Finding Our Roots: Ethnoecological Restoration of *lhásem* (*Fritillaria camschatcensis* (L.) Ker-Gawl), an Iconic Plant Food in the Squamish River Estuary, British Columbia.

by

Leigh Joseph
B.Sc., University of Victoria, 2010

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of the Requirements for the Degree of

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in the School of Environmental Studies

Supervisory Committee

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Dr. Nancy Turner (School of Environmental Studies)
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Abstract

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Fritillaria camschatcensis L. Ker Gawl (Liliaceae), is a herbaceous flowering plant that grows in estuarine and subalpine habitats within its range from the northern limit in Alaska to its southern limit in western Oregon. This plant holds cultural significance in the Pacific Northwest as an important root vegetable that was cultivated in estuarine root gardens by many Indigenous Peoples. The bulbs of *F. camschatcensis* offered an important source of carbohydrates to a traditional diet that was high in protein, fats, oils and fibre. *Lhásem* is the Squamish name for *F. camschatcensis*, commonly known as northern riceroot, or chocolate lily.

The Squamish Nation is very interested in restoring traditional plant foods into the community along with the traditional knowledge linked to them. *Lhásem* is a plant that many Squamish people were interested in learning about, thus it was an excellent candidate for ethnoecological restoration. Ethnoecological restoration brings cultural context, practices and technologies together with contemporary ecological restoration approaches and offers culturally relevant ways to restore a plant to the landscape.

The east side of the Squamish Estuary, which borders the town of Squamish, has been impacted by a range of human-disturbances over the past century including: draining for agriculture, redirection of the Squamish River, dredging and the presence of industrial sites in close proximity to the estuary. All of these impacts have likely contributed to the decline of *lhásem* populations on the east side of the estuary. Through an ecological survey of the east and west sides of the Squamish Estuary I determined that the populations of *F. camchatcensis* are present and thriving on the west bank of the Squamish River. I collected vegetation and abiotic data and found that salinity is the most important abiotic factor affecting *lhásem* habitat. A logistic regression showed that salinity and the presence of *lhásem* are negatively correlated. Results of the vegetation data analysis indicated that *Maianthemum dilatatum* was an indicator for where *lhásem* is

found growing on the west side of the Squamish Estuary and *Aster subspicatus* was the indicator for *lhásem* on the east. *Lhásem* restoration gardens were planted to explore the growth within one growing season across two restoration treatments, terrestrial sites and estuarine sites. The results indicate that terrestrial garden sites were more successful than estuarine garden sites and that whole bulbs were more successful than bulblets in the first year of growth. Through community interviews with elders, adults and youth, I documented the contemporary interests in the restoration of *lhásem* and found that the major interest of the community was focused on health, traditional food revitalization and knowledge renewal. I facilitated educational events in which Squamish Nation youth and community members learned about the plant and how to manage it in the Squamish Estuary gardens. Overall this research provides information for the future restoration of *lhásem* in the Squamish Estuary as well as a template to restore other culturally important plants.

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Acknowledgments

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Dedication

For Grandpa Chester and Granny Eva

Chapter 1: Introduction

1.1 Research Project Overview and Research Questions

There is growing interest among many First Nations groups in British Columbia in the revitalization of traditional knowledge, use and practices pertaining to native plant foods (Devereux and Kittredge, 2008; 2nd Annual Traditional Foods Conference, 2009). My MSc research is part of a large-scale renewal of Indigenous knowledge and a search for deeper understanding of the relationship between humans, plants and environments through the study of ethnobiology.

I began working with the Squamish Nation Education Department four years ago as an ethnobotany consultant. During this time I informally surveyed Squamish Nation members to determine what plants might be of interest to focus on in an ethnobotany-related research project. Squamish Nation members expressed a great interest in traditional foods, and specifically in northern riceroot (*Fritillaria camschatcensis* (L.) Ker-Gawl), a traditional plant food that they would like to see re-integrated into their lives and eventually into their diets. Consequently, northern riceroot was an excellent candidate for further research and a promising focal species around which to organize ethnoecological restoration activities (Higgs, 2003; Senos *et al.*, 2006). Broadly, my MSc. research addresses contemporary concerns and interests related to the reinstatement of traditional foods in the diets of Indigenous Peoples. Xay Temíxw, the Squamish Nation land use and management plan, lists some of the highest cultural priorities for use and management of the traditional territory: access to traditional harvesting areas;

building food security (through promotion of indigenous traditional food); and increased protection for important ecological and cultural sites including the Squamish estuary (Xay Temíxw Plan, 2001).

In this project I worked with elders, adults and youth of the *Sḵwx̱wú7mesh* Nation of southern coastal British Columbia to study the ethnoecology of northern riceroot, called *lhásem*[1] in the *Sḵwx̱wú7mesh* language. *Lhásem* is an angiosperm of the Lily Family (Liliaceae) commonly found growing in coastal estuarine ecosystems around the northern Pacific Rim. It is also found in moist meadows and along stream banks at sea level as well as subalpine elevations (Bouchard and Turner, 1976; Hitchcock and Cronquist, 1973; Kuhnlein and Turner, 2009; Marchant, 1981; Pojar and MacKinnon, 1994; Sommargren, 2008). Its bulbs were commonly harvested by the *Sḵwx̱wú7mesh* as well as by many other coastal First Peoples in British Columbia, and were a highly regarded root vegetable, usually prepared by steaming and served with other foods such as eulachon grease (Bouchard and Turner, 1976; Turner, 1971, 1973, 1995; Turner and Kuhnlein, 1983; Turner and Peacock, 2005). This plant has not been harvested for over 70 years now yet Squamish People still knew of this plant and were very interested in it. I became interested in how a plant such as *lhásem can* comes back into the psyche of a people before the plant has physically returned to the land. Likewise, how do plants with such stature become focal species that motivate traditional foods revitalization happening in so many Indigenous communities, including Squamish? The answers to these questions are integral to my research. I worked closely with the Squamish Nation Education Department, the Squamish River Watershed Society (SRWS) and the

[1] This same name was also used in the *Sḵwx̱wú7mesh* language to refer to *Fritillaria affinis* (Schult.) Sealy var. *affinis* (synonym *F. lanceolata* Pursh), commonly referred to as chocolate lily, a name also used locally by some for northern riceroot.

Squamish Estuary Management Committee (SEMC) to develop and undertake this project.

My purpose for undertaking this research was two-fold: 1) to contribute to the revival and documentation of traditional foods in the Squamish First Nation; and 2) to lay the foundation for the restoration of a traditional root vegetable[2] in an ecologically and culturally relevant way. I explored the ecological habitat characteristics for *lhásem* in order to help restore populations of this important plant food at sites that can eventually be accessed for harvesting by members of the Squamish Nation.

This research was also aimed at providing insights into the priorities and motivations for renewal of traditional foods in the Squamish Nation, as well as exploring how Indigenous and scientific knowledge can be used together in a collaborative manner to enrich ethnoecological research (Berkes, 2012; Hunn, 2007). Moving in the direction of collaboration is essential to building understanding and communication among knowledge systems. Creating more capacity for positive cross-cultural and interdisciplinary learning to support the reintegration of traditional foods into contemporary Indigenous diets is thus a main goal of this and other similar research (Beckwith, 2004; Pukonen, 2008; Cullis-Suzuki, 2007).

In this thesis I use ecological and ethnoecological methods to pursue four research objectives that all relate to achieving a better understanding of *lhásem* and its place in the ecocultural world of the Squamish. They are:

[2] Root vegetables are the subterranean part of a plant that generally stores carbohydrates in various forms. For my purposes I am focusing on roots that were used extensively as important vegetables within the traditional diet of many First Peoples in the Pacific Northwest.

1. To describe the plant community composition and micro-environmental conditions at a reference site where *lhásem* populations are growing relatively undisturbed by intensive human industrial activities.
2. To apply ecological and cultural parameters to design and implement the first stages of an experimental estuarine garden site in the Squamish River estuary. This garden will provide educational opportunities for the *Sḵwx̱wú7mesh* community in the immediate future and harvesting opportunities for *lhásem* in the long-term.
3. To document traditional cultural knowledge of the Squamish Estuary, with an emphasis on knowledge and experience of *lhásem* harvesting, cultivation and consumption.
4. To document contemporary perspectives of elders, adults and youth on the importance of traditional foods, such as *lhásem* (northern riceroot), in order to inform future generations of Squamish People and future ethnoecological restoration projects.

This thesis consists of four chapters: this introductory chapter, which provides detailed background information for my research; Chapter 2, which covers the ecological survey conducted on *lhásem*, habitat characterization and future restoration and addresses the questions: "What are the ecological indicators (biotic and abiotic) of *lhásem* habitat in the Squamish estuary?" And "What is the success of *lhásem* in a restoration garden setting after one growing season?" Chapter 3, which focuses on the socio-cultural context for the restoration of *lhásem* and addresses the following questions: "What is the extent of knowledge of *lhásem* among the Squamish Nation?", "What is the level of interest in

restoring *lhásem*?" and "What is the role of restoration in addressing the health concerns of the Squamish Nation?" Chapter 4 is a concluding chapter, which draws together the key results, limitations, and ideas and recommendations from the research.

The remainder of this chapter provides background and context for the study, including: historical impacts on Indigenous food systems Indigenous environmental knowledge and management, historical impacts on the Squamish Estuary, historical cultural use of root vegetables in north-western North America, nutrition transition, study area, the Squamish Estuary: setting for *lhásem* research and restoration, ecological restoration: a brief history, cultural significance of *lhásem*, botany of *lhásem*, Traditional Ecological Knowledge (TEK), science and TEK.

1.2 Historical Impacts on Indigenous Food Systems

Many traumatic events have taken place in the recent history of First Nations in Canada that have obstructed the oral transmission of knowledge between generations, including the knowledge and practices around Indigenous foods. With the arrival of European settlers in Western Canada in the late 1700's, through the period of colonization that spanned to the 1900's, came many catastrophic changes in the lives of First Peoples across the country including: loss of access to land and resources, loss of the children in the villages to residential schools, banning of cultural practices and a shift from a life on the land to a more sedentary life (Turner and Turner, 2008). As part of the goal of the cultural assimilation policy, a kind of social taboo was developed by

colonizers around Indigenous foods, enforced through residential school and through the legislative banning of cultural practices such as the potlatch which were largely centered around traditional foods. There was also a loss of access to traditional food cultivation and harvesting sites due to land alienation and imposed regulations (Suttles, 1987; Theodoratus, 1989; Turner and Turner, 2008). In North America, residential schools have arguably had the largest direct impact on the transmission of cultural knowledge between elders and younger generations. The act of removing entire generations of youth from their communities and cultures created a widespread gap in knowledge transmission (Lutz, 1995, 2008; Suttles, 1987; Thom, 2005; Turner *et al*., 2008). The legacy of these schools was the systematic dismantling of people's cultures. Indigenous children and youth were prohibited from speaking their own languages, and actively discouraged from enacting traditional spirituality or cultural practices, as well as being separated from their traditional territories, traditional diets, and their families and cultural teachings. This separation resulted in generations of Indigenous people experiencing a profound disconnect from their culture in many ways and a deep pain and sense of loss that has resonated through generations of Indigenous People (Turner and Turner, 2008; Turner *et al*., 2008).

Many traditional harvesting areas have also been made inaccessible by development and privatization of what were formerly traditional lands. In combination with the loss of important food harvesting areas, the legacy of residential schools has led to a major decline in the numbers of Indigenous Peoples cultivating, harvesting and eating native plant foods (Deur, 2005; Kuhnlein, 1992; Turner and Turner, 2008). There

have also been numerous invisible losses[3] such as: cultural/lifestyle losses, loss of identity, health losses, loss of self-determination and influence, emotional and psychological (Turner and Turner, 2008). Habitat loss and deterioration have reduced the availability, quantity, and in some cases, the mere presence of many native plant foods (Turner and Peacock, 2005).

1.3 Indigenous Environmental Knowledge and Management

For thousands of years Indigenous Peoples around the world have managed natural resources and environments sustainably (Deur and Turner, 2005; Kuhnlein *et al*. 2009; Martin, 2004; Minnis, 2004). There are complex protocols and technologies found in many indigenous cultures for harvesting natural resources as well as altering habitats to promote certain highly regarded species. At the time of European contact there was a common misconception that there was no active cultivation or management of natural resources taking place by First Peoples in Canada (Deur and Turner, 2005; Turner and Kuhnlein, 1983; Suttles, 1990, 2005; Theodoratus, 1989). This misconception was at the heart of the European justification for taking land from the First Peoples and distributing it to European settlers who would make "proper use" of the land by turning to more familiar agricultural practices (Suttles, 1990, 2005; Theodoratus, 1989). What European settlers did not see was that complex interactions between First Peoples and the land existed in many in-depth ways including sustainable cultivation and harvesting, strict access rules, taboos, protocols and ceremonies. Early anthropologists assumed that the

[3] Invisible losses are those losses that Indigenous Peoples have sustained as a result of colonialism that are generally not widely recognized or acknowledged by land and resource managers, politicians and scientists.. They are emotional, psychological and spiritual and cumulative, and can be reflected intergenerationally (Turner *et al*., 2008).

matter of food procurement for First Peoples of north-western North America was one of ease and abundance (Deur, 1999). The perception was that the coastal First Peoples sustained themselves primarily on an endless supply of seafood and that they were not using, and had no real need for land-based resources (Deur and Turner, 2005). Armed with the tools for clearing land, and introducing European agricultural practices, the early settlers overlooked the numerous food systems and technologies already in place to manage natural resources. Among the key habitats for traditional root vegetable production were the highly productive tidal estuarine ecosystems, historically used by coastal First Nations to cultivate a number of key food species in managed garden sites (Turner and Kuhnlein, 1983; Deur, 2000; Lloyd, 2011). There are special names for these tidal root gardens in many coastal languages and complex systems of ownership of the garden plots (Turner, 2005). The most common Indigenous root vegetables grown in these gardens, included *lhásem* (*Fritillaria camschatcensis*), Pacific silverweed (*Argentina egedii*) and springbank clover (*Trifolium wormskioldii*) among others, provided important carbohydrates and other essential nutrients and were a valued component of a traditional diet high in protein (Kuhnlein and Turner, 1981, 1991; Turner, 1995; Turner and Peacock, 2005).

1.4 Historical Impacts on the Squamish Estuary

The Squamish estuary has undergone significant human-related disturbances over the past century, particularly on the east side bordering the town of Squamish. The first recorded account of a European person settling in the Squamish Valley was in 1874, five families lived there by 1892, construction of the railroad began in 1914, Squamish was

incorporated as a village in 1948, and in 1964 Squamish was incorporated as a municipality (Squamish History, 2012). Historical information indicates that parts of the east estuary were drained for agricultural purposes, probably in the early 1900s when hay farms were established (Hoos and Vold, 1975; Lim and Levings, 1973; Page, 2004; Squamish History, 2012).

One of the most significant impacts to the Squamish River estuary was incurred through large amounts of fill that were deposited in the construction of dykes, railway corridors, and industrial platforms. In the early 1970's, an immense heap of dredge spoils material (over 150,000 truck loads) was deposited in the Central Delta of the Squamish Estuary with the intent of creating a coal port. This site was never constructed, but the dredge spoils pile remained in that spot for nearly 30 years. In 1999 the Squamish River Watershed Society (SRWS) and the Department of Fisheries (DFO) initiated a multi-year project to remove the dredge spoils, in order to restore the site to a productive estuary site over a 6-year period. The majority of the dredge spoils were removed by 2005 and the site was re-vegetated with indigenous plants (Skwelwil'em, 2007). A large industrial chemical plant also operated in the eastern portion of the estuary from 1973 to 1992. This plant was run by NEXEN Chemical and has been largely blamed for mercury contamination in parts of the estuary. In 1972, for reasons of flood control, BC Rail constructed a large training dyke that drastically redirected the flow of the Squamish River (Figures 1.1 and 1.2). After the redirection of the river from this dyke, significant erosion of the west bank began.

Figure 1.1 Aerial view of the Squamish Estuary 1950's before the training dyke was built by BC Rail. Image reproduced from Tobe, 2009. Arrow indicates location of shipping port.

Figure 1.2 Aerial view of the Squamish Estuary in 1972 after the training dyke was built: the black arrow indicates the location of training dyke and shows redirection of main Squamish River flow. The white arrow indicates the shipping port for reference between maps. Image from Tobe, 2009.

1.4 Historical Cultural Use of Root Vegetables in North-western North America

There is an extensive history of estuarine root gardens cultivated by Indigenous Peoples in the north-western North America. The active cultivation of plants taking place in pre-contact North America is a piece of history that was not captured or highlighted in most early writings by anthropologists and other Europeans documenting Indigenous life-ways (Deur, 2005). In more recent times researchers revisiting these ethnographic documents, and collaborating with Indigenous knowledge holders have found that a large body of evidence exists which supports the extensive cultivation of food plant resources that was taking place in the north-western North America prior to contact with Europeans (Deur, 2002, 2005; Turner and Peacock, 2005). Traditional cultivation practices for edible roots include such localized treatments as tilling, weeding and fertilizing but they also include larger-scale alteration of the natural environment to increase the productivity of certain preferred species (Deur, 2002, 2005; Turner and Peacock, 2005). These alterations include: building up areas of the estuary to increase surface area for the estuarine root gardens, removing rocks and gathering soil to enhance the soil profile for the ease of harvesting (Deur, 2005). The regions that were selected for these estuary root gardens were also within a specialized zone of the estuary that was above the high marsh and into the transitional salt-tolerant meadow (See Figure 1.3 below).

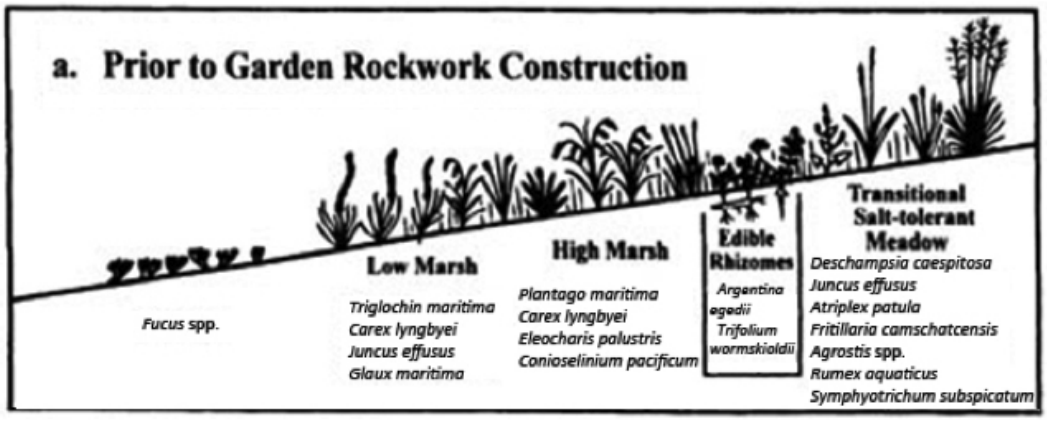

Figure 1.3 Diagram of zones in estuary with plant species listed below zone name. Diagram from Deur 2005, p 313.

These are the zones in the estuary that are high enough that they are not frequently inundated with salt water, but low enough to receive water from occasional flooding. (Deur, 2005). The fall flood season also tends to coincide with the dieback of much of the vegetation, which means that when the flooding takes place there is a higher concentration of organic material deposited into these higher regions of the estuary. The detritus supplies nutrients and leads to a nutrient rich environment over time (Deur, 2005). It was these higher zones where the estuarine root gardens were built. It is currently not known whether these exact processes took place in the Squamish Estuary. Human alteration of a natural system such as an estuary to enhance the viable gardening area, soil structure and soil nutrients is another example of the knowledge and expertise that Indigenous Peoples applied to overcome the challenges of cultivating plants in a region dominated by dense forests and nutrient-poor soils (Deur, 2002, 2005). There are accounts not only of the cultivation of culturally important plant species but also the trade and relocation of the plants to establish or enhance root gardens in some areas that may not have been as plentiful as others (Deur, 2005).

It seems that root gardens may have offered a reliable source of food in traditional diets where the availability and abundance of most foods varied considerably from year to year. Root gardens were an important backup for the years when the salmon run wasn't good or when other important foods were running low. Overall, estuarine root gardens were clearly an important part of the traditional diets of the Coastal First Peoples. Since knowledge of these managed zones is not present in all regions it is necessary to look at evidence from across different Indigenous communities in order to restore the root gardens in the Squamish Estuary. Contemporary restoration studies of estuarine gardening practices involve a certain degree of reconstruction (Deur, 2005). The methods used by different Indigenous groups are so similar and consistent that they point to root gardening being a very widespread practice historically (Deur, 2005). As Kwakwaka'wawk Clan Chief Adam Dick, *Kwaxistalla* states, "Every village had their own gardens. You know, every different village had gardens like the ones we had…because that's what we ate. Not only these people here, but all over the whole coast" (*Kwaxistalla*, quoted by Deur 2005: p. 322).

At the time of colonization Indigenous Knowledge was not highly valued so it is not surprising that Europeans paid little attention to the value of the traditional diets of the Indigenous Peoples. As a result, there was little to no attention paid to the important food cultivation[4] and harvesting areas that Indigenous Peoples utilized and needed access to (Deur, 2005; Theodoratus, 1989; Turner and Peacock, 2005). When land was privatized and broken up into parcels many significant food production and harvest sites were lost, or at least the access to these sites was cut-off. Europeans didn't recognize the

[4] Cultivation has been redefined by Deur (1999) to include a continuum of practices that involve the repeated and purposeful manipulation of plants and their environments to enhance productivity.

food cultivation practices that existed before their arrival, as these systems did not fit their definition of what productive agricultural land should look like. Thom (2005) p. 5, writes that "the western separation of space from place is an important part of the colonial project, objectifying worlds-not-lived-in". The western idea of empty wilderness became part of the rationalization for taking "empty lands" (Thom, 2005).

