the University of British Columbia's Birding Club walk, the student was told that *Tamiasciurus douglasii* eat *Symphoricarpos* (Snowberries, also named Waxberries). The birding Club group observed *Tamiasciurus douglasii* on site at Snowberries picture, and also at rose bushes, (Appendix 1). These berries are not found within the original 1967 Dene landscape planting plans. Yet during her walks photographing she found these plants living within Dene House landscape. The hypothesis that *Tamiasciurus douglasii* were limited mainly by abundance of food, not den sites to old growth forests, (Ransome, 2001) found that when food was added survival "increased significantly or remained unchanged," (p.7). However, populations of *Tamiasciurus douglasii*, Ransome concluded were "not limited by the availability of food or den sites during his study. A review of literature of the *Tamiasciurus douglasii* written by Sanders (1983) and Lehmkuhl (2004) show that the species diet is largely truffles and mushrooms although Sanders also concluded that 12% of their diet is conifers seeds. Sanders concluded that *Tamiasciurus douglasii* eat “both mushrooms and truffles, but eat more of the latter,” (p.10). Weigle (2007), recommended that to preserve the *Glaucomys sabrinus* over its extensive range one will have to consider its various roles including how it is vulnerable to anthropogenic and possible climatic changes in the size, arrangement, and quality of its home forests, (p.897). Wheatley et al. (2005) concluded that the *Glaucomys sabrinus* was neither associated with old-aged or conifer forests, instead they were “habitat generalists”. A generalist species is able to thrive in a wide variety of environmental conditions and can make use of a variety of different resources (for example, a heterotroph with a varied diet). A specialist species can thrive only in a narrow range of environmental conditions or has a limited diet, such as the *Calypte anna*.

Calypte anna was observed 29th September, 2017 (Appendix 1) at the site of rose bushes drinking nectar. Although not on the COSEWIC Designation: Threatened species registry, this avian requires food yearlong in ways it cannot find readily available through floral sources: glucose. Graham et al. (2016) found that wintering conditions impact the timing and condition of birds as they migrate north. The University of British Columbia therefore, must ensure these at-risk birds are adequately nourished yearlong, particularly during winter season. In addition, due to the high energetic cost of flight, Gass et al. (1999) found that *Selasphorus rufus*, (Rufous hummingbirds) whilst migration from BC to Mexico face a real challenge of achieving enough nutrients during flight and thermoregulation at near-freezing morning temperatures. It is critical for UBC to maintain enough nectar-bearing flowers to ensure 30% sucrose dietary intake for this avian species. Gass et al. further explain that these nectar foraging birds have the highest metabolic rates known among vertebrates of which dietary energy intake equal rates of energy expenditure, (p.314). Plasma glucose levels of *Calypte anna* (Anna’s Hummingbird) as one of the world's smallest nectarivorous birds, Beuchat and Chong, (1998) found were the highest ever measured in a vertebrate. Nectar is so vitally important to *Calyptae anna* that they have a remarkable ability to survive with no protein in their diets as long as nectar is available, (Brice, 1991). Maternal *Calypte anna* is selective during afternoon as an adaptive measure while raising young, Carpenter and Castronova, (1980) found, in order to provide a longer-lasting food reserve of proteins to sustain the nestlings overnight. The authors explain further, that their diet is composed of two definitive classes: carbohydrates, consisting of primarily flower nectar, and proteins, furnished by insects, (p.175). To end nocturnal fast, high-carbohydrate nectar would serve as a quick energy source, these authors suggest, while protein-rich insects which are slower to digest energy and have a high specific dynamic action would serve as a longer-lasting heat source for the approaching night. Both foodstuffs, nectar and proteins provide approximately equivalent caloric yield per gram, (Carpenter and Castronova, 1980). Floral nectar is a mixture of sucrose, glucose and fructose, (Chen and Welch, 2014). Chen and Welch found that humming-birds can fuel energetically expensive hovering flight almost exclusively using recently ingested fructose. The authors found that these birds must forage frequently by fueling in flight with ingested monosaccharides to avoid the metabolic cost of fat synthesis from those sugars prior to their oxidization. They found it remarkable that hovering hummingbirds are able to utilize fructose and glucose equally, a physiological feat which "no mammals are thought to match", (p.589). Even to the point of having "novel physiological capacities for the oxidation of fructose by active muscle tissues", (p.589). These birds cannot exist on nectar and protein alone, Flemming and Nicolson, (2003) found because water intake of nectarivores is "intrinsically linked to nectar concentration", (p.1845). Nectar contains important electrolytes for humming birds. These birds shut down water excretion on concentrated diets thereby avoiding electrolyte loss.

Nectarinia osea will consume nectar and liquidized arthropods from artificial feeders, (Markman, 2014). However, the authors further explain they will only feed their young with whole arthropods. Nutrient content is so important to sustain parental care to nestlings, Markman found, that by increasing the rate at which other foods are delivered to their young and to increase the time spent on other parental care activities, higher nutritional value of foodstuffs must be offered. McWhorter et al. (2006), review the foundation for understanding *Calypte anna* foraging ecology that has been shown to be the physiological processes are determinants of feeding behavior. These authors present new findings suggesting that not all sugar uptake is mediated. While they agree hummingbirds have the highest glucose intake of all avian they must rely on passive non-mediated intestinal nutrient absorption to meet their high mass-specific demands. McWhorter et al. (2003), state their results support the hypothesis that nectar-feeding birds have low protein requirements but cast doubt on the notion that they are facultatively ammonotelic. Regulation of energy and water are by necessity closely linked in nectarivores, because the easily available sugars in nectar are accompanied by an excess of water but few electrolytes, (Nicolson and Fleming, 2014, p.1015). Hummingbirds rely on renal water reabsorption, these authors explain, and they do not generally cope with salt loading. These authors further explain that hummingbirds have little plasticity in dealing with digestive and renal challenges of their nectar diet compared to other nectarivores.

A consequence of how floral shape and size as they affect the feeding habits of hummingbirds, is worthy of notice by Landscape Architects, (Sapir and Dudley, 2013). These authors explain that nectar-bearing flowers are “characterized by many different shapes, sizes and orientations, which may affect the way hummingbirds feed from them”. The horizontal orientation of nectar to hummingbird bill was the most frequently visited flower in this study. However, the authors cite a study that found 85% of plant species possessing downward-facing flowers were the most pollinated by hummingbirds,

> We suggest that the prevalent pendent flower orientation evolved not because of the energetic consequences for pollinating hummingbirds, but rather to offset costs related to sun and rain damage, as well as to preclude pollination by unintended agents such as insects and bats, (p.233).

Many humming-bird-pollinated flowers are orientated downwards, thereby requiring that trochilids feed while hovering with the bill vertically upward. The authors studied *Calypte anna* feeding from artificial flowers that were orientated horizontally, tilted 45 degrees downwards and pointing vertically downwards. The authors found that floral orientation was shown to directly influence hummingbird flight energetics which could “presumably have a strong influence on patterns of floral evolution”, (p.233). Higher cost of hovering may reduce flowering attractiveness if it is associated with higher metabolic costs.

As a COSEWIC Designation: Threatened species since 2014, the *Bombus occidentalis* also is threatened globally, (Colla and Ratti, 2010, p.32). The authors build on scholarly knowledge which shows that because baseline data and natural history knowledge for most bee species is extremely scarce, as a result, “important pollinators may undergo drastic declines unnoticed,” (p.32). The authors noted that *Bombus occidentalis* declines in western Canada have been based on personal accounts rather than facts or research, indicating that more scholarly research must be done. Particularly, there are few baseline data for comparing previous and current abundances of *Bombus occidentalis*, the Western Bumblebee. Colla and Ratti provided a comparison of the numbers of *Bombus occidentalis* after 20 years in the Fraser Valley of British Columbia, Canada. This article found that *Bombus occidentalis* was the second most abundant bumblebee in blueberry fields in 1981 as well as the second most common *Bombus* species in natural vegetation. Drastically, this species in 2003-2004 was less than 1% of the *Bombus* collected the authors caution. In cranberry fields *B. occidentalis* was the most abundant bee in 1982 but was only represented by 2 individuals (0.3% of bumble bees) in 2003 and was entirely absent from these fields in 2004. In urban habitat adjacent to this region the *Bombus occidentalis* was also very low in abundance with only 2 individuals, (0.1% of bumble bees) in 2004. Colla and Ratti attest that these results provide quantitative evidence that wild populations of *B. occidentalis* have declined in western Canada. These authors infer that "amplification of diseases from managed bumble bee populations is a likely threat" for the reason of decline. To prevent such a collapse of *Bombus occidentalis* wild populations Colla and Ratti recommend the managed *B. occidentalis* become highly regulated. Regulations would they believe, would prevent not only the devastation of *Bombus occidentalis* and of their loss on native fauna and flora as well as inadequate pollination of agricultural crops.

Along British Columbia and Yukon Territories highways, *Bombus occidentalis* pollinate flowering plants, as they forage. These Bombus have become adapted to cool temperatures. To address the knowledge gap of Northern B.C. populations, a sampling of floral patches along five Canadian highways and southeastern Alaska was done in late summer, 2010 (Hatten, Strange and Maxwell, 2015). In this snapshot survey, 14 Bombus species were observed and found,

> Bombus assemblages to be structured by broad geographic features and regions. The Bombus species *B. occidentalis* and *B. terricola* were relatively abundant in sample sites west and east of the Rocky Mountains, respectively, and *B. (Pyrobombus) vagans*, *B.(Cullumanobombus) rufocinctus*, and *B. identalis* were the most abundant species across all sites, (p.170).

These authors concluded that *Bombus occidentalis* and *B. terricola* are relatively common along ALCAN Highway and were segregated west and east of the Rocky Mountains, respectively, via relatively well-established distribution pattern for these species. Hatten et al., recommended an early-to-mid season study could yield important complementary data on bumble bee communities found along the region's highways. In addition, a "study of roadside management practices for these communities might also be warranted," (p.179).

Researcher Biologists, Koch and Strange, (2012), found that *Bombus occidentalis* are experiencing "dramatic declines" in population abundance, geographic range and genetic diversity. Furthermore, the prevailing hypothesis concerning their decline is the transmission of the intracellular fungal pathogen, *Nosema bombi* (Microsporida), and other pathogen species from commercially reared bumble bees to wild populations. These authors also cited an Alaskan *Bombus occidentalis* knowledge gap. *Bombus occidentalis* was the most abundant species collected in the survey and prevalence of *Nosema bombi* infections was the highest in this species. However, despite this infection the numbers of *B. occidentalis* was commonly detected in sampling surveys which the authors suggest may provide important insights on the role of pathogens, especially *Nosema bombi* in bumble bee decline in U.S.A.

A study done by Nguyen and Nieh, (2011), tested the ability of the *Bombus occidentalis* species to stimulate colony foraging for food varying in quality. They then analyzed the behaviour of successful foragers inside the nest to learn more about potential foraging activation movements. Nguyen and Nieh outlined their study methods thus, "the number of bees entering a foraging arena was positively correlated with food sucrose concentration" and "foragers spent significantly more time imbibing higher concentration solutions," (p.60). Additionally, the forager's path inside the nest significantly increased with sucrose concentration. Scientists, Rao et al., (2011), reiterated the dramatic decline of the *Bombus occidentalis* was mainly due to pathogens introduced into the wild from captive-bred bumble bees used for pollination of greenhouse crops. This study focused on Oregon's western and southern regions and noted only 10 individuals have been recorded since 2000. However, Rao et al., note that mainly due to geographic isolation or potential resistance to the pathogens that decimated populations in the western parts of Oregon, *Bombus occidentalis* populations persist in northeastern regions of the Pacific Northwest. Future research is required to determine *Bombus occidentalis* occurrence in other regions of its historical range to assess the extent of the decline. Also critically important the authors attest, is for protection of this species in both agricultural ecosystems and in native habitats. Sheffield et al., (2016), reiterate the species decimation and the intense need for conservation action under strict "designatable units" as they are clearly defined to prevent catastrophic loss. They mention that several species of bumble bee are currently threatened. Their article focused on *Bombus occidentalis* which is a conservation concern for North America and has declined throughout its range. The southern *Bombus occidentalis* ranges throughout western United States and into western Canada from southern Saskatchewan and Alberta, and throughout British Columbia north to ca. 55-degree North. These authors agree the likely cause of mortality has been in part to exposure to "novel" parasites. The article focused on species recognition between Bumble bees partly due to the evidence they provided that the *Bombus occidentalis* sister species was the more stable population of the two towards parasite resistance.