1.5 Nutrition Transition

"White mans food change everything. Everywhere white man goes he change food." (*Khahtsahlano*, from Matthews, 1955, p. 10)

Traditional food systems of Indigenous Peoples are composed of items from the local, natural environment that are culturally acceptable" (Kuhnlein, 1996).

There are many reasons why *lhásem* is not widely eaten by the Squamish people today. One is related to a global phenomenon known as "the nutrition transition" which refers to the relatively recent shift that Indigenous Peoples have experienced moving from their traditional diets to a modern day diet composed largely of unfamiliar foods. Here, I explore why this is important specifically to my research in Squamish.

Indigenous Peoples across Canada have experienced a relatively recent and rapid shift away from their traditional diets that were high in proteins, fats, oils, fibre, fresh greens and berries, to diets high in sugars, processed and refined foods, saturated fats and low in fibre (Kuhnlein, 1992, 2006). The foods that make up traditional diets are based on diverse factors that vary across Indigenous communities. Some considerations for what foods are important to a traditional diet include; availability, productivity, access, flavour and nutritional value (Ames, 2005; Kuhnlein, 1992, 2006).

Many changes have taken place in the lives of Squamish Peoples since European contact. The impacts of the residential school system, banning of the potlatch, loss of traditional land base and loss of access to and management of natural resources have all led to a decline in the knowledge and practices surrounding traditional diets (Turner and Turner, 2008).

As a consequence of the "nutrition transition" the frequency of some very serious diet-related diseases have risen exponentially in communities that were not prone to these types of chronic diseases prior to contact (Waldram *et al*., 2007). Type II diabetes, hypertension, certain types of cancer and cardiovascular disease have all increased (Waldram *et al*., 2007). Diabetes is a disease that has a multi-factorial etiology meaning that there are multiple, and potentially interacting, possible causes. Among the most prominent causal factors are diet, obesity, lack of physical activity, and metabolic and hereditary pre-disposition (Waldram *et al.,* 2007). The level of daily exercise required to maintain a traditional diet, along with a diet comprised of many traditional foods that we now recognize to be healthful, largely prevented diseases that are now common in Indigenous populations.

Obesity, physical activity and diet are not independent of one another. Each of these factors was impacted when the traditional ways of life of Indigenous Peoples were altered and in many cases banned (Deur, 2005; Turner and Peacock, 2005; Theodoratus, 1989). When a wage-based economy became the norm, more sedentary labour replaced a way of life that was previously dedicated to getting out on the land and cultivating, harvesting and preserving food for the year (Lutz, 2008). Today many Indigenous

Peoples are eager to take control back over their physical, spiritual and cultural health. Many Indigenous communities now understand all too well the consequences of this shift in diet and lower physical activity along with the possibility that there is a genetic or hereditary disposition to such diet related health problems (Waldram *et al.,* 2007). Many Indigenous communities are working towards addressing diet as a root cause of many of these health problems. Specifically, they are investigating what can be learned from their traditional diet (Kuhnlein, 1992; Turner and Kuhnlein, 1991). Although the goal is not to move back to a completely traditional diet, there are many lessons that Indigenous Peoples can learn from the lifestyle of their ancestors, namely that daily activity and a healthy, local diet can help address these health concerns head-on (Kuhnlein and Turner, 2009).

This interest in harnessing the lessons from a traditional diet is one of the main motivations for my research. Many Squamish Nation members are concerned about the levels of type II diabetes, obesity and the other types of chronic diseases listed above. Many of these same people also see learning about their traditional diet as a way to take ownership over their health in a culturally significant way (Joy Joseph-McCullough pers. comm. 2011; Charlene Williams, pers. comm. 2011). *Lhásem* was a plant that came up time and time again in my conversations with Squamish Nation members about traditional foods over the past few years. Due to loss of habitat, *lhásem* has been absent from former harvesting sites and other accessible areas for decades. Thus, the majority of people who were interested in this root vegetable had never seen it let alone eaten it prior to my research.

1.6 Study Area

The traditional territory of the Squamish People encompasses broad geographical and ecological diversity, including: rugged mountain peaks, alpine ridges, deep river valleys, temperate rainforest, extensive wetlands, island archipelagos and expanses of coastline. This dramatic landscape lends itself well to the many land-based stories that describe the origins and history of this rich territory. The territory spans from Kitsilano (*Khahtsahlanogh*), through West Vancouver to Squamish (*Skwxwú7mesh*) and further north, past the town of Pemberton (Figure 1.4). The Squamish People (*Sḵwx̱wú7mesh*) are part of the larger Coast Salish cultural and linguistic group (Suttles, 1990). Today *Sḵwx̱wú7mesh* people live in nine communities throughout their territory that encompassed 23 village sites in the past. My research focused on the Squamish River estuary, located northwest of the town of Squamish, where the Squamish River meets Howe Sound. Site A is the Squamish Nation managed part of the estuary and this is the site that has been selected for *lhásem* restoration by the Squamish Education Department. The hope is that by establishing the restoration gardens in a place that is easily accessible for Squamish Nation members, and that is under the jurisdiction of the Squamish Nation, the long-term success of the project will be enhanced.

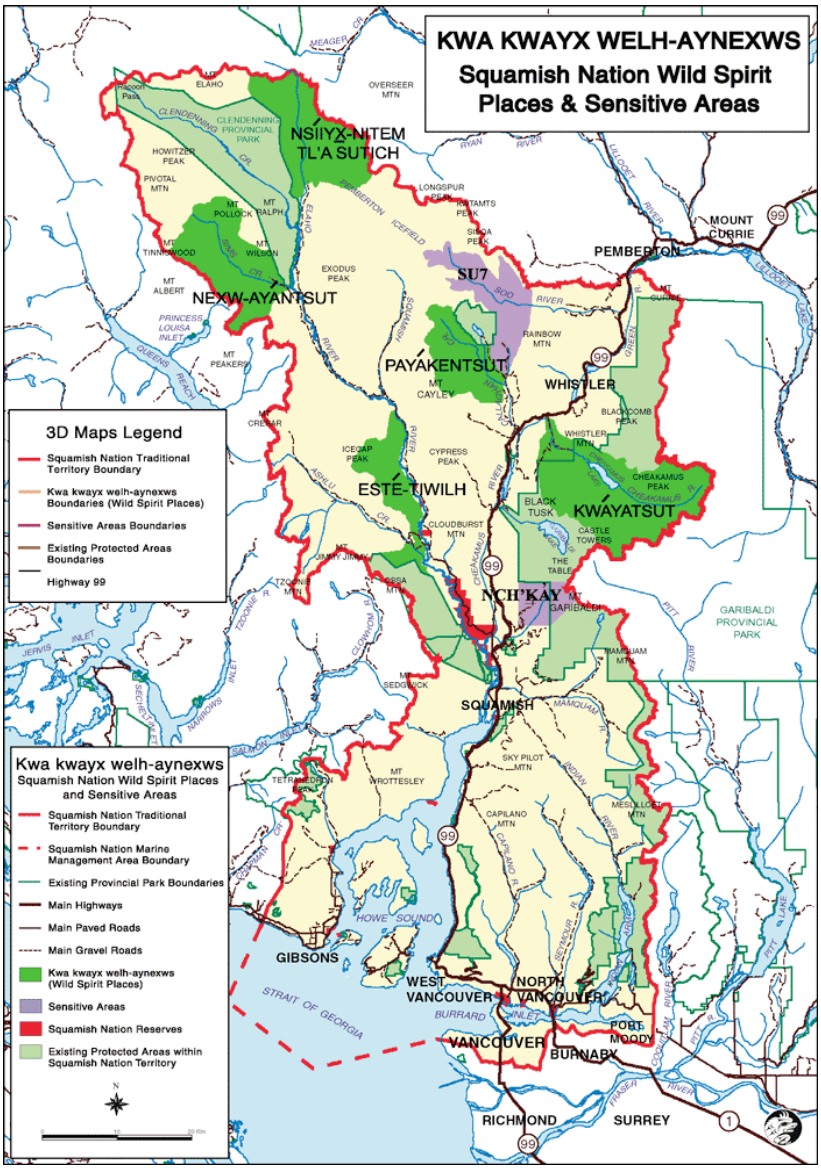

Figure 1.4 Map of Squamish Territory showing cities, town, large rivers and lakes, and wild spirit places. http://store.wildernesscommittee.org/campaigns/historic/stoltmann_wilderness/reports/Vol24No06/map

1.7 The Squamish Estuary: Setting for *lhásem* Research and Restoration

The Squamish River Estuary, the site of my research and a major part of *Sḵwx̱wú7mesh* Nation territory, is located at the head of Howe Sound and is considered a fjord head estuary, meaning that it is in a region where deep U-shaped valleys were carved out by glacial activity. Over 3650 km^2 of coastal rainforest drain into the

Squamish River, which passes through the 673 hectares of Squamish Estuary before emptying into Howe Sound. The estuary is a highly productive ecosystem providing wintering, migration and feeding habitats for many bird species along with feeding, spawning and rearing ground for a variety of fish species, including ooligan, steelhead and salmon (Emmet *et al*., 2000; Skwelwil'em, 2007). The estuary provides good habitat for a number of mammal species as well including black-tail deer, black bear, cougar, coyote, moles, voles, and rabbits (Emmet *et al*., 2000; Skwelwil'em, 2007). The Squamish Estuary also acts as a critical flood control mechanism for the town of Squamish, and the estuarine vegetation purifies water and filters pollutants (Skwelwil'em, 2007). There are many ecologically important estuarine plants in the Squamish estuary. One example is the marine flowering plant eelgrass (*Zostera marina*), which helps to stabilize the seafloor as well as provide important sub-tidal habitat for diverse marine life (Cullis-Suzuki, 2007).

1.8 Ecological Restoration: a brief history

Ecological restoration is the process of repairing ecosystems that have undergone anthropogenic impacts and/or damage. The practice of ecological restoration considers the historical context of an ecosystem and how to restore the plants, soil and habitat to create an ecosystem that operates as a whole (Higgs, 2003; Apostol and Sinclair, 2006). Restoration projects may involve reintroducing plant (and animal) species that have been extirpated, removing invasive plant species, eliminating harmful substances, rebuilding soils and reintroducing natural processes such as fires (Higgs, 2003; Senos, *et al.*, 2006).

Interest in ecological restoration has increased steadily over recent decades and has been extended to incorporate cultural elements and to take cues from what traditional ecological knowledge can offer the discipline (Apostol and Sinclair, 2006; Deur and Turner, 2005). The shift to incorporating traditional ecological knowledge into restoration efforts is essential in building collaborative approaches to restoration that honour and respect the immense wealth of expertise that exists within so many Indigenous communities. Reintroducing cultural practices of stewardship and cultivation is also essential to rebuilding the integrity of cultural landscapes (Higgs, 2003).

Ethnoecological restoration is a discipline that brings a cultural and spiritual context to ecological restoration, adding a depth of meaning to the culture or people involved. Ethnoecological restoration confronts historical impacts on traditional life ways by considering cultural histories and looking to traditional key resources and management practices for focus and methodologies. This form of restoration considers the Indigenous perspective and is coordinated by, or involves, Indigenous people throughout the restoration process (Bartley, 2005). The integration of Traditional Ecological Knowledge and Wisdom (TEKW) and ecological restoration is one example of the concept of *focal* restoration. Focal restoration builds an approach to restoring ecosystems based on what is important culturally and spiritually as well as ecologically (Higgs, 2003). Higgs identifies three bases of restoration: historical fidelity, ecological integrity, and focal practice (2003). Focal restoration offers a deepening of the meaning behind ecological restoration. These ideologies have inspired and influenced my own ethnoecological restoration work in Squamish. I believe that incorporating local knowledge as much as possible into the restoration, and involving the community

throughout the process, is essential in approaching ethnoecological restoration in a meaningful way.

1.9 Cultural Significance of *Fritillaria camschatcensis*

The bulb of *F. camschatcensis* was eaten by almost all Northwest Coast peoples and was harvested, usually when dormant, in spring or fall. The bulblets are rich in sugar and starch (Turner and Kuhnlein, 1983) and were a highly important component of the traditional diets of many First Peoples. *Lhásem* bulbs were typically harvested by women and generally grow quite shallowly in the soil, as illustrated by the Haida names that translate roughly to "round thing you dig out of the soil with your finger" (Turner and Kuhnlein, 1983). In Squamish, *lhásem* was a highly regarded food plant and was harvested along the Squamish River. The bulbs were often served with ooligan oil or grease (Bouchard and Turner, 1976; Kuhnlein and Turner, 1991). Due to the degree of ecological damage the Squamish Estuary has sustained, it's been many years since Squamish people have been able to access and actively harvest *lhásem.* One of the last documented memories of harvesting came from a recollection from Dr. Louie Miranda Sr. in an interview with Nancy Turner and Randy Bouchard, in which Dr. Miranda recalled harvesting *lhásem* with his mother at the confluence of Pilchuck Creek and the Squamish River. He recalled the "peppery" flavour of *lhásem* from a time when his mother would gather it on the east bank of the Squamish River as a food (Turner and Bouchard, 1976).

Linguistic evidence is often used to indicate the importance of food species in traditional diets. Generally only plant foods and other plants that were culturally

significant would be named by specific terms; other less salient plants were usually only named in a general way (e.g. “flower,” “grass”) (Turner, 1988).

Table 1.1 includes a wide variety of names for this food plant across a range of Indigenous languages from Alaska down to the north-western United States. The food uses, however, are similar across different linguistic groups (Kuhnlein and Turner, 1991).

Table 1.1. Ethnobotanical uses and names for *Fritillaria camschatcensis* in indigenous languages within the plant’s range in north-western North America. Information on habitat, use and additional points of interest are also shown. Information taken from a variety of published and unpublished ethnobotanies.

People	Name	Harvest Time	Habitat / Use	Notes	Reference(s)
Yupik/Chugach (Alaska)	***laa’aq***	mid-late summer	Bulbs eaten fresh or dried into cakes with crow berries (*Empetrum nigrum*) stored in seal oil.		Wennekens, A.J. (1985).
Gitxsan	***gasx***	late spring/early fall	Bulbs were abundant in meadows along Skeena, Kitwancool and Kispiox Rivers. Dense areas associated with old garden plots. Bulbs boiled or pitcooked.	It was said that one woman could pick as much as five or six hundred pounds quickly and easily.	Smith, H.I. (1997). Johnson, L.M. (1997).
Nisga’a	***gasgam*** ***ts’im*** ***ts’eets’iks***		Stripped the bulblets and boiled them and ate them with hemlock (*Tsuga heterophylla*) cambium and ooligan grease.		Marchant, C.,J. (1981).
Haida (Massett, Alaska)	***stla k'iist'aa***	May or July	Dug bulbs and roasted them on embers and ate them with ooligan grease. Families from Massett would sometimes eat the bulbs in a paste form with sugar, or molasses and/or ooligan grease.	Elders in Haida Gwaii say that the bulb hasn’t been harvested for food since 1880. According to George Young if the bulbs were washed by the sea they would taste good after.	Turner, N.J. (2004).
Haida (Skidegate)	***7inhllng***	May or July			
Nuxalk	***7ilk***	Late August through to October	The bulbs were boiled in water and drained and then eaten with ooligan grease or hemlock cambium. More recently people in the Nuxalk territory have added sugar to the riceroot for flavor.	Harvested when flower stalks are between 12-18in. The Nuxalk believe that when harvesting riceroot it is important to replant some of the bulblets so that they can regenerate into mature plants for future harvests.	The Nuxalk Food and Nutrition Program Staff. (1985)

Kwakwaka'wakw	***xúkwem***	May and July [fall also]	Kwakwaka'wakw people dug the bulbs with a special yew wood digging stick then left the bulbs out in the sun to dry and stored them in cedar boxes covered in their own leaves. The bulbs were steamed in baskets and had ooligan grease poured over them.	The Kwakwa ka 'wakw believe that when harvesting riceroot it is important to replant some of the bulblets (especially the primary ones, called g*agemp*)so that they can regenerate into mature plants for future harvests.	Turner, N.J. (1982); Clan Chief Adam Dick (pers. comm.).
Squamish	***lhásem***		Root vegetable prepared with fish heads and eaten with ooligan grease.	*Lhásem* refers to *F. camschatcensis* and *F. affinis.*	Bouchard, R. & Turner, NJ. (1976).
Nlaka'pmx	***? q'áw'ex***	May and July	Was called "flat potato" and was so sweet that it could be eaten raw. The bulbs were dug between May and July and were washed and stored for later use. The bulbs were often eaten with Saskatoon berries in a stew with other root vegetables or pitcooked.	According to one of the interviews a family would go through a sack of riceroot bulbs in a winter and would use them quite sparingly.	Turner NJ 1990.
Ditidaht	***kwaxapx***		Ditidaht people refer to *F. camschatcensis* as riceroot, mission bells or Indian rice. The bulb was cooked and eaten in a similar way to tiger lily (*Lilium columbianum*) bulbs.		Turner, NJ 1983.
Nuu-chah-nulth (Hesquiaht)	***kuuxwapiih***		The bulbs were dug and roasted before eating. Sometimes the bulbs were dried for later use and then reconstituted in water before preparing.	Hesquiat people use *Fritillaria camschatcensis,* which they also called mission bells and riceroot.	Turner, NJ 1982.

Due to habitat loss and destruction, and the cessation on management practices, *lhásem* is not found in the same density and numbers as it was when it was routinely harvested and cultivated. My research is aimed at developing a restoration protocol that can be applied in other areas to restore this food plant in a sustainable and culturally relevant way.

1.10 Botany of *lhásem* (*Fritillaria camschatcensis*)

This section covers pertinent information on the reproduction and life history of *Fritillaria camschatcensis*. It is important to understand the plant being restored in order to increase the success of restoration activities, including transplanting and harvesting. *Fritillaria* is a genus of the Lily Family (Liliaceae) that consists of approximately 100 species of erect, herbaceous plants that grow up from underground perennial bulbs or corms. *Fritillaria* species are distributed across the Northern Hemisphere, with 17 species native to North America, ranging from southern California to Alaska. Three species occur in Canada, all limited to British Columbia and Alberta: northern riceroot (*F. camschatcensis*), chocolate lily (*F. affinis*) and yellowbell (*F. pudica*). Many of the North American species, including *F. camschatcensis* and *F. affinis*, give rise to adventitious bulblets that grow around the bottom of the bulb and tend to resemble grains of rice (Marchant, 1981). *Fritillaria camshcatcensis*, the focal species of this study, can be found growing in coastal areas with high rainfall. It is most frequent in the upper regions of tidal estuaries but sometimes occurs in mountain meadow ecosystems (Sommargren, 2008). The range of this species extends around the rim of the North Pacific, from Japan and the Kamchatka Peninsula to the coast of Alaska and British Columbia, as far south as parts of western Washington and Oregon (Fig. 1.5).

Figure 1.5 Distribution map for *Fritillaria camschatcensis* (Klinkenberg, 2012) [http://www.efloras.org/object_page.aspx?object_id=8341&flora_id=1]. Points at the southern and northern ends of the range indicate where the records of the populations decline.

Common names for this species include: northern riceroot, riceroot lily, riceroot fritillary, mission bells, black lily, Indian rice, wild rice and Kamchatka lily (Marchant, 1981). During the course of the current research *F. camschatcensis* was referred to as *lhásem*, a term synonymous with its close relative *F. affinis*, also commonly known as chocolate lily[5]. Although the habitats of the two species are relatively distinct, their ethnobotanical roles are similar; within their ranges the bulbs were eaten as part of the

[2] The common name chocolate lily is often used for *F. camschatcensis* as well as *F. affinis*. The name *lhásem* is used for both species in the Squamish language.

traditional diets of virtually all of the First Peoples in British Columbia (Kuhnlein and Turner, 1991). *Fritillaria affinis* is found growing on dry to mesic bluffs and in drier, open meadows (E-Flora BC: Electronic Atlas of the Plants of British Columbia, 2012).

The two *Fritillaria* species are readily distinguished morphologically. Both are herbaceous perennials. *F. camschatcensis* grows 20-80 cm tall with a single sturdy, unbranching stem. *F. affinis* grows from 20-60 cm tall. The leaves of both species are glossy green, entire and sessile, with prominent venation. In *F. camschatcensis,* the leaves grow in 1-3 main whorls of 5-10 leaves per whorl spaced along the stem and average 5-10 cm long and 0.5-2.5 cm wide, whereas in *F. affinis* the leaves grow in 1-2 whorls of 3-5 leaves along the stem and average 5-10 cm long and 0.5-3 cm wide. The flowers are borne terminally in both species. *Fritillaria camschatcensis* flowers are short-stalked, nodding, narrowly campanulate (bell-shaped), spreading or flaring when blooming, with colour ranging from greenish-bronze to purple-brown, to (occasionally) yellowish. There are usually several to many flowers per stalk. *Fritillaria affinis* flowers are longer-stalked, nodding, broadly bell-shaped, and chocolate brown to dark purplish, usually with yellow or green mottling. The flowers are borne singly or in small clusters of 2 to 5 (Klinkenberg, 2012; Marchant, 1981; Hitchcock and Cronquist, 1973).