The diet of Hirundo rustica is best noted in entirety by Orlowski and Karg (2011) in those avain living in Poland,

> Analysis of faecal sacs of nestling *Hirundo rustica*, Barn Swallows from 52 breeding colonies located within fifteen spatially-separated villages in Poland has revealed that the basic component of the diet was Coleoptera (56.1% of all identified prey items), followed by Hymenoptera (24.1%), Diptera (16.1%) and Hemiptera (3.3%). The average mass of all prey items with known weight amounted to 3.40 mg (95% CL, 3.16–3.63 mg;

> median=0.49 mg) dry weight. Coleopterans associated with dung and manure jointly made up 23.5% of the number and 24.3% of the total biomass of all representatives of the order. Statistically significant negative relationships between the average weight of prey and number of prey found in 52 analyzed breeding sites suggest a particular need for Barn Swallows to find larger-bodied prey rather than to exploit the local abundance of smaller prey. The high percentage of Coleoptera in the diet of nestling Barn Swallows probably results from extensive or traditional farm management based on rules of organic farming in agricultural areas of central Europe, mainly commonly used organic fertilizers, and suggests the importance of these insects as a more easily accessible and larger-bodied prey in comparison to some small Diptera or Hymenoptera. We believe that a large number of randomly collected faecal samples from tens of breeding sites allow us to precisely describe variation in the diet of the Barn Swallow. Our work has great importance for documenting of the food composition of the Barn Swallow in traditional European countrysides, i.e. under environmental and agricultural conditions which, as a result of transformations of the system of farming, ceased to exist in the western and northern part of this continent, (p.1023).

These authors (2013) writing on another Polish study also concluded that the *Hirundo rustica* was the least diverse among insectivorous avian, of House Martins, Swallows and Swifts. Diet was determined through faecal analysis. Average body mass of all prey found in the diet of Swifts was nearly three times smaller than in Swallows and two time smaller than in House Martins. Their findings show that three species consume the same types of insect prey, but they take different proportions, and "hence biomass, of the major prey groups. House Martins had the widest niche and greatest overlap," (p.475).

Researchers Orlowski and Kang (2013) examining the effects of livestock farming on *Hirundo rustica* diet showed,

> Our results imply that Barn Swallows were foraging beyond the immediate area of the farm buildings in which they nest, suggest considerable adaptability in the species' diet and further emphasize the ecological role that livestock play in providing a source of prey of a required size rather specific identity. Furthermore, a statistically significant positive effect of average mass of prey (which is a direct consequence of the presence of cattle at a breeding site) on colony size suggests that livestock farming provides a more profitable prey community, which may ultimately increase local populations of Barn Swallow, (p.111).

The *Hirundo rustica* has been a COSEWIC Designation: Threatened species since 2011 by the Canadian Species at Risk Act, SARA. Authors, Arena, Battisti and Carpaneto (2011) studied

Italian coastal *Hirundo rustica* to detect differences in habitat use and seasonal dynamics among other Barn Swallow species. Two types of habitat were surveyed: wetlands consisting of reed beds and rush beds as well as altered habitats, consisting of orchards and urban areas. Comparing all species showed that swifts reached the highest mean point density in altered habitats. At first, all breeding species were numerous in wetlands until these sites become exploited when aerial foragers arrive whereby the swifts shift to urbanized or reclaimed zones for nesting after some ten-days. The decline of North American Chimney Swift populations which are aerially-foraging insectivorous bird populations was noted by Fitzgerald et al. (2014) who explained has been ongoing for decades now. These authors cite the hypothesis that this decline is due to habitat loss. The University of British Columbia's *Hirundo rustica* nest at Gage Residences whilst forage in Totem Residence and Totem field areas as observed by Mr. Varner. Chimney Swifts (*Chaetura pelagica*) Fitzgerald et al. assessed in their study because nest site use and availability is easily assessed. Their findings showed that *Chaetura pelagica* prefer an average chimney that had a greater length exposed above the roofline and greater inside area, which were not associated with residential buildings. They applied the ldf coefficients to predict chimney occupancy in three southern Ontario communities, and found that given that >75% of suitable sites were unoccupied, therefore swifts are not likely experiencing competition from habitat saturation. Fitzgerald et al. discussed that based on their results, Chimney Swift populations and likely other aerially-foraging insectivorous birds, are limited by other processes not measured in their study, such as changes in prey. The *Hirundo rustica* was studied in U.K. by Henderson et al. (2007) to provide a nationally representative data on habitat selection in foraging barn swallows. They found that cattle were the single most important and most consistent variable associated with foraging *Hirundo rustica* in every U.K. region. Horses were also important in the southeast. Grassland was only important if livestock was present. Foraging rates were higher where count circles contained a mixture of grass and arable fields rather than just one or the other. The authors results showed there was a

> general positive relationship between foraging pass rates and the presence of tall trees in boundaries, and this was significant in the arable eastern region of U.K., where their relative importance of concentrating prey may be more acute, (p.371)

Henderson et al. concluded that historical changes in the distribution and availability of habitat features associated with foraging *Hirundo rustica* in U.K. are consistent with regional differences in population change for this species. These patterns of association are discussed in terms in land use, the widespread loss of mixed farming and simplifications to landscape complexity.

The challenge then remains how to diversify landscape for *Hirundo rustica* survival? To reiterate authors, Henderson et al. (2007), Grassland was only important if livestock was present. Foraging rates were higher where count circles contained a mixture of grass and arable fields rather than just one or the other. How is University of British Columbia to succeed in enabling this type of ecological biodiversity? A warning is sounded by (Stanton et al., 2015 p. 637) who suggest males are less able to attend to nesting requirement whilst foraging longer distances when food is scarce close to nesting areas. Tachycineta bicolor, (Tree Swallows), especially males, breeding at agricultural sites spent more time away from the nest box, presumably foraging, resulting in reduced nest attentiveness. RFID technology provides an effective technique to measure behaviour in birds and these findings suggest mechanisms by which prey abundance and agricultural land use may affect declining aerial insectivorous bird populations.

Methodology

Throughout summer and fall of 2017, the student took walking tours of Totem Residence planted areas that had been identified of interest by Mr. Thrift and Mr. Varner, whilst taking photographs of potential food sources for these fours species. She also spoke with two University of British Columbia's Botanists to help her identify those plants she had photographed in various stages of spring, summer and autumn growth and decline. It was not until 29^{th} September, 2017 when she joined a walk with the University of British Columbia's Birding Club members that she was able to see first-hand those species actively foraging for the food sources she had photographed, (Appendix 1 and 2).

A digitized repertoire for Landscape Architects use, as "My Google Maps" of the UBC Totem Residence grid was created by this student who added her photographs to those areas seen during the 29^{th} September bird count walk where the three-people present had witnessed the four-species foraging for food, (Appendix 4).

As a Geography undergrad, the student was actively reading UBC Geography department, Dr. Brian Klinkenberg's *BC Flora* and *BC Fauna* websites, (Appendix 6) for a greater insight into plant and animal identification methods.

Analysis

The student created a SEEDS Google Map of Totem Residence area (Appendix 4) and attached her photographs after observing these animals and avian foraging. She read through the 1960s to 2010 and 2011 University of British Columbia's Landscape Planting Plans to count those plants originally planted in the key areas she identified with UBC Birding Club members during the 29th September walk. A comparison of what was originally was in the area with what has been counted in the same area this Summer and Fall 2017 was then compared to establish what remains or has been overgrown by any invasive species. She identified any animal species at risk and examined how optimum species survival could be established and maintained.

comparison of original landscape planting plans w/what exists today in the exact same spot. I'll simply count #'s and add photos to My Google maps to transfer into KML files for future reference.

Under consideration in observing habitat quality she asked, "did the original landscape architects in 1967 have these threatened species' biodiversity habitat under consideration and how do these species now create an urgency to prevent their extinction?" In addition, how can UBC create enough biodiversity to sustain Threatened Species' overall habitat richness? Will UBC enable the Hirundo rustica, Barn Swallow, found nesting in Gage Residence (refer to Tetrapods Excel chart), to forage in open fields especially when their bio-diverse spatial areas that include farmland and livestock contributing enough insects to maintain a healthy community? What is UBC doing to preserve Hirundo rustica's Gage Residence nesting areas? How can UBC enable there is enough food for Calypte anna, Anna's Hummingbird yearlong when glucose is the most important foodstuff even more critical then protein a study found? Is UBC considering ways to control the invasive, Sciurus carolinensis, Eastern Grey squirrel which a study found endangers the native Tamiasciurus douglasii, Douglas Squirrel through their aggressive behaviour controlling food sources?

On the September birding club count of Totem grid the *Tamiasciurus douglasii* and *Calypte anna* were both seen feeding at Dene House gardens. During the summer, this student saw

during her walks the *Bombus occidentalis* pollinating *Calluna vulgaris,* common heather at Dene House gardens.

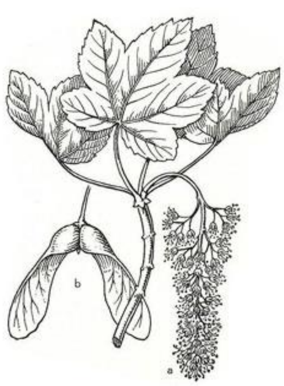
An overview of the original landscape plans reveals of those seeds that drop to the ground, and all

shrubs and plants growing above the ground;

Dene House (1966):

Tsuga heterophylla (Western Hemlock) five plants which contain enough coniferous cones to make up *Tamiasciurus douglasii* diet of scales which they pull off and eat. The tree associated with temperate rain forests holds moisture necessary for hydration. One *Quercus alba*, Wild Oak tree was planted which drops acorns the student saw and photographed as seen eaten by *Tamiasciurus douglasii.* Seventeen of the *Stranvaesia davidiana*, also known as the Chinese photinia were planted which are of the Rosaceae (Rose) family that have red fruit eaten by birds and *Tamiasciurus douglasii.* Seventeen *Pseudotsuga menziesii*, (Douglas Fir) were planted which drop cones eaten by *Tamiasciurus douglasii* and birds. Fourty flowering fruit shrubs of the Japanese *Skimmia japonica* were planted bearing berries eaten by birds and *Tamiasciurus douglasii*. Of the heather family which were witnessed pollinated by *Bombus occidentalis* are 20 *Pieris japonica*. Fourty-four *Cotoneaster 'cornubia'*- deciduous shrubs with simple, entire leaves and clusters of small white or pink flowers in spring and summer, followed by showy red, purple or black berries were planted. The

student witnessed red, purple and black berries which are eaten by animals, bees pollinate the flowers and hummingbirds drink nectar. Three Korean-native cherry trees, *Prunus × yedoensis* were planted which are then pollinated by bees. Seventeen *Cotoneaster salicifolius* were planted which yield red berries eaten by animals. Its