Fritillaria spp. are pollinated by carrion flies and this accounts for their dark purplish-brown appearance and their unpleasant odour (Pojar and Mackinnon, 1994). They have evolved to attract their pollinators; the dark appearance of the flowers mimics carrion, as does their rather unpleasant “rotten” smell – adaptations that are common in fly- and beetle-pollinated flowers (Pojar and MacKinnon, 1994). Both species bloom

from April to July within their British Columbian range and seed capsules in the Pacific Northwest generally dehisce in the late summer/early fall. The seed capsules of *F. camschatcensis* are cylindrical and club-shaped, housing numerous (20-50)[6] flat seeds per capsule. In contrast to the capsules of *F. affinis*, which are distinctively winged, those of *F. camschatcensis* are sharply 6-angled but not winged.

Fritillaria camschatcensis grows up from a bulb composed of a compressed stem called a " basal plate" that has numerous of fleshy scales and rice-like bulblets attached to it, creating the overall appearance of a ball of rice grains stuck together (Langens-Gerrits, 2003; Pojar and Mackinnon, 1994; Turner, 1995; Turner and Bouchard, 1976). The bulb usually grows shallowly (5-20 cm) in the soil and tend to grow clumped together with other bulbs. In contrast, *F. affinis* bulbs tend to have fewer bulblets. The bulbs of both species were traditionally harvested for food with a specialized digging stick, often made of yew wood (*Taxus brevifolia*) or ironwood (*Holodiscus discolor*), or were dug out by hand (Kuhnlein and Turner, 1991; Turner, 2004).

1.10.1 Reproduction of *Fritillaria camschatcensis*

F. camschatcensis can reproduce by two modes: sexual reproduction (seed production), and vegetative reproduction in the form of clonal multiplication of the adventitious bulblets from the main bulb. Not all plants with viable bulbs flower each year and in a non-flowering year the plants will still send up photosynthetic vegetative growth, allowing the bulb to continue to grow and flower in succeeding years (Shimzu *et al*., 1998).

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[6] This number is based on my field observations. I have not found a reference source for the exact numbers of seeds in *F. camschatcensis* seedpods.

1.10.2 Sexual Reproduction

As noted previously, sexual reproduction in *F. camschatcensis* is facilitated by pollination of the flowers by flies. *F. camschatcensis* produces two types of flowers, male flowers and co-sexual flowers (Shimzu *et al*., 1998). The male flowers have only stamens, with a degenerated pistil, whereas the co-sexual flowers have both stamens and pistil. This species is not self-compatible (Shimizu *et al*., 1998). *Fritillaria camschatcensis* is the first example within this genus of a plant with sexual lability, meaning that the flowers can change between being male and co-sexual. This most likely allows plants to abort development of the female reproductive parts and produce only male flower parts, thus focusing on pollen production. Such a situation may arise if the plants are stressed or if onset of blooming is late (Gerry Allen, pers. comm, January, 2012).

The growing cycle of *F. camschatcensis* is as follows. In mid to late spring a shoot emerges from the bulb and develops into a leafy stem with several flower heads at the top. As each flower matures and opens, it emits a strong odour that attracts fly pollinators. Upon successful pollination and fertilization, a fruiting capsule develops. The capsule matures and dehisces in late summer or early fall, dropping the seeds close by[7]. Although the number of seeds produced is high, seedlings have rarely been observed in the limited field studies that have been conducted on reproduction strategies or the life cycle of *F. camschatcensis* (Marchant, 1981; Shimzu *et al*., 1998). Figure 4 shows these different stages (Shimzu *et al*., 1998). The germination time for seeds in this species is 3-6 years. This fact, along with a rapid rate of clonal reproduction, may indicate that sexual

[7] Any seed distribution vectors that may exist have not been documented or linked to specific species in the literature, although deer browsing of seed capsules was observed in the Squamish Estuary during this study.

reproduction plays another role other than population maintenance, possibly promoting genetic diversification (Shimzu *et al*., 1998).

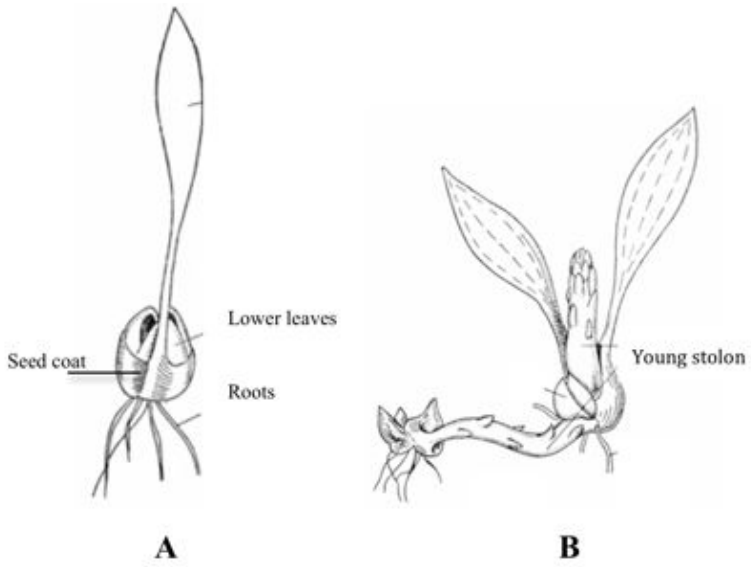

Figure 1.6 Drawings of seedling stage of sexual reproduction. A) shows seedling with remnant seed coat and B) shows later stages of seedling reproduction with seed coat remnants at base of stem (Images from Baranova, 1981).

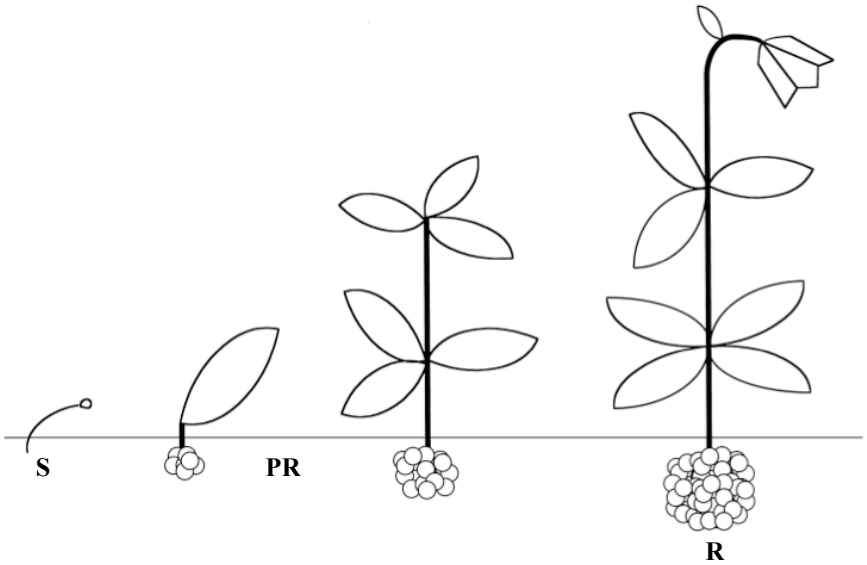

Figure 1.7 Diagram of three life cycle stages of sexual reproduction as outlined by Shimzu *et al*., 1998 from seedling stage (S), pre-reproductive stages (PR) and reproductive (R).

Actual seedling recruitment has been reported as less than 5 % in wild populations (Baranova, 1981; Shimzu *et al.,* 1998). Possible reasons for low seedling recruitment

could be: pollination failure or lack of pollinators at the right time, grazing, seed predators, soil pathogens, breakdown of seed coat over time and competition (Hill, 2012). A common characteristic between all *Fritillaria* seeds is that the embryo is undeveloped at the time of dispersal; thus, before seeds can germinate the embryo must complete its development, and in order to do this the seed requires uptake of water and lower temperatures (4-5º C) (Hill, 2012). All of these factors together may contribute to the low number of seedlings observed in wild populations.

1.10.3 Vegetative Reproduction

The primary form of population maintenance for *F. camschatcensis* appears to be through vegetative reproduction (Shimzu *et al*., 1998).[8] Clonal reproduction ensures a certain population of plants persists in situations where seed germination may be complicated, limited or time consuming. The bulbs of *F. camschatcensis* are rosulate with sympodial branching[9] and are composed of a compressed stem with compressed internodes, with the lower leaves metamorphosed into fleshy scales. The bulb of *F. camschatcensis* is considered a "tiled" bulb according to the types of bulbs identified by Baranova (1981). This type of bulb is characterized by growing on a stolon and is made up of many small, loosely packed fleshy scales called bulblets. The bulbs of *F. camschatcensis* can multiply vegetatively in two ways. Firstly, the bulb can divide after

[8] The genet of a clonal plant is defined as the genetic individual that develops from the zygote and that produces ramets vegetatively. A ramet is an individual member of a clone (Scrosati, 2002).

[9] Sympodial branching is when the apical bud withers at the end of the growing season and growth is continued the following season by the lateral bud immediately below. Rosulate means leaves grow in a circular arrangement and monocarpic means the plant only flowers and fruits once during the growing season.

forming two axilliary[10] buds, eventually forming multiple bulblets on the same plant, each capable of growing into a stem. Alternatively, already formed bulblets can shed from the mother bulb to create a new and independent ramet. Vegetative reproduction plays a more prominent role in reinforcing populations of *F. camschatcensis* season to season than sexual reproduction (Shimzu *et al*., 1998).

Typically, *Fritillaria* species have two periods of dormancy that correspond closely to seasonal changes in soil temperature. In autumn the bulbs send out adventitious roots from the base of the compressed stem and the inflorescence bud also elongates during this period. With the onset of colder weather in the late autumn and early winter the first dormancy period begins and the bulbs lie dormant until spring. In the spring, with rising soil temperatures and moisture levels, the bulbs break dormancy and start the bulk of their seasonal growth where the roots and shoots grow to completion. Stalk elongation requires cooler temperatures (5-9º C) during daylight hours. Individuals flower for 10-14 days after pollination occurs and the development of the seed capsule takes 6-8 weeks (Baranova, 1981). In the early summer after the plant has flowered and as soil temperatures begin to rise again the bulbs enter the second period of dormancy where they do not grow roots or undergo shoot elongation until cooler autumn temperatures prevail. Barnova (1981) reports that the bulbs of *Fritillaria* renew themselves each year and thus the shoot of the previous year is not present in their structure (Fig 1.8). However, this may vary from year to year based on available resources and seasonal variation (Gerry Allen, pers. comm., January 2012).

[10] Axillary buds are buds that develop at the axil of a leaf of a plant. The axil is where the petiole of the leaf attaches to the stem.

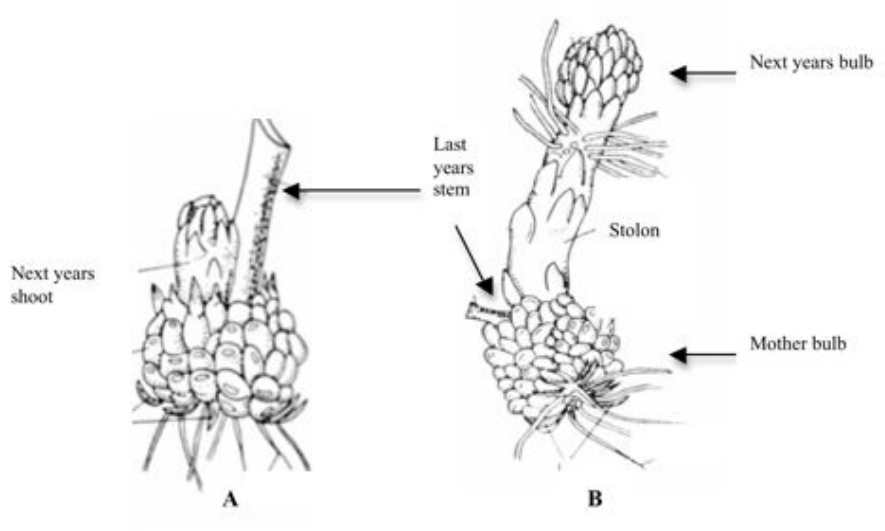

Figure 1.8. Vegetative growth in *F. camschatcensis*. A shows bulb with sympodial branching taking place with new lateral shoot beside old shoot. B shows the extension of the new shoot and production of new roots at the base of the new developing bulb (Illustrations from Baranova, 1981).

Figure 1.9 shows *F. camschatcensis* bulblets in various stages of development. I have not found any conclusive information on how long it takes for a bulblet to develop into a mature bulb so I am unable to comment on the exact timing of these different stages. Photoplates shown in Figure 1.9 are meant to identify some of the important stages in the life cycle of *F. camschatcensis*.

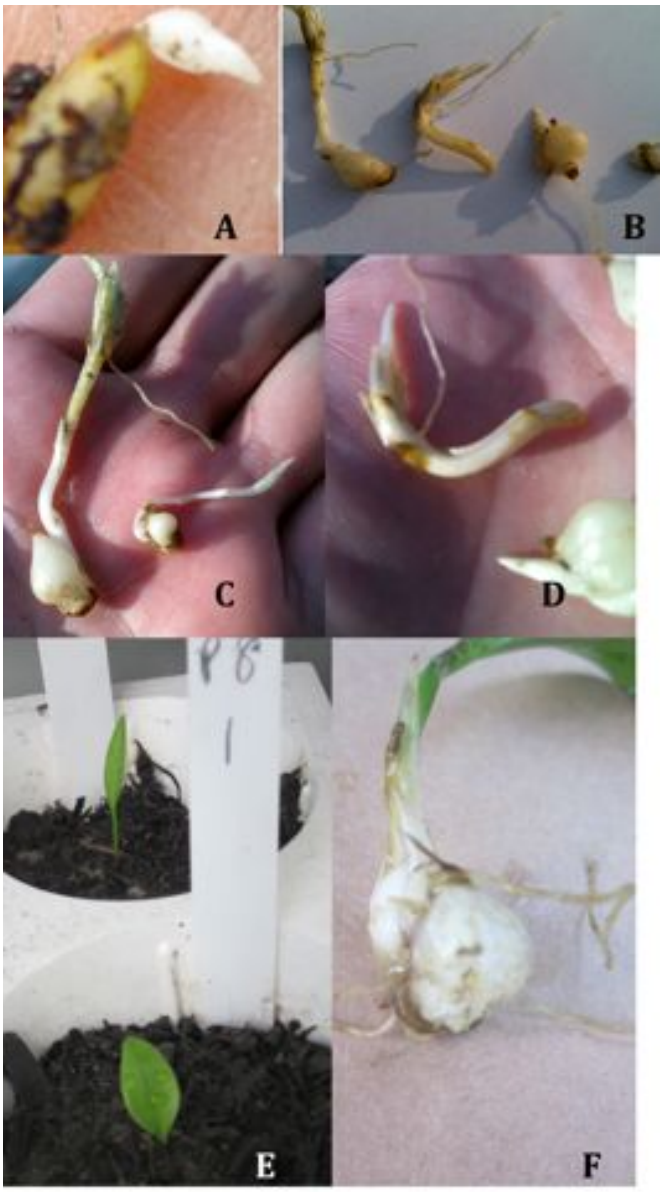

Figure 1.9. Photo plate of stages of bulblet development and early growth of *F. camschatcensis* bulbs. A. Single bulblet sprouting B. Bulblets in various stages of sprouting and sending up shoots C. Bulblet with long shoot and new roots growing D. Bulblets demonstrating sympodial growth E. Bulblets sending up vegetative leaf after being stripped from mother bulb and replanted F. Close up of bulblet that has begun dividing and has new root and shoot growth.

Figure 1.10. Older individuals of *F. camschatcensis* G. Growth of next years shoot in the autumn H. Whorls of leaves and development of flower heads in late spring I. Flower head fully developed and opening in late spring J. Mature flower being pollinated by fly K. Flowers begin to wither and seed capsule development is evident L. Seed capsules are fully developed late summer M. Mature seed capsule splits in late summer early fall and seeds mature N. Large bulbs of *F. camschatcensis* harvested for feast in Kingcome Inlet B.C.

Figure 1.11 shows the general dormancy cycle of *F. camschatcensis* in a growing year. This diagram corresponds with important management considerations when

harvesting riceroot or when conducting activities related to restoration such as transplanting.

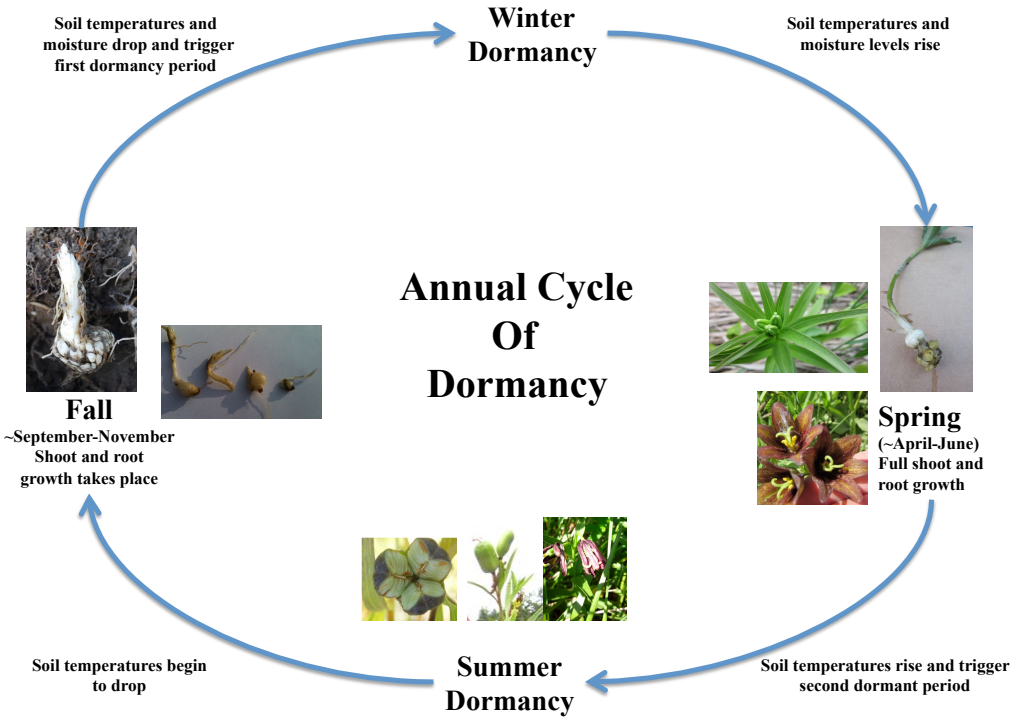

Figure 1.11. Diagram of general periods of dormancy of *F. camschatcensis* throughout the annual growing season.

Life cycle information and phenological development are important in assessing the timing for potential transplanting and separating bulbs as well as when to plant out the seeds. Understanding more about the lifecycle of *F. camschatcensis* can therefore assist in future restoration efforts and can also provide a foundation for renewing knowledge of the plant in the Squamish Nation, as well as increasing community interest and participation. The ability of *F. camschatcensis* to recruit from bulblets as well as from seed is a very positive trait from a restoration viewpoint. The observation that

bulblets develop into new plants when separated from the mother bulb, suggests that disturbance associated with traditional harvesting practices facilitated recruitment (Deur, 2005). There are animals that forage in estuaries that play a role in the disturbance and the dissemination of *F. camschatcensis* including geese, deer and bears. There are accounts of grizzly bears commonly digging up *F. camschatcensis* bulbs and in the process spreading out the bulblets (Turner, 2012, Under Review).

1.11 Traditional Ecological Knowledge (TEK)

Traditional Ecological Knowledge (TEK) is a term that has been developed to describe the wealth of knowledge, practice and belief held by Indigenous peoples, which has accumulated through generations of lived experience (Berkes, 2012). There are concerns about the use of the word "traditional." Some people feel it doesn't adequately emphasize the dynamic nature of culture and, instead, implies a sort of static antiquity – something out of date and old-fashioned. Some suggest using Indigenous Ecological Knowledge in its place (Thompson, 2004). However, "TEK" is currently widely used and understood, and, as long as it is carefully defined it serves the purpose to describe complex Indigenous environmental knowledge systems. Within my research I use the term TEK throughout, adopting the definition provided by Berkes (2012: 7): "a cumulative body of knowledge, practice and beliefs that pertains to the cultural, spiritual and practical connection of indigenous people, and other living beings, to their traditional territories, to the land". The word "wisdom" has been added by some to the end of the phrase and is a way of implying that Traditional Ecological Knowledge and Wisdom (TEKW) is knowledge accumulated over long time periods that adjusts accordingly to

changing times and contexts: a true system of knowledge (Turner *et al*., 2006).

1.12 Science and Traditional Ecological Knowledge and Wisdom (TEKW)

Scientists and Traditional Knowledge holders have much to offer each other. There has been an increase in collaborative efforts between Indigenous people and scientists to address key environmental problems such as: need for restoration, effective resource management, food security and climate change (Senos *et al*., 2006). These respectful collaborations are very important and contribute to the renewal of cultural knowledge and practice in meaningful ways. Science and TEKW methodologies also have much to offer each other. Both knowledge systems utilize long-term observation and monitoring, systematic experimentation, and incorporate empirical knowledge (Anderson, 2005). Both science and TEKW utilize what we might call "naturalist skills", including identification of different species along with an in-depth understanding of the living context for those species (e.g., lifecycles, germination times, response to changing environmental conditions from year to year) (Hunn, 2007). Traditional Ecological Knowledge and Wisdom can be considered qualitative and diachronic in ways, using observations from a single locale over a long time period (Kimmerer, 2002). This may also be true of long-term ecological restoration or ecological monitoring studies. Combining these two knowledge systems can address the human interaction with the natural environment in a multifaceted way. Ethnoecology can examine the human/nature interface more clearly within the cultural context that is essential to move forward respectfully and with meaning. My MSc research aims to identify ways in which these two knowledge systems can be used in a complementary manner. Science can supply

quantitative data from large areas, and TEKW can supply qualitative, long-term, baseline data and cultural perspectives from a certain location or region, which when taken together, can lead to robust results (Moller *et al.*, 2004). There are, however, also challenges to bringing these two knowledge systems together. Science and TEKW are rooted in different worldviews, it can be a challenge to know how these two complex systems of knowledge can be integrated or used to complement each other.