cousin, *Cotoneaster salicifolius repens* provides avian and squirrel ground cover. One-hundred-fifty-five plants were planted. This student witnessed numerous plants on her walk of Dene House. One *Acer pseudoplatanus,* (Maple tree) was planted which drops seeds (pictured – courtesy of *Plants for a Future: Acer pseudoplatanus* website) eaten by birds and squirrels. Fourty *Hypericum patulum 'hidcote'* were planted which bear bright yellow flowers also known as St. John's Wort. They are a deciduous shrub which provides avain ground cover. The yellow flower is very fragrant which may or may not provide nectar for hummingbirds and pollination sites for bees. Thirteen *Cotoneaster franchetii* which bear red berries were planted which may or may not be food sites for animals. Eight *Forsythia 'lynwood gold'* which yield bright yellow flower grow up to 10 feet may or may not provide bee pollination sites. Fifteen *Philadelphus 'Bouquet Blanc'* or Mock orange 'Bouquet Blanc' is an early summer or mid-summer, fragrant, semi-double to double, white flowers borne singly or in clusters, which would most likely provide avian nesting sites as well as bee pollination sites. One *Cornus florida rubra*, flowering dogwood was planted. Thirty and thirty-two Rhododendron, 'coral bells' and 'gumpo' respectively were planted. These plants would provide avian nesting sites however shockingly are toxic to bees. Here is Countryfile Magazine: British Countryside, an expert guide to the top ten plants that landscape architects and managers should avoid to keep bees happy and buzzing, plus the perfect alternatives from their website: http://www.countryfile.com/countryside/top-ten-plants-are-bad-bees

> rhododendron hides a poisonous secret – its nectar is toxic to bees. ... The resulting honey from rhododendrons has also been known to contaminate honey, making it unsafe for humans to eat, courtesy of 'Top ten plants that are bad for bees' website which goes on to say, Lavender, alliums, fuschias, sweet peas - keen gardeners know the very best flowers to entice bees to their gardens. But what about plants that are bad for bees?

Thirteen *Philadelphus virginalis 'virginal'* which bear very fragrant white flowers lasting only

two-weeks at the most do not provide enough nectar for humming birds due to the short flowering life-cycle. Eighteen and 28 *Ceanothus 'Gloire de Versailles'*, and *'Marie Simon'* respectively which the student confirms are a "butterfly magnet" and took a photo of a white butterfly within the flowers. The low-growing shrub, *Leucothoe axillaris*, Coastal doghobble, *Ericaceae* (Heath Family), are bee pollination sites of which 17 were planted in 1966. Unfortunately, these shrubs are poisonous to humans. The North Carolina NC State University website of plants, states that the poison part are the leaves and nectar from flowers, with the poison delivery mode as ingestion. They caution that the poison risk severity is highly toxic, and may be fatal if eaten by humans. This shrub is best in a forested areas or natural areas in wet woodlands; on a landscape as a cultivated woody ornamental shrub. Humming birds may be able to gain nectar from the flowers.

Hem'lesam (2010-2012) planting plans:

Thirty-One *Amelanchier alnifolia,* (Saskatoon Serviceberry) were planted which are excellent squirrel berries members of the UBC Birders Club mentioned. Fifteen *Acer circinatum,* (Vine Maple) drop seeds eaten by squirrels and avians. Nine *Pinus contorta*, (Shore Pine) provide seeds for avians and squirrels as noted above. Poisonous 42 and five *Azalea 'Northern Lights'* and *'Orchid Lights'* respectively, were planted which are flowering shrubs in the genus *Rhododendron*, particularly the former sections *Tsutsuji* and *Pentanthera*. Azaleas bloom in spring, their flowers often lasting several weeks which may or may not provide nectar to humming birds. One thousand-five-hundred-twelve *Mahonia aquifolium 'Compacta'* (Compact

Oregon Grape) were planted providing squirrel and avian food. Fifty-Eight *Ribes sanguineum 'King Edward VII'* (King Edward VII Flowering Currant) were planted providing squirrel and avian food.

Seventy-three *Rosa acicularis* (Prickly Rose) were planted providing humming bird nectar and bee pollination sites. Two-hundred-eighty-five *Symphoricarpos mollis,* (Creeping Snowberry) were planted providing squirrel and avian food.

https://drive.google.com/open?id=18VwAOMqbNeyn6O509IpHc7jM7sEZZxeG as photographed by the student and added to her My Google Maps grid. One-hundred-ninety-eight *Vaccinium ovatum 'Thunderbird'* (Thunderbird Evergreen Huckleberry) were planted providing autumn squirrel and avian food, courtesy by *Fresh by Northwest* website. Three-hundred *Vaccinium vitis-idaea* (Lingonberry) the Northern Mountain-Cranberry *Ericaceae* (Heath family) were planted which the *Lady Bird Johnson Wildflower centre* website claims can be used throughout winter for animals to eat, as well during flowering season produce nectar for humming birds in their bell-shaped flowers,

> Pink, bell-shaped flowers occur in small, terminal clusters and are followed by red, edible berries. A low, evergreen shrub with creeping stems and upright branches bearing small, terminal clusters of pink, nodding, bell-shaped flowers. The acidic fruits, sometimes called lingonberries, are somewhat bitter but can be used as a substitute for regular cranberries when cooked. They often overwinter on the plant and become sweeter by the time the snow melts.

Four-hundred *Fragaria vesca* (Woodland Strawberry) were planted however either this student

did not visit at the most opportune moment, she only photographed one solitary plant which provide both squirrel and avian food. The *Gaultheria procumbens,* (American Wintergreen), 1,444 plants were planted which native to North America produces a red teaberry which is safe enough to eat. The *Polystichum munitum,* the western sword-fern, is an evergreen fern native to western North America, where it is one of the most abundant ferns. It occurs along the Pacific coast from southeastern Alaska to southern California, and also inland east to southeastern British Columbia, and the spores would be eaten by squirrels of which 1,043 were planted.

<u>Kwakiutl House (1967)</u>:

These plants were written directly onto the plans and not in an itemized list as were the other plans. The student cannot find out where the marsh is that adjoins the Totem forest which is also across from Kwakiutl House. These plans appear to be around the House itself? More knowledge is required. I am requiring this are where the squirrel is and is also bounded by a concrete curb

https://drive.google.com/open?id=0B33OpHNPilbrZjh2WjhQamNvdkk

https://drive.google.com/open?id=0B33OpHNPilbrNTVQbzBza25jOGc

https://drive.google.com/open?id=0B33OpHNPilbrNWNHWUl1NDV2N0E

The student does see that 40 *Mahonia Aquafolium* (Oregon Grape) were planted which are both squirrel and avian food.

Also of note in the area which may be within this marsh area the 1967 landscape architect noted that in “this area” the following additional plants to be included are:

15 *Pinus Nigra* (Austrian Pine) 6 to 8 feet

10 *Tsuga Heterophylla* (Western Hemlock) 6 to 8 feet and

10 *Pseudotsuga Taxifolia* (Rocky Mountain Douglas fir) 6 to 8 feet

which would drop cones for squirrel food sources.

Significance

Habitat loss is the most significant threat to *Hirundo rustica* survival due to simplifications to landscape complexity as observed by Henderson et al. (2007) in the United Kingdom. Both the *Hirundo rustica* and *Bombus occidentalis* are listed as threatened on the Canadian Species at Risk Act Registry, SARA with a COSEWIC Designation as a Threatened Species. The *Bombus occidentalis* once was prevalent throughout the countryside however, now due to parasites introduced through commercially managed Bumblebee populations of the greenhouse industry, has a great conservation need to become protected by those Landscape Architects and custodians as a part of ecological biodiversity (Appendix 3). The *Calypte anna* requires as the literature suggests, regular glucose feeders installed during cooler non-growing seasonal temperatures because the species lives within UBC yearlong. The invasive *Sciurus carolinensis*, (Eastern Grey Squirrel) observed during the 29th September 2017 UBC Birding Club walk is more aggressive than the much smaller *Tamiasciurus douglasii* robbing forests of food the Douglas Squirrel requires (Appendix 5). Planting more *Symphoricarpos* (Snowberries, also named Waxberries) would enable *Tamiasciurus douglasii* observed at Dene House, survive.

Future Research Directions

The invasive species of *Iris pseudacorus* (yellow flag iris) has overtaken the sedge beds, reeds beds, cat tails bed and grass beds within the marsh area across from Kwakiutl. This is the area directly beside Totem forest. The client replied he would instruct his staff to remove *Iris pseudacorus* because it chokes out avian nesting sites of sedges, reeds, and grass.

Investigation of how the marsh has receded from Totem Residence area over the 1967 Landscape planting plans to the completion of 2011, third phase would show how groundwater could be restored to the remaining marsh area. Frogs have been seen in the area south of Totem field and used to live within this Totem marsh area.

Sciurus carolinensis (invasive Eastern Grey) squirrel must be relocated under live capture. In this it has been shown they deforest food sites used by *Tamiasciurus douglasii*.

Glucose feeders during winter and cooler temperature months should be installed for *Calypte anna's* survival. These feeders must be kept clean with clear glucose solutions. The literature points to the fact that glucose is even more necessary for the species survival than protein. The feeders must be kept at a horizontal beak position enabling regular visitation by *Calypte anna*.

Noise was a factor in habitat loss and food avoidance the literature suggests, which must be kept to normal levels within residential areas.

Biodiversity of habitat preventing loss of mixed farming and simplifications to landscape complexity would enable the Gage Residence nesting site *Hirundo rustica* to forage within Totem Residence area and surrounding Totem Field.

Everything must be done to promote *Bombus occidentalis* survival by creating bee houses similar to the Mason bee's homes that have been built near the Department of Forestry apple tree grove. Size of bee entry-hole is critical because the smaller bee would require a hole entry suited to its size.

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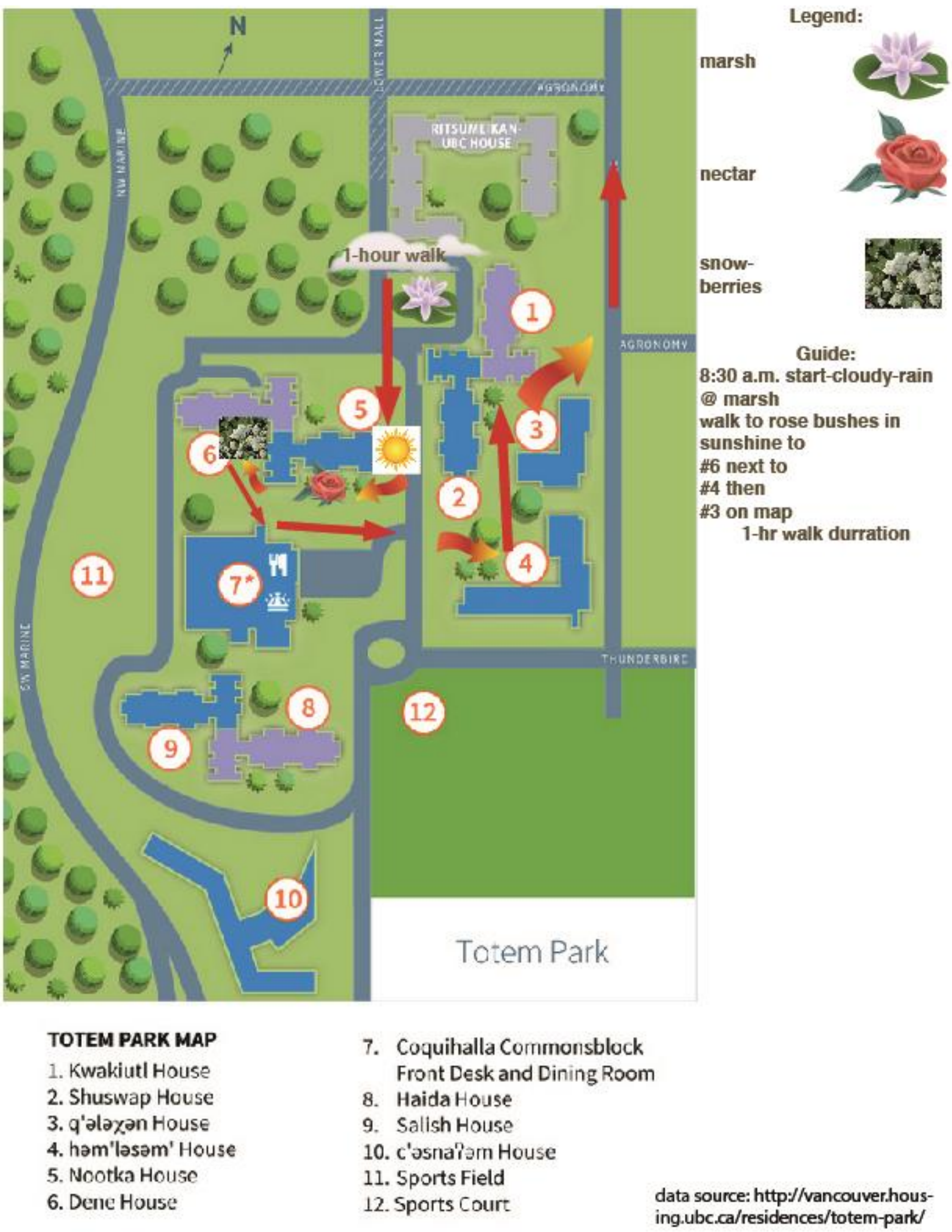
Appendices