The following chapters show how I approached bringing science and TEKW together through my research of the ethnoecological restoration of *lhásem*.

Chapter 2 Characterizing *Lhásem* (*Fritillaria camschatcensis*) Habitat in the Squamish Estuary

2.1 Introduction

For thousands of years Indigenous People around the world have managed natural resources and environments sustainably (Deur, 2000; Deur and Turner, 2005; Minnis, 2004; Martin, 2004). There are complex protocols and technologies developed by many Indigenous cultures for harvesting natural resources as well as maintaining and altering habitats to promote the production of certain highly regarded species (Deur, 2005; Turner and Peacock, 2005; Beckwith, 2004). The edible plant Northern riceroot (*Fritillaria camschatcensis* (L.) Ker. Gawl.) is part of a complex system of food production and resource management developed by Indigenous Peoples of the Pacific Northwest of North America (Anderson, 2005; Deur, 2005; Turner and Peacock, 2005). This plant grows in estuarine environments and up until relatively recently would have been found growing in abundance in the Squamish River estuary. The Squamish Nation name for riceroot is *lhásem*.[11] The Squamish Estuary is important both historically and culturally to the *Sḵwx̱wú7mesh* (Squamish) People. There were three village sites located in the estuary, food harvesting sites (including sites where *lhásem* was harvested), and areas of spiritual importance (Bouchard and Kennedy, 1986; Matthews, 1955; Xay Temíxw Plan, 2001).

Over the past century, the Squamish estuary has undergone significant anthropogenic disturbances, particularly on the east side of the estuary which borders the town of Squamish. Impacts include: draining for agriculture, the redirection of the river

[11] From this point on *Fritillaria camschatcensis* will be refered to by the Squamish name *lhásem.*

by a training dyke, the disposal of large quantities of dredge spoils, the presence of a log sort and a garbage dump and past industrial activity. These impacts have degraded the east side of the estuary and have nearly eradicated populations of *lhásem* on the eastern side.

The connection between landscape and culture is one that is integral to the Squamish People. The degradation of culturally important ecosystems, such as the Squamish Estuary, greatly increases the vulnerability of traditional knowledge linked to cultural practices such as harvesting and management (Turner, 2005; Turner *et al*., 2000; Turner and Turner, 2008). In the Squamish Estuary this includes the loss of knowledge of *lhásem*. My research is part of a larger movement in the Squamish Nation to strengthen their connection to the land, their culture and their diet through renewing their traditional knowledge and practices (Chapter 3).

One approach to renewing cultural knowledge and traditional practice is to focus ecological restoration on culturally salient species. This form of restoration considers the Indigenous perspective and is coordinated by, or involves, Indigenous people throughout the restoration process (Bartley, 2005). Restoring *lhásem* into the Squamish Estuary has the potential to connect people to their language, the land, their history and traditional diet (Higgs, 2003; Turner *et al*., 2000). Ethnoecological restoration of *lhásem* is linked to many other aspects of culture and has the power to rebuild the Squamish People's connections with the land by reinstating a traditional food and creating more stewardship for an important ecosystem.

My research explored the potential to restore *lhásem* in the Squamish estuary and

asked the following interrelated questions:

- What are the ecological indicators (biotic and abiotic) of *lhásem* habitat in the Squamish estuary?
- What is the success of *lhásem* in a restoration garden setting after one growing season?

To address my research questions I examined *lhásem* habitat in the estuary, and explored the interaction between *lhásem* abundance and abiotic parameters. Through my field work I explored how best to approach the restoration of *lhásem* in areas where it formerly occurred on the east side of the Squamish River Estuary. The answers to these questions – along with understanding of social and cultural parameters of *lhásem* history and use – are key to framing *lhásem* restoration activities for the future.

2.2 Methods

2.2.1 Study Site

My study area was located in the traditional territory of the *Skwxwú7mesh* (Squamish) First Nation, in south-western British Columbia approximately 50 kilometres north of Vancouver (Figure 1.4, Chapter 1). Squamish is located at the foot of the Coast Mountains and Squamish territory is situated mainly within the Coastal Western Hemlock Biogeoclimatic Zone (CWHZ). The CWHZ is made up largely of temperate coniferous rainforest, dominated by western hemlock (*Tsuga heterophylla*) and western red cedar (*Thuja plicata*) (Meidinger and Pojar, 1991). Mountainous topography and proximity to the ocean result in a moderate climate and high annual precipitation. Precipitation at Squamish is approximately 2200 mm annually and the average annual temperature is 8.9 degrees Celsius (Wang, 2012). Squamish is geographically and

ecologically diverse, making it a place that is rich in plant and animal life. This richness is highlighted through the language, stories, songs, and traditions of the Squamish people (Floyd Joseph, Pers. Comm. 2012; Hill-Tout, 1978; Matthews,1955).

The Squamish estuary is located where the Squamish River meets Howe Sound, and covers 673 hectares of land (Skwelwil'em, 2007). The estuary is a low lying river delta where freshwater and marine environments converge. It is dominated by wetland vegetation and shrub communities tolerant of the brackish waters and wet soils (Mackenzie and Moran, 2004).

2.2.2 Characterizing Ecological Conditions in the Squamish Estuary

To determine the optimal conditions for *lhásem* growth, I surveyed the heavily impacted eastern side and the less impacted western side of the Squamish estuary in the spring of 2011. These surveys, which were conducted in order to select appropriate sites for *lhásem* restoration, examined *lhásem* abundance, plant community composition and abiotic conditions at four site types in the estuary: 1) Terrestrial east (TER_E), Estuary east (EST_E), Terrestrial west (TER_W), and Estuary west (EST_W). Less impacted sites were located on the west side of the Squamish River and impacted sites were located on the east side. Sites were classified using definitions from the Skwelwil'em Management Plan (2007), where estuary sites were typically low-lying, frequently inundated, and wetter than more elevated sites classified as terrestrial.

At each of the four site types I established 6-10 transects perpendicular to river channels (Figure 2.1). Transect locations were determined randomly by selecting numbers between 50 and 100 that corresponded to distances in meters. Transects were between 50 and100 meters in length depending on the width of the site. In areas of the

estuary where the floodplain was narrower I ran shorter transects). Along each transect I placed 1m^2 quadrats at the distance required to obtain 10 evenly spaced quadrats per transect. In each quadrat I compiled a plant species list and visually estimated the percent cover of all vascular plants. For each quadrat I also measured: soil moisture, soil temperature, pH and salinity. Soil moisture and salinity were obtained using a ThetaProbe Type ML2x soil moisture probe in the field. At each transect I also collected four soil samples in the center of quadrat numbers 1, 3, 6, and 9. These samples were bagged, labelled and frozen prior to delivering them to the BC Ministry of Environment Analytical Chemistry Services Lab on August 14th 2011, where they were analyzed for soil moisture, salinity, pH and mercury levels.

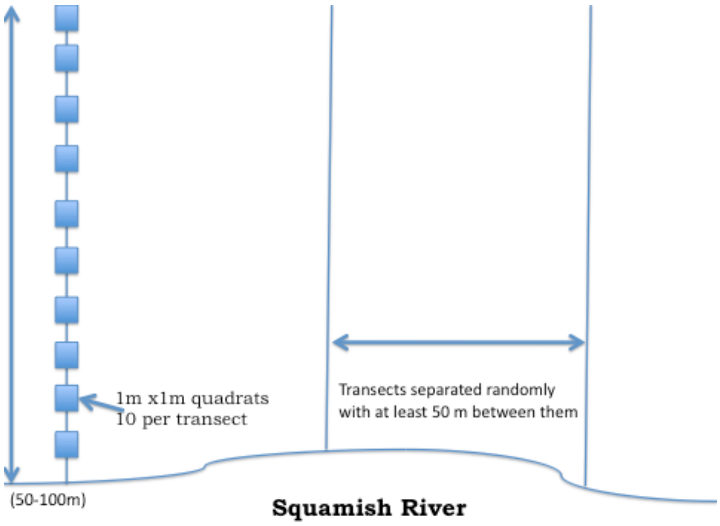

Figure 2.1 Transect setup used in the ecological assessment of the Squamish Estuary.

Figure 2.2 shows an overview of the estuary with the impacted eastern and less impacted western portions of the estuary labelled and also shows areas that were surveyed as part of this research.

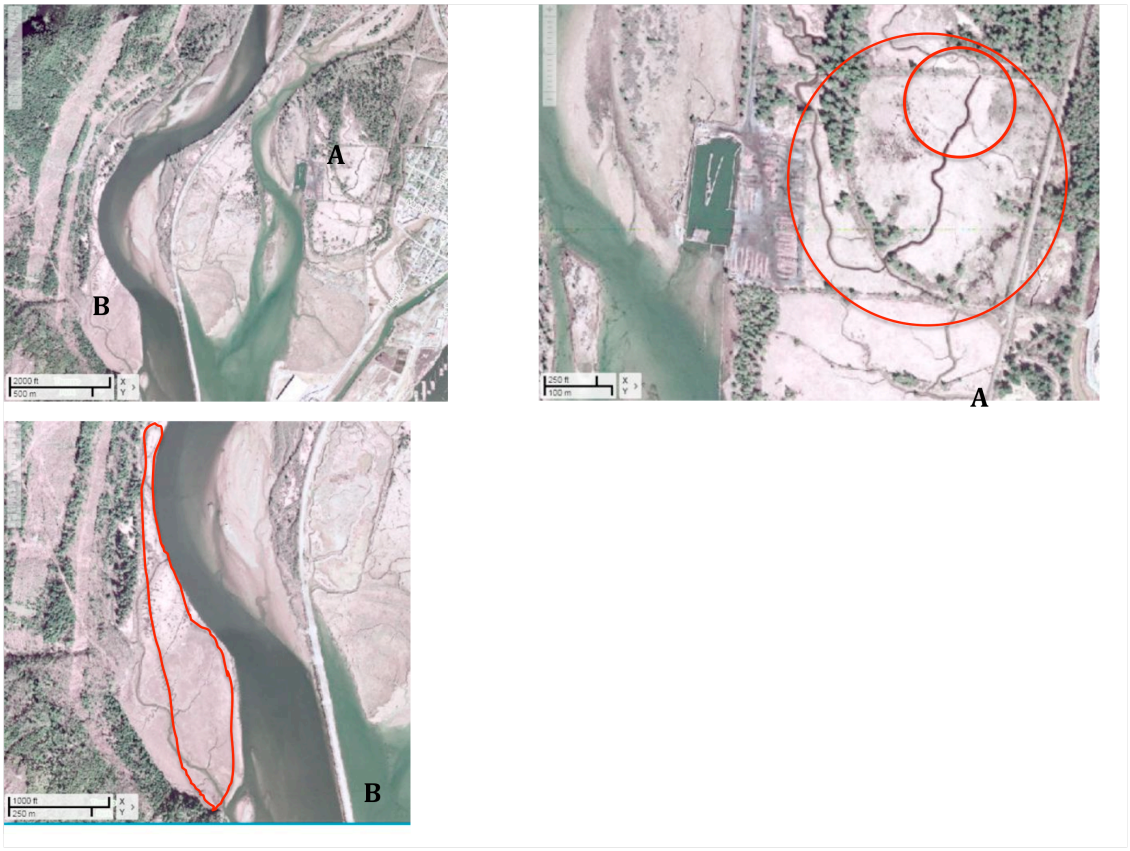

Figure 2.2 Overview maps of the Squamish Estuary Wildlife Management Area. Top left shows: A) the impacted eastern side and B) shows the less impacted western side. Top right: shows the east estuary with small circled area representing where restoration gardens were located and large circle showing the rough boundary of the area surveyed on the east side. Bottom left: West bank of Squamish River estuary where, red outline roughly indicates general survey area. Map from (http://maps.squamish.ca/publicmaps/Viewer.html?Viewer=Parcel%20Viewer%20-%20Public).

2.2.3 Statistical Analysis

nMDS/Anosim/SIMPER

Several non-parametric multivariate approaches were used to examine differences in plant community composition at the four sites types sampled in the Squamish estuary, and to characterize differences at sites with and without *lhásem*. These are described in the following sections. All analyses were all run using a log transformed (x+1) matrix of percent cover values.

To compare plant community composition among the four site types in the Squamish Estuary I used PRIMER (V6) to calculate the Bray Curtis Distance matrix from log transformed percent cover data recorded in each quadrat (Clarke and Gorley, 2006, Clarke and Warwick, 2001). Non-metric multidimensional scaling (nMDS) is an ordination technique that uses the distance matrix to assess similarity or dissimilarity among samples. The best 2-dimensional representation of the data was selected based on low stress level and clarity of visual representation. To examine differences among sites this 2-D ordination was visualized using the following factors: site type (including east/west terrestrial, east/west estuary), presence/absence of *lhásem* and a combination of these two factors. I also explored the data using a factor for transects but the ordinations were too busy and less informative than the ones included here.

To test for statistical differences in community composition I used PRIMER to perform an analysis of similarities (ANOSIM) using the same factors listed above. ANOSIM acts on the resemblance matrix and runs a test analogous to the standard univariate 1 or 2 way ANOVA (analysis of variance). ANOSIM tests the null hypothesis that there are no significant differences in species composition among groups specified by the levels of a single factor. The significance of the R_{ANOSIM} statistic was calculated by performing 999 randomizations of the original data. If the global R is larger than any of the 999 permuted values then the null hypothesis is rejected at a significance level of $p<0.001=p<0.1\%$ ($<1/999 = <0.001$). ANOSIM also performs pairwise tests to examine differences among site types. All tests yield a R_{ANOSIM} statistic that can be used to evaluate the similarity/dissimilarity between site types. Values of $R_{\text{ANOSIM}} > 0.75$ indicate

that site types are well separated, values between 0.5 and 0.75 describe overlapping but distinguishable groups, and values < 0.25 are characteristic of groups that can barely be separated.

To assess the relative contributions of plant species to the similarity/dissimilarity measures, I used the Similarity Percentages (SIMPER) feature of PRIMER. This analysis helped to determine which species make the biggest contribution to similarity/dissimilarity among site types. The species that contributed approximately 70% of the differences between sites are included in Tables 2.1-2.5. I have included SIMPER results for site type comparisons that correspond to R_{ANOSIM} values of close to 0.5 or higher so as to isolate the comparisons between the sites that are most dissimilar.

Univariate Analysis

To explore the relationships between abiotic data and the presence/absence of *lhásem*, I used SPSS to create scatter plots and run a logistic regression of presence/absence of *lhásem* as a function of: soil moisture, salinity and pH. I also explored the differences between the east and west, with regards to presence and absence of *lhásem*, using pivot charts to display the mean values of the abiotic data.

PCA Principle Components Analysis

To visually examine the relationships between abiotic variables, and presence/absence of *lhásem*, I performed a principal components analysis (PCA). This analysis was run in SPSS using a correlation data matrix of standardized, log transformed, abiotic variables and graphed in the statistical program "R". PCA reduces

the dimensions of multivariate data using a smaller number of axes (PCs). I included data on soil moisture, salinity and pH in this analysis.

2.2.4 Soil Analysis

Soil samples were taken with a soil auger in the top 30cm of the soil profile. The following methods were used to analyze soil samples at Analytical Chemistry Services Lab. To screen for mercury, 1 g of fresh soil was digested in 4 ml of nitric acid and 1 ml 30% hydrogen peroxide in a closed-vessel microwave digestion system. After cooling, the sample volume was made up to 15 ml with 10% hydrochloric acid. The samples were analyzed on the Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES) using a hydride generator accessory. This system is capable of detecting about 30 parts per billion Hg in the digest solutions, which equates to about 0.50 parts per million in the original soil. After removing the sub-sample for mercury, the remaining samples were placed in weighing boats, and initial weights were taken. These were air-dried for several days before re-weighing to obtain the air-dried moisture content (MC). The samples were then crushed and sieved through a 2 mm sieve. A sub-sample of the 2 mm sieved soil was oven-dried to obtain a moisture correction factor (MF) to allow us to express results on an oven-dried basis where appropriate. The samples were not oven-dried as it might have changed the soil composition through heating and altered the pH and E.C. values. Therefore a small sub-sample was oven-dried and converted the air-dried results to an oven-dry basis. To measure electrical conductivity (E.C.) saturated pastes were prepared from a portion of the 2 mm sieved, air-dried materials. The pH was determined using 1:1 soil: water suspensions of the <2mm material. The normal procedure calls for 10 g soil and 10 ml water, but in some cases less than 10g of soil was available. In these

cases available soil was mixed with distilled water in a 1:1 ratio. Some of the samples also had high moisture holding capacity, and additional water had to be added to form a suspension. Both of these deviations were noted on the lab's final report.

2.2.5 Bulblet Experiment

Early in my research I harvested a small number of *lhásem* plants and stripped the bulblets and planted them out in seedling trays, then replanted the central disk of the bulb in a pot. To determine how quickly and successfully *lhásem* grows from bulblets and from the central disk of the bulb, these plants were watered on a bi-weekly basis, but otherwise left undisturbed for a one-year period.

2.2.6 Restoration Experiments

To assess the potential to restore *lhásem* at sites in the Squamish River estuary two restoration trials were established on the east side of the estuary. The overall restoration site in the Squamish estuary was located at grid reference 49º42'06.28"N 123º49'09.16"W. To explore the potential to establish *lhásem* across a range of moisture conditions treatments were established in: 1) drier, elevated sites, considered terrestrial and 2) lower, semi-saturated sites considered estuarine. Once appropriate areas for restoration were selected, restoration garden site placement was randomized and experimental plots were built. In total, 12 restoration garden plots were established: 5 estuarine and 7 terrestrial. Sheet mulching techniques were used to prepare the restoration gardens. The vegetation in each garden plot was cleared to the ground using scissors, then cardboard sheets measuring 1m x 2m were laid down to suppress unwanted plant growth. Inside each 1 by 2 meter plot, 8 holes were cut in the cardboard and one of two planting

treatments was randomly assigned to each 1 by 1 meter subplot: 1) 4 *lhásem* plants; and 2) 4 clusters of individual *lhásem* bulblets (Fig. 2.3). Whole plants or bulblets were evenly spaced and the cardboard was then covered with a mixture of estuary mud and cattail leaves and stems (Fig. 2.4).

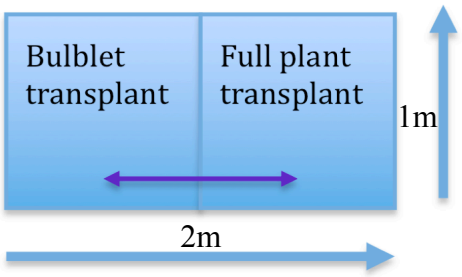

Figure 2.3 Layout of the experimental garden plots used in the restoration trials. In each 1x2 m plot two treatments were applied (bulblets and full plants). The $1m^2$ area where bulblets or full plants were established was randomized.

The *lhásem* plants and bulblets used in the restoration experiment were collected, from salvaged plant bulbs from the eroded bank and from direct transplants from the west bank of the Squamish River estuary. The gardens were revisited in May, 2012 and were measured for success and failure. Success was measured as a plant growing, failure was no plant growing. These results were then analyzed using logistic regression and visually represented using a box and whisker plot.

Figure 2.4 Finished experimental restoration garden (2 x 1 m) with cardboard layer covered in mud and then covered with cattail husks.

2.2.7 Educational Garden

In partnership with the Squamish Nation Education Department I also developed an educational garden plot at an accessible location (Fig. 2.5). This garden is distinct from the experimental restoration gardens and was to be used for educational purposes. The educational garden was prepared using similar methods to those used to establish the experimental gardens. Differences included that a weed whacker (rather than using scissors) was used to cut the vegetation to the ground in a 4m x 4m area and landscaping fabric and soil were used in place of the cardboard and mud. The planting of the educational garden was conducted as an activity for a Squamish Nation youth camp. A group of 12 youth helped transplant *lhásem* bulbs and bulblets from the west bank into the educational garden. The central bulbs left over from the original bulblet planting experiment were also planted in the educational garden. The Squamish Education Department has taken responsibility for the monitoring and upkeep of the educational garden.

Figure 2.5 Planting of educational garden plot in Squamish Estuary as a part of the Squamish Nation Youth and Culture camp. Upper left photo from left to right in:(front) Phillip Williams, Anna Billie, Shaelyn Baker, John Joseph, Damien Joseph, Leigh Joseph (back) Jasmine Williams, Jonny Williams, Dallas Lewis, Dalious McCullough(very back) and Anthony Joseph.

2.3 Results

2.3.1 Plant Community Composition in the Squamish Estuary

The four site types surveyed in the Squamish estuary had significantly different plant community composition. Figure 2.6A is an nMDS ordination based on the percent cover of vascular plants in 285 quadrats[12]. The clumping together of the different symbols into four distinct groups in Figure 2.6A indicates that the sites had distinct community composition. A stress value of 0.14 indicates that this 2-D ordination was a good representation of the data. Differences were confirmed statistically using ANOSIM

[12] The total number of quadrats was 290, however, 5 quadrat results were omitted from these analyses, as they had no vegetation.

analyses, which showed significant differences between four site types (Table 2.1). All R_{ANOSIM}-values were found to be moderate to high, and were significant at a level of 0.1%[13]. Large differences were identified between west and east sites (less impacted and impacted sides of the estuary), but terrestrial and estuarine communities on one side of the estuary were typically more homogenous (Table 2.1). SIMPER analyses provided information on the dominant species contributing to the differences among sites. The dominant species at terrestrial west sites were false lily of the valley (*Maianthemum dilatatum*) and Lyngby's sedge (*Carex lyngbei*) (Table 2.2). Estuary west sites were almost completely dominated by Lyngby's sedge (*Carex lyngbyei*) (Table 2.3). Terrestrial east sites were dominated by Pacific silverweed (*Argentina egedii*), and *Agrostis* sp. (Table 2.4). Estuary east environments were dominated by cattails (*Typha latifolia*) and Pacific silverweed (*Argentina egedii*) (Table 2.5).

Plotting sites with and without *lhásem* on the nMDS ordination (Figure 2.6 B) indicates that *lhásem* was found predominantly in terrestrial west sites. SIMPER analyses also showed that *lhásem* was one of the species that characterized terrestrial west sites and separated this region from other site types (Tables 2.2 and 2.5).

[13] 0.1% is equivalent to $p<0.001$.

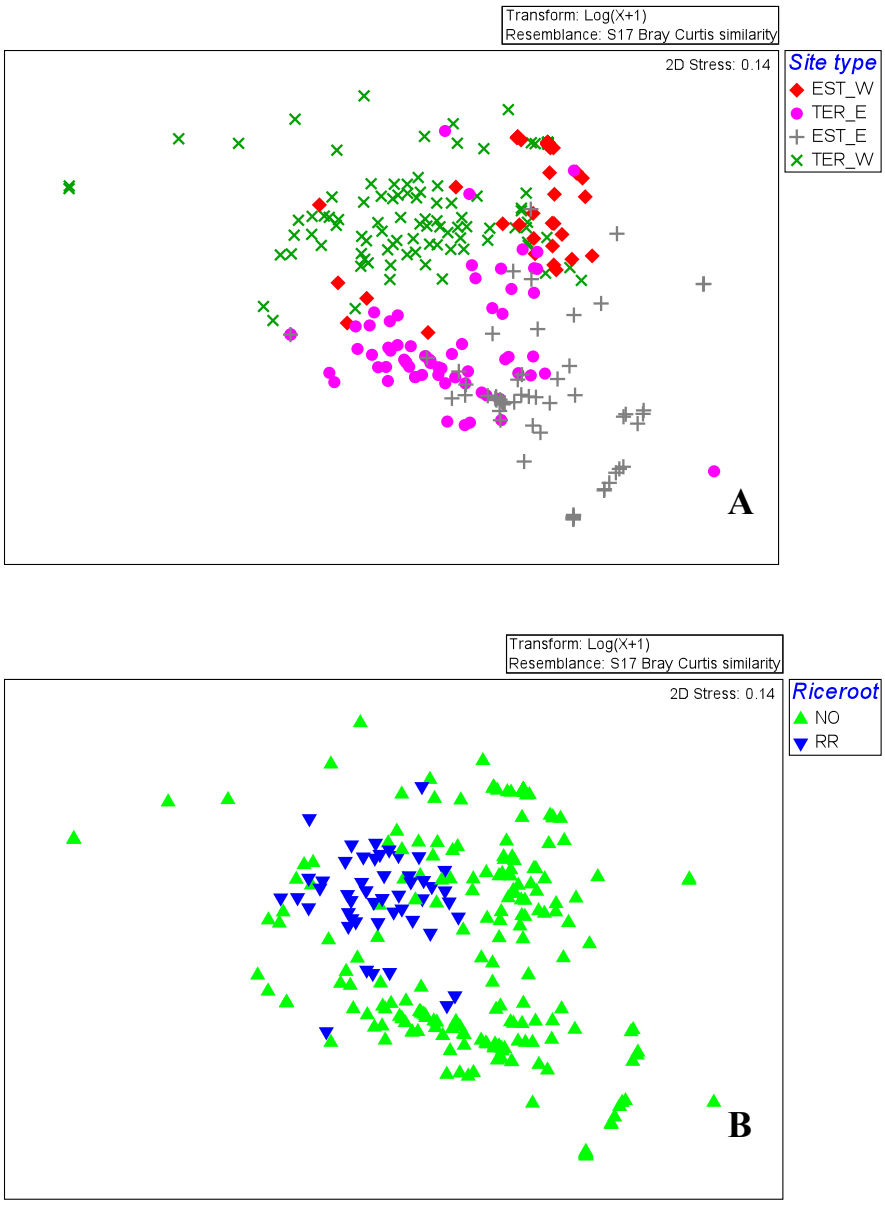

Figure 2.6. nMDS ordinations of vascular plant percent cover data (log x+1) at sites in the Squamish estuary. A. 2-D ordination showing the four site types sampled in the estuary. Site types are abbrevaited as follows: TER_W = Terrestrial West, EST_W=Estuary West, TER_E = Terestrial East, EST_E = Estuary East. **B.** nMDS ordinations showing sites where *lhásem* was present (blue = RR) and absent (green=NO).

Table 2.1 Comparison among site types in Squamish Estuary using the ANOSIM procedure. The global R_{ANOSIM}[14] for this test was 0.494, p<0.001. Values of R_{ANOSIM} > 0.75 indicate that site types are well separated, values between 0.5 and 0.75 describe overlapping but distinguishable groups, and values < 0.25 are characteristic of groups that can barely be separated.

Groups	R_{ANOSIM}	Significance (p value)
TER_W, EST_W	0.242	<0.001
TER_E, EST_E	0.336	<0.001
TER_W,TER_E	0.443	<0.001
TER_W,EST_E	0.661	<0.001
EST_W, TER_E	0.652	<0.001
EST_W, EST_E	0.716	<0.001

Table 2.2 Output of the SIMPER analysis for the comparison between Terrestrial West (TER_W) and Terrestrial East (TER_E). Table shows the average percent cover for each species at each of the sites and the percent contribution of that species to the overall dissimilarity between these sites. Average dissimilarity = 80.66.

Indicator Species	Average Cover Terrestrial West	Average Cover Terrestrial East	Percent Contribution	Cumulative Contribution
Argentina egedii	0.00	2.71	15.46	15.46
Carex lyngbyei	2.31	0.39	13.03	28.49
Agrostis sp.	2.07	0.00	10.14	38.63
Maianthemum dilatatum	1.47	0.24	7.95	55.35
Lathyrus palustris	0.43	1.30	6.90	62.25
Fritillaria camschatcensis	1.03	0.00	4.77	72.99

Table 2.3 Output of the SIMPER analysis for the comparison between estuary west and estuary sites east. Table shows the average percent cover for each species at both sites and the percent contribution of that species to the overall dissimilarity between these sites. Average dissimilarity = 91.01

Indicator Species	Average Cover Estuary West	Average Cover Estuary East	Percent Contribution	Cumulative Contribution
Carex lyngbyei	3.78	0.39	27.62	27.62
Typha latifolia	0.00	2.71	20.81	48.43
Argentina egedii	0.58	1.76	11.53	59.96
Lathyrus palustris	0.07	1.30	8.30	68.27
Poa sp.	0.00	1.14	7.84	76.11

Table 2.4 Output of the SIMPER analysis for the comparison between estuary west and terrestrial east. Table shows the average percent cover for each species at both sites and the percent contribution of that species to the overall dissimilarity between these sites. Average dissimilarity = 85.74.

Indicator Species	Average Cover Estuary West	Average Cover Terrestrial East	Percent Contribution	Cumulative Contribution
Carex lyngbyei	3.78	0.64	25.06	25.06
Argentina egedii	0.58	2.93	18.99	44.05
Agrostis sp.	0.27	1.75	13.07	57.13
Lathyrus palustris	0.07	1.39	9.61	66.73
Aster subspicatus	0.33	0.58	4.76	71.50

Table 2.5 Output of the SIMPER analysis for the comparison between terrestrial west and estuary east. Table shows the average percent cover for each species at both sites and the percent contribution of that species to the overall dissimilarity between these sites. Average dissimilarity = 91.37

Indicator Species	Average Cover Terrestrial West	Average Cover Estuary East	Percent Contribution	Cumulative Contribution
Typha latifolia	0.00	2.71	15.46	15.46
Carex lyngbyei	2.31	0.39	13.03	28.49
Maianthemum dilatatum	2.07	0.00	10.14	38.63
Argentina egedii	0.85	1.76	8.77	47.40
Agrostis sp.	1.47	0.24	7.95	55.35
Lathyrus palustris	0.43	1.30	6.90	62.25
Poa sp.	0.00	1.14	5.98	68.22
Fritillaria camschatcensis	1.03	0.00	4.77	72.99

2.3.2 Indicators of *Lhásem* Habitat

To examine the relationship between *lhásem* and other vegetation in the estuary additional SIMPER analyses were run. These analyses explored the species composition at sites in the Squamish Estuary with and without *lhásem*. Table 2.6 below shows the species responsible for the top 70% of the similarity within these site types.

Terrestrial west sites without *lhásem* had high cover of *C. lyngbyei* and as well as moderate presence of *M. dilatatum*. Terrestrial west sites with *lhásem* present were dominated by *M. dilatatum, F. camschatcensis and Agrostis* species. Terrestrial east sites

with no *lhásem* present were dominated by *A. egedii* and an *Agrostis* species. Terrestrial east sites with *lhásem* present were dominated by *F. camschatcensis* and *A. subspicatus*. Estuary west sites without *lhásem* present were dominated by *C. lyngbyei*. Estuary east sites without *lhásem* were dominated by *T. latifolia* and *A. egedii*.

Table 2.6 Output of the SIMPER analysis for vegetation data for sites with and without *lhásem*. Table shows the average abundance for each species at both site types and the percent contribution of that species to the overall similarity between these sites.

Site Type	Dominant Species	Average Abundance	Contribution %	Cumulative %
No *Lhásem* Terrestrial West	*Carex lyngbyei*	2.71	58.59	58.59
	Maianthemum dilatatum	1.33	11.86	70.45
***Lhásem* Present Terrestrial West**	*Maianthemum dilatatum*	3.11	31.61	31.61
	Fritillaria camschatcensis	2.49	24.38	55.99
	Agrostis sp.	2.20	15.66	71.64
No *Lhásem* Terrestrial East	*Argentina egedii*	3.04	55.81	55.81
	Agrostis sp.	1.86	23.27	79.08
***Lhásem* Present Terrestrial East**	*Fritillaria camschatcensis*	3.16	41.25	41.25
	Aster subspicatus	2.97	29.96	71.21
No *Lhásem* Estuary West	*Carex lyngbyei*	3.78	92.58	92.58
No *Lhásem* Estuary East	*Typha latifolia*	2.17	58.05	58.05
	Argentina egedii	1.76	20.66	78.70

2.3.3 Abiotic Conditions and *Lhásem* Abundance in the Squamish Estuary

Soil moisture and electrical conductivity at sites with *lhásem* varied considerably across the Squamish estuary. A key difference was that terrestrial west sites with *lhásem* present had a much lower electrical conductivity and higher moisture than terrestrial east sites with *lhásem* present (Fig 2.7). This step in the analysis was exploratory and although statistical analysis was not completed for these comparisons the ranges in salinity and moisture were shown to be highly variable across site types.

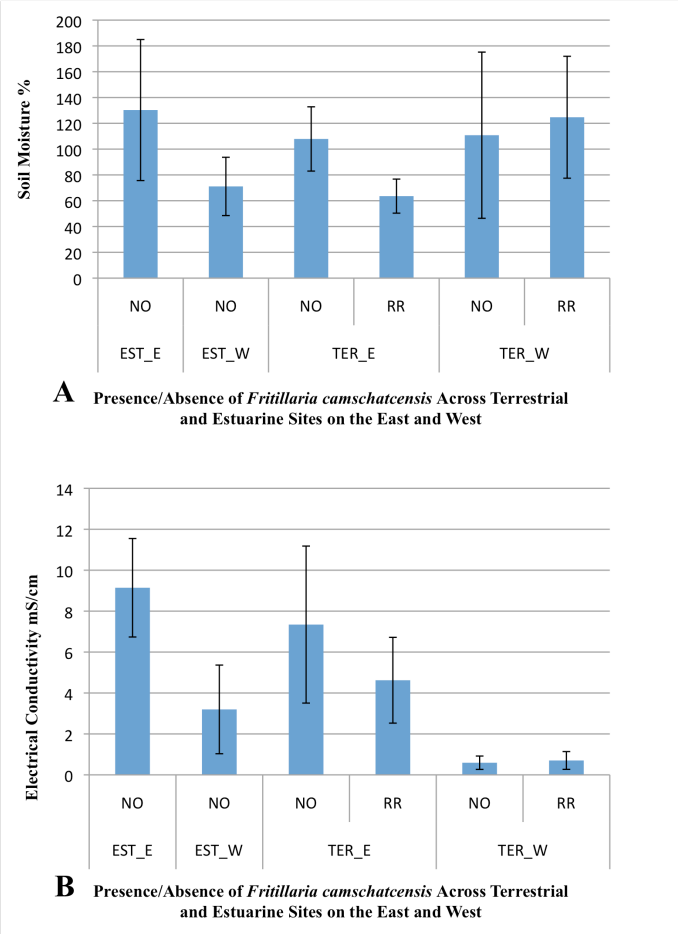

Figure 2.7. Graphs of abiotic factors across different site types with *lhásem* present or absent. **Graph A**. Average moisture across sites in percent, **Graph B**. Average electrical conductivity across sites. Bars show the mean, and error bars represent ± 1 standard deviation. **Site Codes** are: Terrestrial West=TER_W, Terrestrial East=TER_E, Estuary West=EST_W, Estuary East= EST_E. NO= No *lhásem* Present, RR= *lhásem* is Present.

Figures 2.8 and 2.9 show scatter plots of *lhásem* abundance vs. salinity and moisture across the four site types. Neither of these comparisons was indicative of linear relationship between salinity or moisture and *lhásem* abundance. However, Figure 2.8 suggests that *lhásem* may be limited by high salinity. Sites with salinity higher than 6 mS/cm have no *lhásem* present and the plants that are in the higher range are the few that were found growing in terrestrial east sites, an area with higher salinity. Figure 2.9

indicates that *lhásem* is tolerant of a range of moisture conditions.

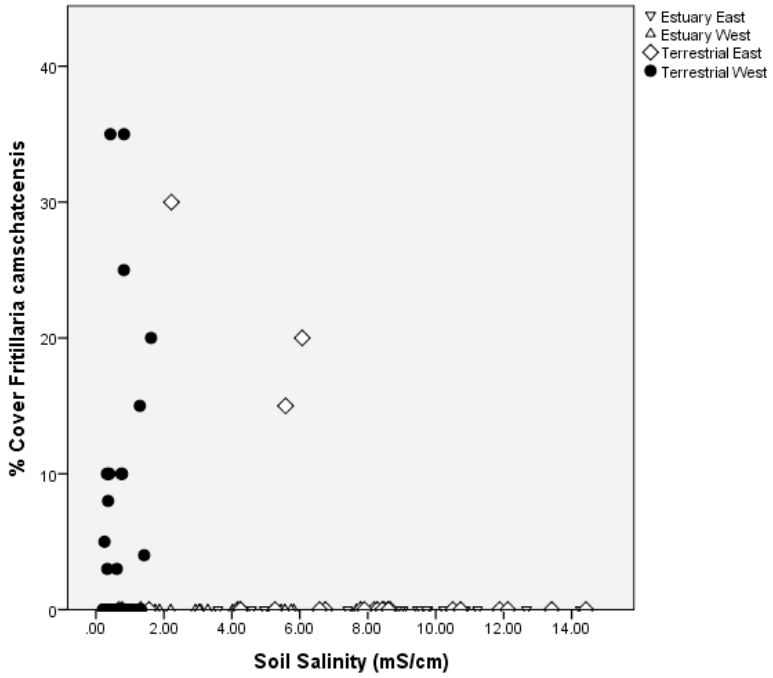

Figure 2.8. Scatter plot of *lhásem* abundance vs. electrical conductivity from sites across the Squamish Estuary.

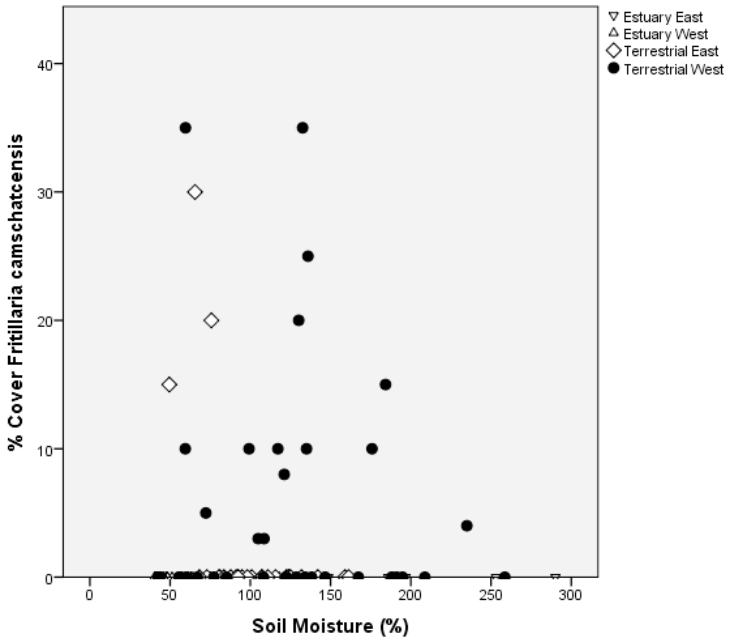

Figure 2.9. Scatter plot of *lhásem* abundance vs. percent soil moisture across four site types in the estuary.

A stepwise logistic regression was run on the soil moisture, electrical conductivity and pH data from the lab analyzed soil samples. The results indicated that salinity was the only significant (p=0.004) abiotic predictor of *lhásem* presence / absence (Table 2.7).

Table 2.7 Final model for logistic regression using abiotic data to predict where *lhásem* is found growing in the Squamish Estuary.

Variables in the Equation

		B	S.E.	Wald	Df	Sig.	Exp(B)
Step 1[a]	MOISTURE_LAB	.007	.005	1.902	1	.168	1.007
	EC_LAB	-.420	.143	8.649	1	.003	.657
	pH_LAB	.432	.762	.321	1	.571	1.540
	Constant	-3.760	4.341	.750	1	.386	.023
Step 2[a]	MOISTURE_LAB	.007	.005	1.876	1	.171	1.007
	EC_LAB	-.396	.133	8.894	1	.003	.673
	Constant	-1.339	.644	4.318	1	.038	.262
Step 3[a]	EC_LAB	-.391	.136	8.308	1	.004	.677
	Constant	-.616	.345	3.181	1	.074	.540

Principle Components Analysis (PCA)

The PCA analysis shows that 45.7% of the variation in abiotic variables was represented by PC1 and 33.9% by PC2. The loadings indicate that salinity was highly correlated with PC1. PC2 was highly correlated with moisture and pH, but these variables were also quite highly correlated with PC1. Figure 2.10 shows that sites with *lhásem* have low to intermediate values on PC1 and are associated with lower salinity and a range of moisture

conditions.

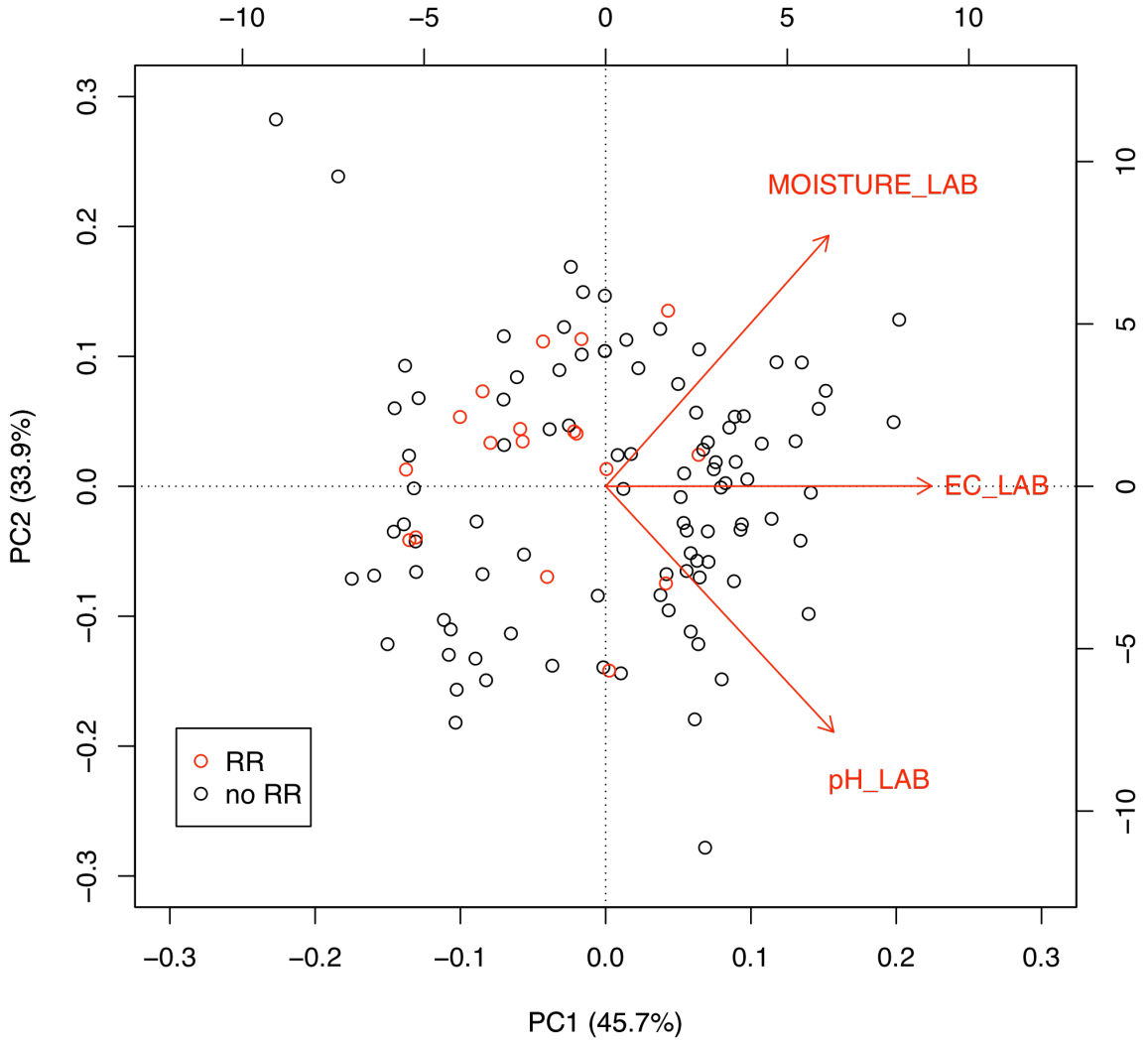

Figure 2.10. Principle Components Analysis of abiotic factors. Plot shows sampling sites plotted on PC1 and PC2. Sites where *lhásem* (*F. camschatcensis*) RR (riceroot) was found in the Squamish Estuary are shown in red and sites where it was not present are shown in black. Red arrows show the loading of abiotic factors at each PC in connection to the presence and absence data for *lhásem*.