1. Madden Totem SEEDS grid taken from UBC website:

   http://vancouver.housing.ubc.ca/residences/totem-park/
2. UBC Birding Club 29.09.2017 walk 8:30 am to 9:40 am field notes
3. Species at Risk Registry; http://www.registrelep-

   sararegistry.gc.ca/sar/index/default_e.cfm
4. SEEDS Google Map of Totem Residence area
5. Eastern Grey Squirrel is an invasive species and threatens Douglas Squirrel habitat
6. BC Flora & BC Fauna websites, UBC Dept. of Geography
7. Map of plant locations

<u>Appendix 1</u>



Appendix 2

Time | Location/species/count | Weather

0830 End of Lower Mall-Wet land adjoining Totem Park-Across from Kwakiutl House overcast rain has stopped

2 NoCr (North West Crows)
5 SoSp (Song Sparrow)
1 Annas Hummingbird – taking nectar from exotic flowers
1 Eastern Grey (Black colour) squirrel
2 Golden Crown Kinglets (conifers & shrubs)
0850 heard SoSp (Song Sparrow) in rushes
20 Bush Tits
1 Pacific or Marsh Wren (in ferns) or could have been an East Wren

Walked around Nootka House from grass area now facing Dene House
Flurry of activity: sunshine gives warm, bright-light

1 Douglas squirrel leaping from trees runs along wall
5 Chickadee
1 Junco
0915 1 Stellar Jay
1 Robin
2 Spotted Tohe
1 Golden Crown Sparrow
1 Anna Hummingbird at Rose bushes taking nectar – roses in full bloom
1 Eastern Grey squirrel
2 Eastern Grey (Black) squirrels
1 SoSp
1 Chickadee

0920 walked from Dene heading East in front of Totem Park Residence to base of Thunderbird cul-de-sac & grassy round-a-bout sunshine strong-remains for remainder walk

0925 3 SoSp
1 Tohe
1 Chickadee
1 Junco

0930 walked from cul-de-sac along pathway to həm'ləsəm' House to next ink drawing on map Greg Thrift Head Gardener drew

1

Time Location/species/count Weather

	1	Glaucuswing gull
	2	Juncos
	2	SoSp
	1	NoCr (North West Crow)
	1	Rock Pigeon
	2	(additional) SoSp
0935	1	Northern Flicker
	1	European Starling (invasive species)

0940 walked along West Mall from həm’ləsəm’ House behind Shuswap in front of q’ələχən House

(picture is facing south looking down sports field with buildings on East-side) the largest building is Coquihalla Commonsblock - also called Totem Park Residence) we walked in front of this largest building to walk @ 0925 towards West Mall

in front of q’ələχən House:

looked at drainage run off into recessed “large planter dug into ground” which is too close to buildings for bird nesting sites- however has clean rain water run off which runs under sedges and reeds for birds to get water and protection.

Walked along Agronomy Road heading East stopping to look at community garden and on to Thunderbird Crescent on top of grassy knoll where Totem pole is.

	1	Tohee
	1	Stellar Jay
	1	Jay (Blue) because of head is blue colour - They appear during the autumn/fall period.
	1	Fly Catcher
	1	Warbler
0950	2	Starlings they are sitting on top of Totem pole about 9’ high? Need binoculars to see them.

Now we are outside Forestry department walking South toward apple trees. In front of us to our right-hand facing West-side is conifers and shrubs.

	1	Eastern Grey squirrel
	1	Golden Crown
	2	Finches – American Gold at apples on ground beside apple trees

1000 walked down around the other side of Thunderbird Crescent now facing East beside conifers and shrubs beside Mason bee hives

	3	Junco on grassy hill eating the bugs in grass
	1	Warbler
	2	sparrows – 1 is a Golden Crown the other 1 is a Ruby Crown sparrow

2

Time Location/species/count Weather

	10	Juncos now join all the other Juncos on grassy hill eating the bugs in grass
	1	Rock pigeon
	1	Tohee
	1	American Gold Finch
	1	Finch (House Finch)

This concludes our walk/bird count tour we walk along West Mall stopping at Biodiversity Museum and Research centre to see birds at bird feeder then on to bookstore patio.

3

<u>Appendix 3</u>

Species at Risk Registry

http://www.registrelep-sararegistry.gc.ca/sar/index/default_e.cfm

Appendix 4

(SEEDS Madden Grid 2017)

https://www.google.com/maps/d/edit?hl=en&mid=12qhTXtyhzhhz2AvMFSb2MPB6oww&ll=49.25896433881307%2C-123.25104611163943&z=18

Appendix 5

The invasive species the Eastern Grey Squirrel threatens Douglas Squirrel habitat:

Government of British Columbia, Vancouver Island "Alien Alert" brochure:

http://www.env.gov.bc.ca/van-island/wildweb/pdf/alien_sp_alert_brochure291009.pdf

Appendix 6:

University of British Columbia, Department of Geography,

Dr. Brian Klinkenberg, editor and project coordinator of *BC Flora* and *BC Fauna* websites:

http://ibis.geog.ubc.ca/~brian/

<u>Appendix 7</u>

Map on page 44

Hem'lesam

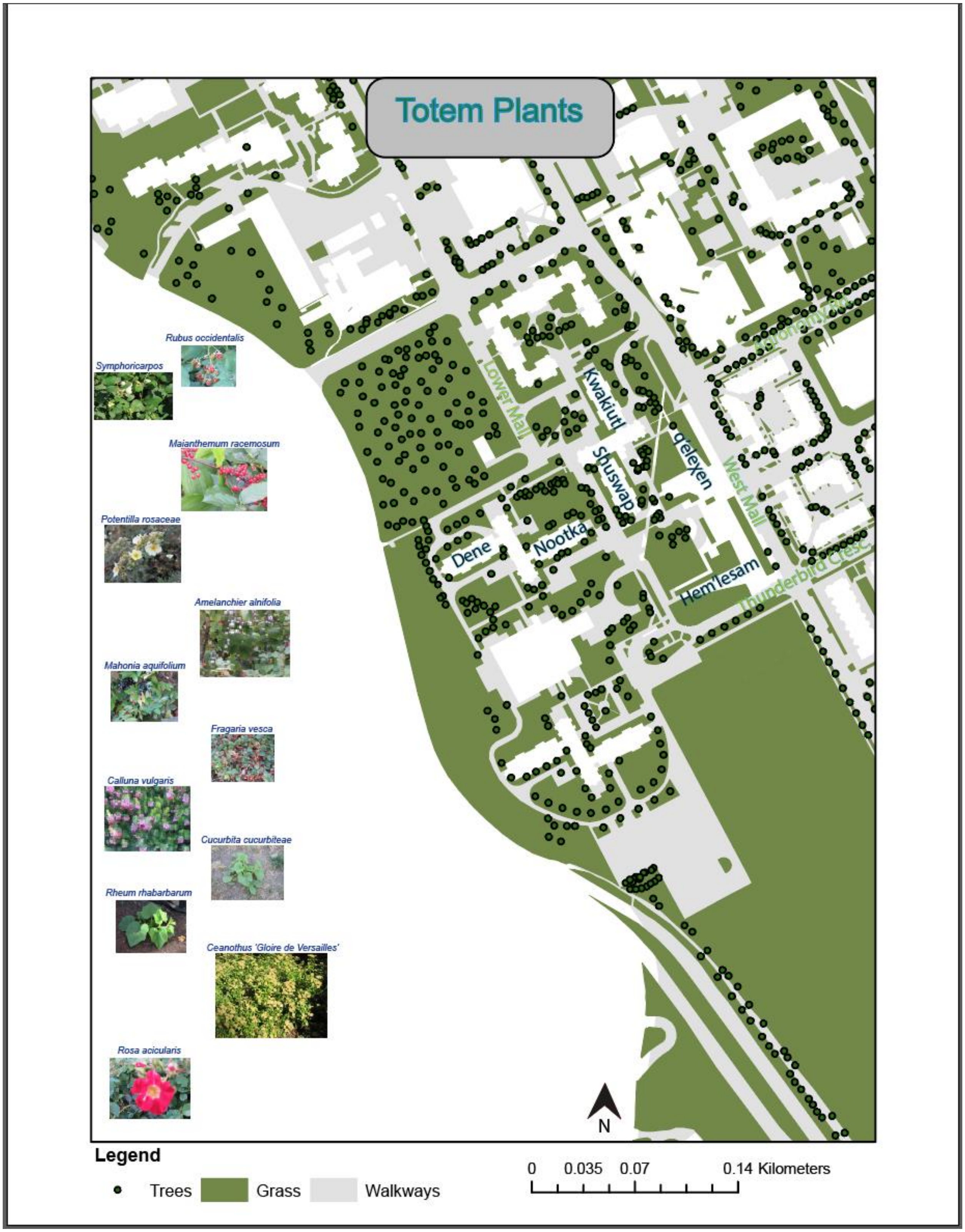
1. *Amelanchier alnifolia* - eaten by *Tamiasciurus douglasii*
2. *Pinus contorta*, (Shore Pine) eaten by *Tamiasciurus douglasii*
3. *Rosa acicularis* (Prickly Rose) - nectar for *Calypte anna*
4. nectar for *Bombus occidentalis*
5. *Mahonia aquifolium* - eaten by *Tamiasciurus douglasii*
6. *Symphoricarpos mollis*, (Creeping Snowberry) - eaten by *Tamiasciurus douglasii*
7. *Vaccinium ovatum* 'Thunderbird' (Thunderbird Evergreen Huckleberry) - eaten by *Tamiasciurus douglasii*
8. *Vaccinium vitis-idaea* (Lingonberry) - eaten by *Tamiasciurus douglasii*
9. *Fragaria vesca* (Woodland Strawberry) - eaten by *Tamiasciurus douglasii*

Kwakiutl

1. *Mahonia Aquafolium* (Oregon Grape) - eaten by *Tamiasciurus douglasii*

Dene

1. *Stranvaesia davidiana*, also known as the Chinese *photinia* - nectar for *Calypte anna*
2. Japanese *Skimmia japonica* - berries - eaten by *Tamiasciurus douglasii*
3. flowers - nectar for *Bombus occidentalis*
4. nectar for *Calypte anna*
5. *Cotoneaster 'cornubia'* - eaten by *Tamiasciurus douglasii*
6. *Cotoneaster salicifolius*
7. *Ceanothus 'Gloire de Versailles'* - butterfly bush


Totem Plants
Rubus occidentalis
Symphoricarpos
Maianthemum racemosum
Potentilla rosaceae
Amelanchier alnifolia
Mahonia aquifolium
Fragaria vesca
Calluna vulgaris
Cucurbita cucurbiteae
Rheum rhabarbarum
Ceanothus 'Gloire de Versailles'
Rosa acicularis
Lower Mall
Kwakiutl
qelexen
Shuswap
West Mall
Dene
Nootka
Hem'lesam
Thunderbird Cresc.
N
Legend
Trees
Grass
Walkways
0 0.035 0.07 0.14 Kilometers