Table 2.8 Loadings from Principle Components Analysis (PCA) showing correlations between the variables PC1 and PC2.

Component Matrix[a]

	Component	
	1	2
logMOISTURE_LAB	.573	.720
logEC_LAB	.837	.001
logpH_LAB	.585	-.706

2.3.4 Mercury Results

Only three sites, out of the 118 sites that were sampled and tested for the presence of mercury, had values greater than 1.0mg/kg of mercury found in the soil. There were 8 sites with values less than 1.0mg/kg and the remaining 107 sites had zero values, meaning no mercury was detected.

2.3.5 Experimental Restoration Treatment

Experimental gardens in the terrestrial sites were more successful than the estuarine sites and whole bulbs were more successful than bulblets (Figure 2.11). Table 2.9 shows the number of successes and failures in each experimental garden plot. The increased success of terrestrial gardens and whole plant propagules was verified by a stepwise linear regression (Table 2.10).

Table 2.9 *Lhásem* growth in experimental gardens one year after planting in the Squamish Estuary. Gardens were established in terrestrial areas and estuarine areas in estuary east. Table shows the number of living plants in each plots (/4).

Garden #	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**	**#7**	**#8**	**#9**	**#10**	**#11**	**#12**
Terrestrial/Bulbs	3	2	0	2	3	2	4	-	-	-	-	-
Terrestrial/Bulblets	2	0	0	0	2	1	2	-	-	-	-	-
Estuary/Bulbs	-	-	-	-	-	-	-	0	0	0	1	0
Estuary/Bulblets	-	-	-	-	-	-	-	1	0	0	0	0

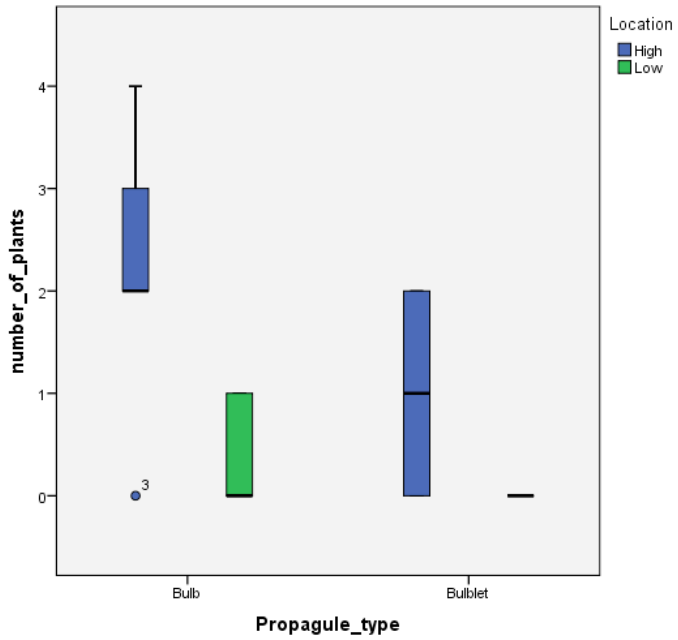

Figure 2.11. Box and whisker plot showing the number of plants surviving (successes) in terrestrial and estuary experimental garden sites created using whole plants and bulblets. The outlier was a plot where there were no plants found growing at all.

The stepwise selection method in the logistic regression model kept both site type and propagule type in the final model indicating that both important in predicting where *lhásem* will grow. However, site location, whether it was terrestrial (higher) or estuarine (lower), was the most significant factor in determining success of *lhásem* in the first year.

Table 2.10 Final logistic regression model for experimental garden results. Model shows that both garden site type and propagule type are important.

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Location(1)	-3.101	1.233	6.322	1	.012	.045
	Propagule_type(1)	-2.061	1.202	2.940	1	.086	.127
	Constant	2.181	1.093	3.984	1	.046	8.857

The bulblets that were planted out in the initial bulblet experiment were not successful. There was a less that 5% success rate for sprouting within the first year of planting. However, qualitative observations from the educational garden indicated that both bulblets and whole plants can be very successful in restoration. This garden was full of mature plants coming up from whole bulbs and vegetative leaves sprouting up from bulblets in high concentrations.

Figure 2.12. Whole plant and bulblets sprouting in educational garden site in spring 2012, one year after educational restoration garden was planted.

2.4 Discussion

2.4.1 Plant Community Composition in the Squamish Estuary

Analysis of vegetation data collected during the field surveys revealed distinct community composition at the four site types, which were each characterized by unique

dominant plant species. Exploring autecological data on these dominant plant species suggests that plant community composition in the Squamish estuary is strongly influenced by soil salinity, moisture regime and the history of disturbance in the estuary (Hutchinson, 1988; Mackenzie and Moran, 2004; Skwelwil'em Management Plan, 2007; SWEMA, 2004). The salt tolerant sedge *Carex lyngbyei* (Mackenzie and Moran, 2004; Pojar and Mackinnon, 1994; Klinkenberg, 2012) was dominant in estuary west sites. These sites had higher salinity than terrestrial west and were located closer to the mouth of the Squamish River where it meets Howe Sound. The proximity of estuary west to the ocean likely accounted for the higher salinity found there. Areas that are exposed to high influx of brackish water and diurnal tidal action are usually dominated by uniform stands of *C. lyngbyei* (Mackenzie and Moran, 2004). Somewhat surprisingly, estuary west sites had less standing water, and despite being lower lying than the terrestrial west sites, had soils that may have facilitated better drainage. Further exploration into the soil characteristics would be necessary to confirm this but, based on my field observations, the soil in the estuary west region was sandy, whereas, the soil in the terrestrial west region was much denser and clay-like. According to Mackenzie and Moran, regions dominated by *C. lynbyei* usually have sandy soils (2004).

Terrestrial west sites were characterized by herbaceous plants including: *Maianthemum dilatatum, Agrostis* sp.*, C. lyngbyei* and *Fritillaria camschatcensis*. *M. dilataum* is commonly found growing in lower salinity sites where estuary regions transition to forest ecosystems. *Agrostis* sp. are generally found in the upper regions of an estuary where freshwater and brackish water systems meet. Whereas *C. lyngbyei* is common in low lying salt marshes with high salinity. *F. camschatcensis* is generally

found in regions that are not subject to extensive inundation and are tolerant of salt spray (Mackenzie and Moran, 2004). The salinity in this region was the lowest out of all the sites measured. This was most likely linked in part to the seasonal timing of my research which lined up with the spring freshet. At this time the salinity is generally lower due to large influxes of fresh water as daytime temperatures rise causing melting of the snowpack. However, the estuary west sites were closer to the ocean than terrestrial west sites and so had a stronger saline influence (Mackenzie and Moran, 2004). Terrestrial sites were also found to be wetter than the estuary west region. This was most likely due to a number of side channels, which fed from the main Squamish River that flowed throughout terrestrial west regions and fluctuated dramatically with daily tidal influence, sometimes flooding the areas on either side of the channels during high tides. This daily inundation of freshwater, which would occur year round, could also have reduced the salinity of this site.

Estuary east sites were dominated by uniform stands of *Typha latifolia* and were the wettest of the four site types and also had the highest salinity. *T. latifolia* is listed as being a species that indicates areas of high moisture and salinity in the Squamish Estuary (Skwelwil'em, 2007; Mackenzie and Moran, 2004). Increased salinity at these sites was most likely caused by small channels that connected it to the ocean. These channels fill and drain with tidal cycles causing an influx of ocean water throughout the area. The estuary east region is essentially cut off from the main influence and flow of the Squamish River due to the construction of a training dyke in the mid 1970's, which resulted in the redirection of the Squamish River (see Historical Impacts Chapter 1). Sites on the east side of the estuary were drained for agricultural purposes to farm hay and

graze cattle (Hoos and Vold, 1975; Skwelwil'em, 2007). *T. latifolia* is also an indicator of past agricultural activity in an area. When there is high nutrient loading this plant tends to dominate with few other plant species present (Mackenzie and Moran, 2004). It is most likely a combination of the alteration of freshwater hydrology, along with the agricultural history, that have led to the lack of vegetative diversity and the high salinity at this site.

Terrestrial east sites were comprised of slightly elevated areas of the estuary, which were dominated by *Argentina egedii* and *Aster subspicatus*. The west side of the estuary had a gradual transition between estuarine and terrestrial sites whereas the east side had patchy "islands" of terrestrial vegetation that were surrounded by the estuarine areas described above. These elevated areas had a greater variety of herbaceous plant species present on them, including one site that had *lhásem* present. *A. subspicatus* is present in high marsh zones in areas that are not frequently inundated and *A. egedii* is a species that is often abundant in highly saline soils (Mackenzie and Moran, 2004).

2.4.2 Indicators of *Lhásem* Habitat

The indicators of *lhásem* habitat identified through SIMPER analysis were *Maianthemum dilatatum* on the west side and *Aster subspicatus* on the east. Hutchinson (1998) writes that using indicator plant species to survey salinity and moisture gradients in an estuary environment is a good way to characterize general trends. *M. dilatatum* is generally found in transitional zones between the freshwater influence of the fluvial system and the upper limits of the brackish influence. It is most common in the transition between upland forests and estuarine ecosystems (Mackenzie and Moran, 2004). The co-occurrence of *M. dilatatum* and *lhásem* could be indicative of niche overlap. The E-flora

Atlas page (Klinkenberg, 2012) indicates that the habitat requirements for *M. dilatatum* and *lhásem* are quite similar. For example, both species exist in soil moisture ranging from very wet to very dry, and both species are classified as growing in a "rich" nutrient class. *M. dilatatum* is also listed as being ocean spray tolerant (Klinkenberg, 2012), which explains its ability to thrive in upper estuarine environments. Perhaps the salinity threshold for *M. dilatatum* and *lhásem* are similar and that is why they are found growing together in less saline regions of the Squamish Estuary. This would suggest the presence of a salinity threshold for both species. It is also possible that *M. dilatatum* offers areas without intense underground competition for root space. Being rhizomatous, perhaps *M. dilatatum* creates less dense mats than many of the sedges and grasses found growing in much of the estuary and may leave more room for *lhásem* to grow (Lezberg *et al*., 2001). *Aster subspicatus* is found growing in moist to mesic sites and is considered a salt tolerant species which is consistent with the saline and mesic conditions found at terrestrial east sites (Pojar and Mackinnon, 1994; Klinkenberg, 2012).

These indicator species will be helpful in identifying sites for *lhásem* restoration. They offer good field indicators of where *lhásem* will most likely be found growing and also clearly delineate areas where *lhásem* will not grow in the estuary. For example, areas dominated by *Typha latifolia* and uniform stands of *Carex lyngbyei* are not suitable habitat for *lhásem.* Alternatively, sites with high concentrations of *Maianthemum dilatatum* on the west and *Aster subspicatus* on the east are good candidates for restoration.

Sommargren conducted one of the only studies on characterizing *lhásem* habitat in the Pacific Northwest in her thesis "The Ecology of Black Lily (*Fritillaria*

camschatcensis) in the Pacific Northwest". She found that *lhásem* is a highly adaptable species (2008). This is good news for the restoration of this species given that it is more likely to survive in a variety of environmental conditions (Sommargren, 2008). The knowledge of its adaptability, together with the awareness of a salinity threshold, and the identification of indicator species will inform future restoration and management efforts of *lhásem* in the Squamish Estuary.

2.4.3 Factors Influencing *Lhásem* Abundance in the Squamish Estuary

The absence of *lhásem* on the east side of the Squamish Estuary was likely related to the cumulative impact of recent habitat alterations. *Lhásem* is not a particularly fast reproducer and disturbance is likely to have compromised population persistence. It has a low success rate in seed germination and relies predominantly on vegetative reproduction (Baranova, 1981). Vegetative reproduction occurs by shedding small vegetative bulblets from the main bulb, which then sprout and eventually grow into independent plants. Consequently, this species does not have a large dispersal range as the bulblets, if left undisturbed, cannot travel far from the mother bulb. The bulblets are small and most likely require certain conditions in order to become viable and to reach the surface of the soil. With the history of impacts such as dredge spoil deposition, the presence of an old garbage dump, industrial activity and motorized vehicle traffic the success of vegetative reproduction of *lhásem* was likely severely hindered. If the soil depth on top of *lhásem* plants was increased through the deposition of dredge spoils or agricultural materials it could have been difficult, or impossible, for sprouting bulblets to reach the surface. Soil compaction could also have reduced *lhásem* habitat on the east side of the estuary

(Adamus, 2006).

In 1977 Philip Grime developed the triangular or C-S-R model that extends the r- and K-selection theory to a focus on plants and their abilities to adapt to competition, disturbance and stress (Grime, 1979). Grime's triangular model can be used to consider the scenario of *lhásem* on the east side of the Squamish Estuary. If the level of disturbance on the east side of the Squamish Estuary was too high, or occurred in combination with some other kind of stress factor, this may have tipped the scales and pushed *lhásem* beyond its threshold for disturbance and stress. It is likely that *lhásem* was abundant in Terrestrial habitats on the west side because this area escaped the vast majority of historical disturbances. The west side of the estuary is only accessible by boat. As such, it provides a useful indicator of what the conditions in the entire Squamish Estuary may have been prior to these disturbances.

Abiotic differences observed across the estuary may have also limited the establishment and survival of *lhásem.* The vast majority of *lhásem* was found growing at sites with low-intermediate salinity, and estuarine sites, where salinity was highest, did not contain *lhásem.* Although frequently described as growing on the margins of salt marshes my surveys suggest that *lhásem* may have a salinity threshold. Logistic regression identified salinity as being the most important abiotic predictor of *lhásem* presence / absence in the Squamish Estuary. Salinity was negatively correlated with the presence of *lhásem* indicating that with rising salinity the presence of *lhásem* diminishes. Scatter plots and PCA results also suggest that there is an upper limit of salinity that *lhásem* can withstand. Evidence that *lhásem* is intolerant of high salinity suggests that this factor should be considered when choosing restoration sites. However, in order to

further understand the salinity threshold, more soil analysis, and garden experiments planted across gradients of salinity, would need to be conducted. The possibility exists that *lhásem* is somewhat protected phenologically from times of peak salinity in the estuary given that it's prime growing season is in the spring when freshwater flooding is more frequent in the estuary (Hutchinson, 1988).

Disturbance and abiotic variation in the estuary are not independent, as disturbances have almost certainly altered the hydrology, salinity and plant community composition of these sites. Furthermore, it cannot be concluded that the presence/absence of *lhásem* defines the niche of the plant in the Squamish Estuary. There are too many variables – site history and disturbance, soil structure and abiotic factors – that will influence the presence/absence of *lhásem*. And there is the possibility that empty niches exist on the east side of the estuary due to the process of rebounding after a period of disturbance. The lack of *lhásem* cannot be equated with poor habitat *per se* as it is most likely that the level of disturbance that populations sustained on the east side was too high for the plant to persist (Gurevitch *et al*., 2006; Skwelwil'em, 2007).

2.4.4 Traditional Management of *Lhásem*

It is important to remember that there has been a long history of Indigenous use and presence in the Squamish Estuary that we cannot easily measure today. It is likely that much of the estuary was managed to some degree, given the presence of Squamish villages, hunting grounds and harvesting sites that were located there (Bouchard and Turner, 1976; Matthews, 1955; Skwelwil'em, 2007). This presence on the land may have altered certain areas and plant populations in ways we cannot be certain of today. We do know that in other areas where *lhásem* was cultivated by Indigenous People that it thrives

under a certain level of management and disturbance. And the hope is that with time and effort *lhásem* will thrive again in a managed garden setting the Squamish Estuary.

Lhásem bulblets did not grow well in propagation trials, with a success of less than 5%. In this experiment the bulblets were stripped off of the central disk regardless of size and it is possible that many of them were not large enough, or mature enough. It is possible that bulblets must reach a certain size before they are viable propagules. This, in combination with transplantation shock, may have led to the low success in my planting trials. Additionally, bulblets were planted in small amounts of soil and may have been more vulnerable to freezing than if they had been planted in their natural soil environment. Interestingly, all the central disks of the bulbs that were replanted flowered and went to seed the following spring/summer. This was contrary to my expectations, which were that the bulbs would go dormant as a result of the level of disturbance that we had exposed them to. The prompt flowering and fruiting of these bulb portions made it very clear to me the level of knowledge that Indigenous People cultivating this traditional food in these kinds of garden settings held. Many aspects of the *lhásem* would need to be understood for people to cultivate and harvest this plant sustainably in quantity including the rate of growth and regenerations from bulblets and the central disc of the bulb.

An interesting result from the educational garden site was that the *gagemp*s, whole plants and bulblets that were planted in the summer of 2011were all thriving in 2012. This garden was revisited many times during the year as part of the educational focus of this research. Groups of Squamish Nation youth visited the gardens and weeded

and disturbed the plants by digging them up and separating bulbs and replanting bulblets. Although qualitative, this observation suggests that disturbance is an important component of the traditional management of *lhásem*.

Lhásem has been managed by Indigenous Peoples in estuary gardens with an optimum level of disturbance for many generations (Deur, 2005). Estuarine gardens would have been tilled and weeded as part of the traditional management practices and through these processes the soil would be aerated and the bulbs and bulblets would be broken up slightly, scattered or divided. Turner and Peacock (2005) describe the traditional management practices for *lhásem* by Kwaxistalla, Clan Chief Adam Dick, from Kingcome Inlet, Kwakwaka'wakw territory. Kwaxistalla remembers tending, cultivating and harvesting root vegetables in family garden plots in the Kingcome River Estuary. One of the management practices he remembers was to replant the central disk of the bulb which had the roots attached called the *gagemp* [literally "grandfather"] to ensure the plants could regenerate year-to-year, harvest-to-harvest. This is where knowledge of the life history and reproduction of a plant becomes very important in regards to managing it sustainably as was done in the Kingcome Inlet root gardens for countless generations (Deur, 2002, 2005; Lloyd, 2011).

It has been documented that such traditional management strategies lead to an increase in the production of indigenous root vegetables, or "geophytes" (Anderson, 2005; Beckwith, 2004; Turner and Peacock, 2005). These factors support that *lhásem* is a species that responds well to a particular level of disturbance. In addition to human management, disturbance would also come from animals and birds digging up bulbs or

eating the seedpods and spreading bulblets and seeds in the process (Turner, 2012, Under review).

2.4.6 Experimental Restoration Gardens

Restoration experiments confirm that *lhásem* can be established in impacted areas of the estuary. These experiments indicated that whole plants are a better option than bulblets, at least in the short term, for restoration. Bulblets would likely require repeated planting over a longer time period to have better success. Although, they take longer to establish, it is possible that they provide a "bank" of future plants that mature at different intervals, increasing population resilience and food supply. Additional experimental work could examine combined treatments. The fact that *lhásem* can grow in disturbed sites and that it can regenerate from bulblets as well as bulbs is a very positive result in regards to the restoration of this plant. These adaptive abilities will aid in the success of restoring this plant to the east side of the Squamish Estuary.

2.4.7 Mercury

The history of industrial activity in the Squamish estuary raises the concern that a food plants grown in this environment will be contaminated. The results from the mercury screening of soil samples from the estuary showed that only 3 sites, all located on the east side, had mercury exceeding 1.0mg/kg. According to the Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health, agricultural soils can be safely used for growing food with up to 6.6mg/kg of mercury present (Canadian Council of Ministers of the Environment, 1999). The amounts of mercury present in the few sites sampled on the east are not close to this upper limit and the

Squamish area should be considered safe for *lhásem* production. An independent survey of mercury contamination in the Squamish Estuary also concluded that there was no risk to human health or the environment as long as there are no large-scale soil disturbances (Skwelwil'em, 2007).

2.5 Conclusions for Chapter 2

A major outcome of this research was confirming that *lhásem* was still actually growing in the Squamish Estuary. This research was carried out to provide a foundation for efforts to restore this culturally significant plant to its original distribution and use. The confirmation that *lhásem* was still actually growing in the Squamish Estuary has massive implications for these initiatives. Prior to this work only very small stands of the plant were observed over past decades. The healthy populations that were surveyed on the west side, will provide a source of propagules for restoration and will also provide a useful reference site for *lhásem* habitat.

All four site types surveyed were found to be different from each other based on vegetation and abiotic data. Sites on the west differed greatly from sites on the east in regards to dominant vegetation species and abiotic patterns. The vegetation patterns identified will be useful in future surveys and *lhásem* restoration efforts in the Squamish Estuary because they will make it easier to identify sites where *lhásem* can grow, and sites where it likely cannot.

Lhásem (*Fritillaria camschatcensis*), was found to be abundant on the west bank of the Squamish River Estuary growing in terrestrial locations and often occurring

alongside *Maianthemum dilatatum*. There was a small and isolated stand of *lhásem* growing in a terrestrial site on the east side of the estuary and this site will be a good reference site for future restoration of *lhásem*. *Aster subspicatus* was the indicator plant that grew densely alongside *lhásem* on the east side of the estuary.

Salinity was identified as being the most important abiotic predictor of *lhásem* habitat in the Squamish Estuary. There is likely a threshold for salinity (and most likely moisture) beyond which *lhásem* does not grow. This being said, overall *lhásem* seems to be quite an adaptable species that can grow in a range of sites and conditions.

Future research could investigate other factors such as topography and microhabitat in regards to *lhásem* habitat (Silvestri *et al*., 2005, Sommargren, 2008). Future studies could also target sampling at sites where *lhásem* is growing and sites where it is not growing, and see if there are subtler differences in the abiotic factors measured in this study but on a smaller site-specific scale. Areas where the data overlapped for terrestrial west and terrestrial east are of particular interest as they could indicate regions of potential *lhásem* habitat on the east side of the estuary. These areas of overlap should be considered for further exploration in future studies.

Chapter 3:Ethnoecological Restoration of *Lhásem* in the Squamish Estuary: the People Behind the Renewal of an Iconic Plant Food.

3.1 Introduction

There is a globally renewed interest among Indigenous Peoples in the revitalization of traditional knowledge, practice and use pertaining to native plant foods (Devereux & Kittredge, 2008; 4th Annual Traditional Foods Conference, 2009; Higgs, 2003; Turner, 2005; Turner and Turner, 2007). Better health is one of the driving forces behind the traditional food renewal movement in North America. Indigenous People in the Pacific Northwest are making efforts to address widespread dietary related health concerns through incorporating more traditional foods into their contemporary diets (Kuhnlein and Turner, 1991; Kuhnlein *et al*., 2006, Kuhnlein, 1992). Squamish is one such community located on the west coast of the province of British Columbia. It is home to the *Sḵwx̱wú7mesh* (Squamish) First Nations who are also known also as the *Skqomic*. The Squamish People (*Skwxwú7mesh*) are part of the larger Coast Salish group and speak *Skwxwú7mesh Snichim*, the Squamish language, which is a subdivision of the Salishan language family that also includes Interior Salish languages (Bouchard and Turner, 1976). The Squamish Nation has occupied and governed their territory since time immemorial (Squamish Nation, 2012). Historically, there were many Squamish villages along the Squamish River, in the Squamish River Estuary, and along the shores of Howe Sound (Bouchard and Kennedy, 1986; Hill-Tout, 1978). My research focuses on the people living in the upper Squamish Valley in and around the current town of Squamish. The Squamish People connect their culture, livelihood and spirituality with the rivers, lakes and ocean that run through their traditional territory. Water is considered a source

of purification, power and can act as a direct connection to the creator (Floyd Joseph, Pers. Comm. 2012). The Squamish Estuary is a highly productive ecosystem (Skwelwil'em, 2007) and the villages located along the shores of the Squamish River would have had access to a great variety traditional foods.

Like other areas of the Pacific Northwest, the Squamish estuary would have hosted extensive estuarine root gardens. The intensive cultivation of plants in pre-contact North America is a piece of history that was not captured or highlighted in most early writings by anthropologists and other Europeans documenting Indigenous life-ways (Deur, 2005). The bulbs of northern riceroot (*Fritillaria camschatcensis* L. Ker Gawl), or *lhásem* as it is known in the Squamish language, is one of the foods that would have been harvested in the Squamish Estuary and eaten with ooligan grease or barbequed salmon heads (Bouchard and Turner, 1976). The Squamish traditional diet would have been high in oils, unsaturated fats, fibre, protein and nutrients and vitamins from fresh greens and berries and *lhásem* would have offered an important source of carbohydrates (Bouchard and Turner, 1976; Matthews, 1955; Hill-Tout, 1978). Traditional root vegetables such as *lhásem* were cultivated in estuary root gardens along the coast in the Pacific Northwest. Unfortunately, *lhásem* has not been harvested in the Squamish Estuary for many decades. Ecosystems in the Squamish Estuary have been degraded by many impacts including: draining for agriculture, redirection of the river, dredging and heavy industrial activities. In the most severely impacted areas populations of many culturally important plants, including *lhásem*, have declined or been eradicated. There are also numerous historical factors including residential schools, banning of the potlatch and the

establishment of the reservation system which have distanced people from their ancestral lands and cultural practices and contributed to the decline in traditional food use (Turner and Turner, 2008).

Since the decline in use of traditional foods and the transition to a contemporary diet high in processed foods and sugars, the Squamish People are eager to find culturally relevant ways to address dietary related health concerns such as type II diabetes, obesity and cardiovascular disease (Pers. comm. Joy Joseph McCullough, 2011; Pers. comm. Charlene Williams, 2011). Nation members are particularly interested in the restoration of *lhásem* so that it can be re-integrated into their diet. Reintroducing a plant food that people are already interested in is a starting point for this move towards improving health through diet. Consequently, *lhásem* it is an ideal focal species around which to organize ecological and cultural restoration activities (Higgs, 2003; Senos *et al.*, 2006).

Despite, ecological impacts, the Squamish Estuary remains critically important in Squamish Culture. This, along with the focus on the health benefits of *lhásem*, sets the foundation for my research investigating the potential of *lhásem* to act as a focal point to engage community members in ethnoecological restoration.

By interviewing Squamish Nation members from three age groups I explored the following three questions:

- What is the extent of knowledge of *lhásem* among the Squamish Nation?
- What is the level of interest in restoring *lhásem*?

- What is the role of restoration in addressing the health concerns of the Squamish Nation?

3.2 Methods

3.2.1 A community-based approach

To contribute to the general renewal of traditional foods this research used a case study approach, focusing on a single plant food and a specific community in British Columbia. Concentrating on a single plant in one community provides richness in context, place, and story (Yin, 1994). However, my research was also rooted in the broader context of traditional knowledge renewal and sought to address dietary related health concerns that Indigenous communities across Canada, as well as internationally (Kuhnlein et al., 2009). To explore local knowledge of *lhásem* and contemporary perspectives on traditional foods in the Squamish Nation I used a community based research approach, which involved the community from the beginning of the project through consultation and community meetings. During my field research I also spent four months living in the Squamish community and participated in a variety of community events. Living in Squamish gave me the ability to engage with the community on a daily basis. Throughout my fieldwork I also strove to involve the community in my research at every possible opportunity. I met with the Squamish Nation education department to seek input on the development of my research. At a more focused level, I conducted semi-structured interviews with Squamish Nation members from different generations.

My key community contact was Joy Joseph-McCullough, the Education Director for the Squamish First Nation Education Department. She aided in connecting me with people in the community to interview. Joy introduced me to several of the key plant use specialists in the Squamish Nation and offered guidance for building community relations throughout my research. Another community contact for my research was Edith Tobe, the owner of EB Tobe Enterprises, a local biology consulting business in Squamish. Edith is also the director of the Squamish River Watershed Society (SRWS) and has been involved in past restoration work and monitoring in the estuary.

3.2.2 Interviews

To document knowledge of *lhásem* I conducted interviews with Squamish Nation members in June, July and August 2011. Seven elders (65+ years of age), five adults (30-64 years of age) and 9 youth (9-29 years of age) were interviewed. The interview with youth was conducted during an all-day event in the estuary as part of the annual Squamish Nation Youth and Culture Camp. In each interview I posed a set of predetermined questions, but the order of these questions was flexible, and varied among individual conversations. The interviews took place in a location of the interviewee's choosing and lasted between 45 to 60 minutes. These interviews were conducted either one-on-one, or in a small group setting, depending on preference of the interviewees. At the outset of the study, I contacted individuals by phone and in person, to ask if they were interested in participating in this project. At this time I also provided them with a letter of informed consent or verbally informed them about the study. At the time of the interview I read through the informed consent form with each participant to make sure that they

understood the parameters of the research and interviewing process. At the end of the study, in keeping with our agreement I archived the interview materials at the Squamish Nation Education Department. All of the individuals I interviewed provided consent to use their name in my research. As such, I have included the names of individuals interviewed in the text to credit the sources of my information. Since I was working with some family members and in a close-knit community, I was careful to maintain a self-critical research awareness throughout the project[15]. This allowed me continually to be aware of research process in light of the ever-changing dynamics I encountered in the field and in the community (Dowling, 2005).

During the interviews I used photographs of *lhásem* bulbs, flowers and seedpods to help people identify the plant, and to recall any memories they may have had of this plant. Showing photographs was a helpful aid in this situation as many of the people interviewed either had not seen the plant before, or had seen it but didn't know it by name or use. I recorded all of the interviews on a digital voice recorder and if the individual consented I also recorded the interview using a video camera. Video and audio recordings have been archived at the Squamish Nation Education Department for future access by Nation members. Four of the interview transcriptions were completed by a transcription agency in Victoria, called Premiere Verbatim. This company provided a signed confidentiality agreement. I analyzed the text of each interview by reading through the interviews once, then categorizing the text into the following themes: health, cultural and historical references, ethnobotanical references and messages to the youth. Transcriptions

[15] I took special care to ensure that family members felt comfortable and consented to being interviewed by me and part of this approach meant interviewing family members in pairs or small groups.

were also searched for key words that corresponded to key research themes. Some of the key words used were: health, diabetes, obesity, riceroot, chocolate lily, family names and place names.

3.3 Results

3.3.1 Interview Consultants

Twenty-one Squamish Nation members from different generations participated in this study. Knowledge of *lhásem* ranged from people who remembered their grandparents harvesting or speaking about the plant, to people who had learned about the plant from friends in other regions, to people who had never heard of the plant before. The majority of the participants, even if they had heard of it, had not seen the plant before. Table 1 shows information about the consultants and their prior experience with *lhásem*.

Table 3.1 Elder, adult and youth participant knowledge of and interest in the restoration of *lhásem*. The youth interview was conducted in a group setting and is summarized as a single entry in this table.

Participant	Age	Experience with *lhásem* (*Fritillaria camschatcensis*)	Where they learned about it as a food	Main interest in restoration of *lhásem*
Ronald Newman (Chum)	Elder (70's)	Recalled his mother and grandmother harvesting it and possibly trading it. Recognized plant from hunting trips in the estuary.	Mother and Grandmother	To educate youth and for the health benefits of eating traditional foods.
Laverne Baker	Elder (80's)	Was told by her elders that *lhásem* became extinct in the last century. Was told by her elders that *lhásem* used to be plentiful and was used extensively.	Elders	To educate the community and bring back some traditional plant foods.
Alana Andrews	Elder (80's)	Recalled going out with her parents to harvest wild rice, most likely *lhásem*, described plant as growing	Parents	Interested in youth learning about the traditional foods.

		in wet, marsh areas and that the edible part looked like rice. She didn't recall seeing the plant.		Interested in protecting the environments where these foods grow.
Bob Baker	Elder (80's)	Remembered seeing the plant out on the flats while hunting but didn't know what it was.	Our interview	Interested in youth learning about traditional foods to educate themselves about what they eat. Interested in preserving areas for harvest.
Shirley Toman	Elder (70's)	Didn't remember the plant.	Our interview	Interested in renewing traditional foods such as *lhásem* to have foods that are healthy and have "spirit" in them still. Interested in restoring *lhásem* to promote healthy eating.
George Moody	Elder (70's)	Recognized the plant from hunting trips in the flats.	Our interview	Interested in renewing knowledge of traditional plants. Interested in trying *lhásem* as a food.
Addie Kermeen	Elder (80's)	Was not familiar with *lhásem*.	Our interview	Felt that it is important to bring back traditional plants for knowledge and health reasons, but that you have to be careful about how you record and share the knowledge.
Vera Douglas	Adult (50's)	Is familiar with the plant from field books.	Books and other Squamish Nation members	Believes that it is important to educate the youth and get them out on the land learning about traditional plants for health reasons and cultural renewal reasons.
Charlene Williams	Adult (40's)	Is familiar with the plant from field books. Heard about a plant from her mother and grandmother that had "rice in the bulb".	Mother and grandmother	Believes that renewing traditional plant knowledge is important for health reasons and to instill pride in the youth to learn about their culture and history and see the value in traditional knowledge.
Chief Floyd Joseph	(Adult, 50's)	Learned about this plant from Kwaxistalla, Clan Chief from Kingcome Inlet.	Chief Kwaxistalla, Clan chief	Believes that carrying on traditional knowledge is essential to building a strong

		Recognized the plant from a trip to the Kingcome Inlet estuary gardens.	Adam Dick Our interview	culture and community. Feels that learning from the way the ancestors lived is important to our health and wellbeing.
Youth Group	13-19	All of the youth learned about *lhásem* and saw the plant for the first time during the daylong estuary fieldtrip.	Our interview	The youth all had great enthusiasm for learning about the plant and for gardening. They remembered many of the details about the plant and shared it with their families.

3.3.2 Interview Results and Themes

The interview portion of this study set out to contextualize the ethnoecological restoration of *lhásem* from the perspectives of Squamish Nation members based on their prior experience and knowledge of *lhásem* and a renewed interest in the plant. The interviews were conducted with people across a range of ages. Several themes recurred across the generations with slight differences in perspective based on participants age, prior knowledge, and experience with, traditional plant foods. The themes that emerged were as follows:

1) Ethnobotany related information or perspectives
2) Health
3) Cultural and historical context
4) Messages to the youth

The following sections are a synthesis of the interview results based on these four themes.

3.3.3 Ethnobotany Related Information and Perspectives

Most Squamish People that I spoke with did not have first-hand experience with *lhásem.* However, there were people who remembered other family members referring to a plant that most likely was *lhásem*. Charlene Williams recalls how she first heard of the plant.

I wasn't really familiar with riceroot growing up. I hadn't even seen one actually until I saw the one that you brought in. The only time I had ever seen it was in books. But I remember hearing my mother, maybe it was my grandmother, when I was younger, talking about a plant with rice in the bulb. (Charlene Williams, Squamish Adult)

Chief Alana Andrews recalls her parents harvesting "wild rice" along the river. She remembers her family collecting it as part of their yearly harvesting.

Water used to come from the mountain and go down and, down around mile thirteen had the spot that was a little wet, damp. And that's where they used to get their wild rice, or they called it wild rice. But I don't know what they called it in Squamish. Because they gathered and, I guess my grandmother was picking berries and drying them, I don't know what dad was doing, but probably fishing and, women were sun-drying it and smoking them and they get it all ready. (Chief Alana Andrews, Squamish Elder)

Ronald Newman recalled traveling out to the Squamish Estuary with his family and remembers his mother and grandmother speaking of the plant.

Yeah, I've seen [riceroot] used to go in the dug out canoe. I used to travel with my dad and George [to the estuary] when we were small only four or five years old. Yeah my mom used to say they used to use it, she and my grandmother would dig it.
(Ronald "Chum" Newman, Squamish Elder)

Although most of the consultants did not have a direct experience or memory of harvesting or eating *lhásem* there were memories that connected the individuals to this plant in a meaningful way.

3.3.4 Ethnobotanical References and Context for *Lhásem* Restoration

From the beginning of my research the Squamish Nation members I spoke with had a particular interest in *lhásem* as a food plant. This was one of the main reasons I focused my research on this particular plant. During each interview there was a sense of excitement for learning about and renewing the use of traditional plant foods in general. The interest in re-introducing traditional plant foods into the Squamish diet was overwhelming and was present across generations. Though many of the people that I spoke with had not actually seen *lhásem* before, and no one I spoke with recalled ever tasting it, there was still a general sense of connection to this plant and an excitement to become familiar with it in the future.

When given the opportunity to talk about traditional plants, with the focus on *lhásem*, people surprised themselves by recalling other plant foods that they used to gather and eat. People mentioned foods such as saskies, nettles, crab apples, berries, camas, and other root vegetables they could not remember the names of, as well as numerous medicinal plants and recipes. These memories were often then linked to times spent with family out gathering these plants and then reminded them of the taste and feeling of eating food off of the land.

Many participants spoke about the importance of renewing traditional knowledge. Charlene Williams spoke of her own experience with knowledge renewal and on the importance of giving thanks and how this teaching in turn instils a sense of responsibility and respect for the natural world.

"The estuary is our traditional territory. And we did do harvesting and gathering / cultivating there. It's important for [the youth] to know. Having a traditional celebration around it and making sure that there's a lot of giving thanks, because our culture is all about giving thanks, and that's how I think we're able to be such a sustainable people because we were never ungrateful for the things that we were taking or getting from the land. When you think of something in that way, it's harder to take advantage of it."
(Charlene Williams, Squamish Adult)

Other interview participants expressed a great interest in eventually re-incorporating *lhásem* into the Squamish diet. Laverne Baker is an elder who holds a great deal of knowledge about traditional plant uses and she expressed her own sense of pride that comes from the expertise, or gifts, that she holds and can share with the community.

"*I'm quite proud to be of the Squamish Nation descendants. And most of all, I value the gifts that we received in our herbal medicines and foods*."
(Laverne Baker, Squamish Elder)

3.3.5 Restoring *Lhásem* in the Context of Health

When asked why they thought restoring traditional plant foods such as *lhásem* was important, participants listed addressing health concerns through traditional diet as the one of the key reasons. This message was especially prominent amongst adult and elders. Some of the elders recalled their personal experience during their time at residential school when a diet made up of traditional foods was replaced by one of highly processed foods.

Other elders and adults reflected on diet related health problems as a major concern to be addressed through education and knowledge renewal. The responses of the youth during the group interview also focused on diet related illness and the search for healthy alternatives. The following quotes are excerpts from the main interviews that are strongly focused on health as a context for my research.

Charlene Williams is a Squamish member who has worked with the Squamish Education Department as a cultural educator for many years. She has worked with youth and elders promoting knowledge renewal and hands on cultural learning. She spoke on the re-emergence of traditional foods and the impacts that highly processed foods have on our bodies.

"I think more people are trying to go back to traditional foods. People are really interested in finding out more about the traditional foods and medicines and plants. With the way that the health of our community has been with diabetes and heart problems and arthritis I think a lot of people are realizing that it has a lot to do with diet. Our bodies aren't used to these new foods and it's causing all of these ailments. People that aren't usually really interested in the culture or the history want to know about the food because they understand that the closer we can get back to our traditional diet, the healthier we'll be."(Charlene Williams, Squamish Adult)

Shirley Towman is a Squamish elder who grew up on a diet of salmon, wild game, berries and some of the fresh spring greens, like "saskies" (edible shoots of salmonberry and thimbleberry). She explained her perspective on how traditional foods still contain what she referred to as "spirit" as opposed to processed foods, which she described as "dead foods".

"I think [the traditional food] still had, what would you call it, the spirit? The spirit was still in the food and it rejuvenated you whereas now it's just nothing. There's nothing there anymore. The food that we get now is so polluted with vitamins and chemicals to kill bugs and everything in the foods and you're getting all that in your system and it's tearing you down. I'm diabetic and my bones are weak. It's a constant battle now because where can we get our foods where they still have Mother Earth's spirit in it. It's just not there anymore because well, I guess because we didn't pay attention and then of course we were taken away to residential school and fed with all that other food if you can call it food." (Shirley Toman, Squamish Elder)

Bob Baker is a Squamish elder who is knowledgeable about traditional plants use in the Squamish Nation as well as in the *Kwakwaka'wakw* territory of Village Island, the home community of one of his grandmothers. When asked why he thought restoring

foods such as *lhásem* was important he shared his perspectives on the fast food that native youth are eating today and his advice to them.

"That's why some of them old people lived to a very old age. Yeah, thinking is that for the youth, young kids they should stop eating all that junk they've been filling themselves up with. It's all right to do it, but not overdo it. Some of them go in there and they just eat and eat and eat and eat. It'll get you sick. But kids don't know what's in this stuff. It's not healthy. You know it's your body, you've got to look after it. Nobody else could look after it for you. But that's my advice to our great-grandchildren, our children, our children after that. You've just got to look after yourself." (Bob Baker, Squamish Elder)

Vera Douglas is a Squamish member who worked in the Squamish education system for 30+ years as a cultural worker in the schools. She has devoted much of her time promoting education on Indigenous history and bringing cultural teachings into the classroom. When asked why she thought that restoring traditional foods such as *lhásem* was important she shared the response below.

"I think a major cause of obesity in a lot of our youth and elders is losing the traditional ways of how to eat appropriately. My goal is to help inspire more people to live healthier lives. Because when you change your eating habits, your tastes for other things, they diminish, knowing that it's causing your body harm." (Vera Douglas, Squamish Adult)

Nine Squamish youth came out to help with the planting of the educational gardens in late July, 2011 as part of the annual Squamish Nation Youth and Culture Camp organized through the Squamish Nation Education Department. During the youth interview that preceded the planting, I asked the group why they thought it was important to restore traditional plant foods. One of the youth responded with the quote shown below.

"We need to get more of our food back because, well, we eat rice, we could use that chocolate lily, instead of rice. Because, all the sugars we eat now give us diabetes. So our people get diabetes more because of all the different kinds of food people bring over and then we started to eat it." (Jonny Williams, Squamish Youth)

3.3.6 Cultural and Historical Context for *Lhásem* Restoration

Many of the interview participants also discussed the impact of historical events on Squamish knowledge. The following accounts speak to the destructive and damaging impact residential schools had on Squamish culture and illustrates participants' hopes for healing and knowledge renewal in Squamish. The quotes also express why these individuals felt that my research was relevant and why they believe that traditional knowledge should be renewed and *lhásem* restored.

"I'm sorry I didn't listen to my dad, he was always out there and if you're not feeling well, then he would go out and he would get something. And then he would either get you to chew it or drink it. Or rub it on. So, you know, things like that you wished you could remember. Like, all of this knowledge that was being given to you and you never absorbed it. And it's just too bad that, you know, at our young age, with the interruption of the residential schools, that you just didn't know how to absorb it anymore. And so a lot of it was literally ripped away from us. You know, it was just a disgusting thing to do to people, and unfortunately we had to live through it and we're still dealing with it. So this knowledge has got to be reintroduced to our people so that we can continue with our lifestyle so that we can live a healthier and stronger life than what we've been living. It's got to happen."
(Shirley Towman, Squamish Elder)

Residential schools had a profoundly negative impact on many generations. Today, more and more people are starting to talk about it and are seeking ways to heal. Traditional knowledge renewal is one way to address past harms and brighten the future for Squamish Nation members. Chief Alana Andrews is a Squamish elder who remembers a time when she and her family grew most of their own foods. And she remembers the difficult experiences that she and her family had.

"*My grandparents were there. And white people came, they told them they had to move, and put them on the barge, all the people that was around Kitsilano. Dad said my grandmother did not even have all her stuff out of the long house and government threw a match and burnt it. They moved and my grandfather took the land and he made it into a big farm. That was a nice place. They had a big yard, we used to plant apple trees, pear trees, berries, we had everything. No, there wasn't too much, you know, you'd have to*

walk a long way to go to a store. So mom used to plant a lot of potatoes and or grandpa and lots of carrots. And I don't know where they got the berries, different berries you know. Lots of cherries and pears, apples. Hungry thirties you know, we had to do for yourself because we didn't have much money. If he didn't have that it [would have been] tough times, eh? I think most of us that lived up here had gardens. Yeah, well, I think it'll be a good idea, for the younger people to learn what our ancestors or elders went through." (Chief Alana Andrews, Squamish Elder)

Many of the interview participants highlighted the importance of spending time learning from elders. Historically, this is a practice that was encouraged from a young age and is a teaching that is still very important in the Squamish culture, yet is one that has declined in practice in the past decades. People like Charlene Williams and other participants are encouraging youth to spend time with elders and are providing opportunities for youth to do so through educational programs and field trips. Charlene Williams expressed the importance of renewing the practice of spending time with elders.

"It's unfortunate that we've lost a lot of these teachings because of residential school and the modern change. But it's not too late to go back and I think it's really important as much as we can to try and get that knowledge from the elders while we can, while they're here. It's so important. Because if nobody sits down with them or goes out on the land with them to learn these things, you know, they're not going to be here forever."
(Charlene Williams, Squamish Adult)

Anna Billie was one of the youth present at the culture camp and she shared her thoughts on why it's important to learn about traditional foods in the context of learning from our ancestors.

"It's important to learn about our foods because our ancestors told us about these foods and if we bring them back and learn how to eat them then we're learning from our ancestors"
(Anna Billie, Squamish Youth)

Understanding the historical context for why some knowledge has declined is also an essential part of understanding the extent that our elders and ancestors had to work to maintain cultural knowledge and practices. It is a belief that the youth have a responsibility today to carry on and strengthen the cultural resolve that people who have gone before them worked so hard to maintain in the face of such hardships and trauma.

3.3.7 Messages to the Youth

A major theme that came out of the adult and elder interviews was the importance of involving, educating and supporting youth to take a meaningful role in traditional knowledge renewal, including learning about traditional diet. There was great interest in renewing traditional plant knowledge among the participants and across generations. Participants stressed the power of oral teachings and the importance for knowledge renewal to come back in a respectful and culturally appropriate way. Many of the elders spoke of the importance of youth learning about Squamish history and culture and paying more attention to diet and overall health. Participants also discussed involving youth in cultural activities so that they can learn about the meaning, protocols and how to undertake important cultural work themselves, explaining that the more you involve youth the stronger our future capacity within the community will be. The following quotes are responses to the question, "What advice would you give to the youth?"

Shirley Towman gave her perspectives on sharing the knowledge that she carries with Squamish youth.

"Well, I think the best thing that can happen is for the youth to find out as much as they can about what we have, what is here. We were always asked as elders to go with a

group of children and we'd go and talk to them. Some of these children had never even been out into the wild before. And I just mentioned that we used to not have to go to the doctor's. If we were not feeling well we'd just go out our front door or back door and the medicine was right there in the forest." (Shirley Towman, Squamish Elder)

Chief Alana Andrews shared her perspectives on how she wishes to share her knowledge with the youth.

"*Yeah, that would be good for the [youth] to learn about traditional plants. The younger generation, so that it's not forgotten. Some days, I sit here and think about long ago and try to remember all the different things, and I remember it, by the time somebody asks about it I've forgotten."* (Chief Alana Andrews, Squamish Elder)

Ronald Newman is an elder who is very knowledgeable about how to prepare and administer many Squamish plant medicines and he shares his thoughts on how he can share with the youth to encourage them to learn more about the plants and the environment.

"Yeah, the youth gotta learn, you know. Wouldn't be hard for them. It's best to start doing it plant your own gardens. Everyone goes to the store right. If they ask me to, then, OK, I'll go. I went to down to the school and to the First Nations office. Walking around the whole school down there and outside, showing them the plants and what [plants] we used." (Ronald Newman, Squamish Elder)

Laverne Baker shared her desire to share her wealth of ethnobotanical knowledge with the younger generations and educate the youth on the knowledge that existed in the Squamish Nation prior to colonization.

"I'm really happy to share what I know because I was just waiting to see if some young person, either my nieces or next-door neighbors or somebody would want to learn about our traditional ways and food preparations and survival before colonization."
(Laverne Baker, Squamish Elder)

Charlene Williams shared her thoughts on how to bring science into a cultural context.

"It's a great thing, using the science to help to restore. That would be excellent and a great thing for the kids to learn, but incorporating those cultural teachings in it too [is important] so it doesn't become just science. It's still very much a part of who we are."
(Charlene Williams, Squamish Adult)

Overall there was a large focus on the importance of involving and educating the youth in cultural practices and knowledge renewal as they are the ones that will carry Squamish Nation knowledge and tradition into the future.

3.4 Discussion

Interviews showed that using *lhásem* as a focal species for ethnoecological restoration in the Squamish Estuary for educational purposes and eventually to harvest as food was received positively by all of the people I worked with in the Squamish Nation and in the general Squamish community (Table 1).

3.4.1 Squamish Cultural Connection to Food

The deep cultural connection to plants adds a layer of cultural relevance when aiming to restore a plant food that was utilized and valued historically by Squamish People. Traditional foods hold great cultural importance and this cultural relevance is one of the factors that make traditional foods an effective way to address diet related health concerns in Indigenous communities (Beckwith, 2004; Cullis-Suzuki, 2008; Lloyd, 2011; Pukonen, 2008; Dilbone; 2011). The Squamish People had a traditional diet rich in proteins, oils, unsaturated fats, fresh greens, berries and root vegetables among other locally available food items (Bouchard and Turner, 1976; Bouchard and Kennedy, 1986; Hill-Tout, 1978; Matthews, 1955). For many Indigenous People plants are a kind of cultural interface between spirituality and physical health. Plants offer nutrition, medicine, shelter, spiritual protection, spiritual awakening and more (Bouchard and Turner, 1976; Deur, 2005; Garibaldi, 2004; Lantz, 2001; Nazarea, 2006; Pukonen, 2008;

Thompson, 2004; Turner, 1988, 2005, 2008). In many cultures there are teachings and protocols for harvesting plants for food and medicine to ensure that the plants are respected and will continue to provide for the people (Turner, 2000, 2005, 2007 2008; Deur, 1995, 2005;).

"Our people look after what we take, we don't take too much, we leave something, we don't go back to that same place, and we go gather elsewhere. All the harvesting is done to take what you need and not take everything. You need to leave something for other people and leave something so that the plant can continue to live. You've got to take care of those things." (Chief Floyd Joseph, Squamish Adult)

Many plants are featured in important cultural narratives and are believed to hold powers well beyond nutritional value and or medicinal properties (Bouchard and Turner, 1976; Turner and Kuhnlein, 1983; Turner, 2004). All of the interviews I conducted had a strong focus on the relationship between plants and physical and spiritual health. The majority of the people that I interviewed were very enthusiastic about *lhásem* specifically as a plant that represented the link between health and culture for them. Traditional food use varies between Indigenous groups and there are cultural and historical relationships that have developed over time between foods and people (Kuhnlein and Receveur, 2007; Turner, 2005). This longstanding relationship between Indigenous People and culturally significant plants builds a strong foundation for linking traditional food renewal within the context of health.

3.4.2 Health and *Lhásem* Restoration

The Squamish People have always had a strong connection to their natural environment, language and health through the foods and medicines that the land provides (Bouchard and Turner, 1976; Bouchard and Kennedy, 1986; Hill-Tout, 1978). Restoring *lhásem* populations to reintroduce this plant food into the Squamish diet created a

powerful cultural foundation that all of the participants of various ages could use to connect to the broader issue of health. Interviews with a range of participants showed that focusing on *lhásem* as a flagship traditional food species is an effective way to build general awareness of the link between traditional diet and health. This foundation also provided a vehicle to discuss a number of broader issues including: cultural connections to food, knowledge renewal and the importance of youth involvement in restoration activities and educational activities that increase their awareness of the importance of the link between traditional foods and health. The growing interest in traditional food renewal in Squamish is paralleled by a renewed interest in many Indigenous communities (Turner and Turner, 2007; Kuhnlein and Receveur, 1996).

3.4.3 Knowledge renewal

Many of the people interviewed spoke of the importance of learning from their elders and expressed a desire to strengthen their connection to culture through a deeper connection to traditional knowledge, including ethnobotanical knowledge. Historically traditional knowledge would have been passed down orally in the Squamish Nation. Although this has changed in relatively recent history, due to damaging historical impacts, it is still extremely important to respect this form of knowledge transmission. Being able to listen well is still a central teaching in the Squamish culture (Pers. comm. Floyd Joseph, 2012; Pers. comm. Joy Joseph-McCullough, 2011; Pers. comm. Charlene Williams, 2011). Being present at an event puts the responsibility on witnesses to carry that knowledge forward and share it with those who weren't present. A teaching passed on to me by my father, which has been prominent in my life is that: knowledge which you learn is not yours to hold on to or benefit from individually, but is for your

community. This way of thinking also obligates knowledge holders to share information and carry their wisdom forward in a positive way.

The restoration of camas in Songhees territory is a wonderful example of how a particular food can connect many different aspects of culture, knowledge and community. In 1999 efforts to restore camas harvesting practices on Chatham and Discovery Islands created connections that spanned language, cultural history and connection to place (Higgs, 2003). Cultural connection to place can greatly enhance the significance of knowledge renewal to the people involved by making it a personal experience that also ties them to their history and ancestors (Berkes, 2012; Nazarea, 2006; Thom, 2005). Indigenous Peoples around the world are looking to their traditional foods to address issues including health, food policy, biodiversity and connection to place (Anderson, 2005; Nabhan, 2000; Turner, 2005). The Muckleshoot People of Western Washington have many projects aimed at renewing knowledge and use of traditional food in their community. Ongoing initiatives include a garden to table project, youth engagement, and providing plant foods and medicines to a local addictions center (Krohn and Segrest, Society of Ethnobiology Conference, 2012).

3.4.4 Everything is Connected

One of the central questions that emerged from my research was: how the interest in *lhásem* came back before the actual plant was re-established on the land. In this section I introduce an analogy for how knowledge renewal has been and is taking place in Squamish within the context of history and culture. Although my work focused on the restoration of a single food plant, I encountered many other aspects of traditional knowledge in the process. With each person I spoke to, and each event we held in

connection to the research, it became more apparent that *lhásem* provided a focal point connecting people to the broader issues of Squamish Foods, Squamish Lands, and Squamish Culture. As others have shown, when you bring a cultural practice or tradition back to an Indigenous community it is not an isolated event (Cullis-Suzuki, 2008; Higgs, 2003; Sakakibara, 2009; Senos *et al*., 2006; Thom, 2005). Discussing culturally important plants provided a powerful way for people to connect with their personal history.

Focussing on a culturally significant plant links the knowledge being revived with many other parts of the culture such as spirituality, cultural identity, language, connection to place, flavours, smells and memories of those that you learned from. For example, during many of my interviews the consultants would have memories come back to them of certain foods and medicines that their parents or grandparents used to harvest and prepare. When I was walking with my dad, Chief Floyd Joseph, he recalled eating "saskis," the fresh salmon berry shoots, and he taught me how to pick the ripe ones out, peel them and eat them. This was a very special moment for my dad and I to share, and it was facilitated by being out on the land and discussing traditional food plants. It was as though when the opportunity to remember and discuss this one traditional plant was offered to people something within them was awakened. Many of the elders that I spoke with prefaced their interviews by saying that they didn't know very much about the *lhásem* or other traditional plants and they were sorry that they couldn't share much with me. But in each interview, I found that as we moved further into memories and personal experience, that all of the elders I spoke with had memories and knowledge that were both important to their individual lives but also made a significant contribution to my

research. Encouraging people to take the journey of remembering in order to rebuild cultural connections to a plant food, such as *lhásem*, is just as important as physically restoring the plant onto the land.

3.4.5 Cultural Knowledge and Ecological Restoration

There are many examples of the importance of place based restoration in Indigenous communities (Beckwith, 2004; Cullis-Suzuki, 2007; Lloyd, 2011; Pukonen, 2008). One example is the Lekwungen communities efforts to restore camas fields on *Tlchess*, an island within their territory. This restoration was successful because of the cultural connection to place and to the food plant being restored (Higgs, 2003). Senos *et al*. discuss the importance of incorporating traditional ecological knowledge into contemporary restoration to ensure cultural relevance and engagement that makes projects meaningful to the Indigenous People involved (2006). Without the cultural context and personal connections to the restoration goals there will be less incentive to integrate the restoration goals into the culture and community. My research echoes this, indicating that if you do not take the time to successfully engage people from the beginning and build the project in a relevant way for them, then it will be difficult to maintain the longevity and success of the project.

3.4.6 Knowledge renewal: Like a Woven Blanket

Recently the Coast Salish tradition of wool weaving has come back into practice in Squamish. Research by Chief Jan George of the Squamish Nation has helped bring back an art form that had long been out of practice. Chief George looked in books and museum collections and collaborated with weavers in other nations to bring together the

strands of information that were required to weave in the style that her ancestors before her had for thousands of years (*L'henAwkxw* Weaving House, 2012). This is a recent story of knowledge renewal, that should serve to remind us that traditional knowledge is not lost. If we speak as though traditional knowledge is lost, it implies that our ancestors were unable to maintain their knowledge through the hardships endured since colonization. This is not the case. There are threads of knowledge, some big and some small, which have been carried on, and will be carried forward into the future. The task at hand is to weave these threads of knowledge together by renewing traditional practice in Indigenous communities.

Blankets are a culturally significant item for the Squamish People. They are given as a gift to elders and to people who help with cultural work, they are used for spiritual protection, and traditionally were worn by Squamish People. The designs woven into the blankets tell a story about who the person wearing the blanket is, where they are from and who their ancestors were. Traditionally, blankets were made using mountain goat wool, plant-based dyes and handmade equipment, including wooden spindle whorls, to process the wool. Today alternative materials are frequently used, but the cultural knowledge is still applied in the same ways. The process of renewing the tradition of Coast Salish weaving has a great deal in common with restoring traditional food systems. It also provides a powerful metaphor that helps to shed light on challenges inherent to the process of ethnoecological restoration.

Imagine a Salish wool blanket with a hole in it. The tattered edges of the hole are surrounded by the broken ends of strands that make up the foundation of the blanket

(Figure 3.1). If you think of the Squamish cultural fabric as analogous to the Salish woven blanket, the hole represents knowledge or traditions that have been forgotten or are now incomplete due to past hardships that the Squamish People have endured. Since original strands surround the hole, it is possible to mend the blanket by weaving strands of new knowledge created through cultural renewal efforts. The blanket analogy also provides an instructive metaphor, which describes the appropriate way to approach ethnoecological restoration and other knowledge renewal programs in Indigenous communities. The first step is to speak to community members and to find the threads of information that still exist. Next, a program of community-based research can help to develop strategies to renew parts of the knowledge system that are missing. There are numerous potential approaches that may be used in subsequent parts of the project. These include: knowledge exchange with other Indigenous Peoples and researching historical documentation. Once you have the strands of new knowledge, you can begin to weave these strands together, joining them with the strands in the original blanket. The act of picking up the threads of knowledge that still exist and weaving them together with new strands of knowledge is in essence the aim of ethnoecological restoration and cultural knowledge renewal. In order for the restoration or renewal to be successful and meaningful to an Indigenous community it is essential to ensure that it is rooted within a cultural context, that it builds on past teachings and knowledge, and is conducted in a culturally appropriate manner (Posey, 2003; Turner, 2005; Turner and Turner, 2007, 2008; Turner *et al*., 2000, 2003, 2008).

The blanket was never lost, but it was damaged, and parts of it are gone. Because the foundation is still there though, Squamish People can use the intact threads to mend

the holes in their traditional ecological knowledge through restoration, cultural renewal and healing.

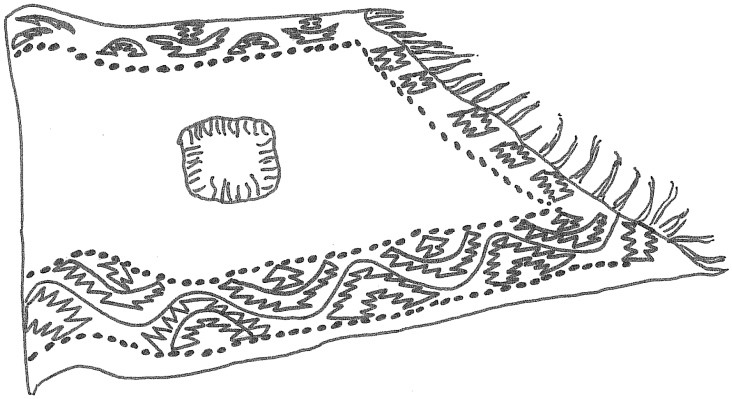

Figure 3.1. Drawing of a Salish blanket based on historical images of Chief Capilano's blanket. The process of mending a blanket provides a powerful analogy for knowledge renewal efforts in the Squamish Nation.

3.4.7 Youth Events

"It's really important that we all know how to gather and how to prepare. We as a people really need to protect the areas where we do our harvesting. It's really important. If we just turn a blind eye and just didn't care, then they'll be gone."

(Charlene Williams, Squamish Adult)

Many of the youth who learned about *lhásem* and other traditional plants through this project were so proud to know about ebible plants that they went home and shared this knowledge with their parents and family members. By doing this the youth are reversing the traditional direction of oral knowledge transmission and effectively helping to close the gaps and reverse knowledge loss . Throughout my research I strived to involve Squamish youth as much as possible. The major events that involved youth were: the youth and culture camp, a presentation and plant walk at one of the middle schools in Squamish and the pitcook at the end of the summer. Youth of all ages came to these

events to participate in hands on activities in the estuary or other outdoor locations. At these times I was able to teach the youth about my research and about traditional plants in general. I found that many of the youth had considerable knowledge to share, which they had learned from family or classes at school. The conversations I had with the youth during these field sessions were very meaningful to my work and helped to build awareness and begin to renew knowledge about *lhásem* and other traditionally important plants across generations.

Figure 3.2. Youth helping to plant *lhásem* at the educational garden site as part of the youth and culture camp. Upper photo from right to left: Jasmine Williams, John Joseph (front), Keira Joseph, Anthony Joseph (back). Bottom photo from left to right: Anna Billie, Damien Joseph, John Joseph.

Figure 3.3. Youth standing next to the educational garden after it had been planted in July of 2011. From Left to Right: (front) Phillip Williams, Anna Billie, Shaelyn Baker, John Joseph, Damien Joseph, Leigh Joseph (back) Jasmine Williams, Jonny Williams, Dallas Lewis, Dalious McCullough (very back) Anthony Joseph.

Involving youth not only facilitates knowledge transmission across generations it is also consistent with the tradition of learning by doing. The youth and culture camp is held each summer and focuses on providing opportunities for youth to learn about cultural practices and technologies through hands on activities. One of the key activities at the youth and culture camp was planting a *lhásem* educational garden. The educational garden was designed to provide an opportunity for Squamish Nation members to become familiar with *lhásem*. During an Aboriginal Peoples Television Network filming in the Squamish Estuary, community members, including Squamish youth, dug up bulbs and separated them out across the garden. Similarly, the two Squamish Nation youth research assistants that I worked with, Dalious McCullough and Vivian Joseph, helped to manage the garden through weeding, replanting bulblets and visiting it throughout the winter. I appreciated having the opportunity to train and employ two young Squamish Nation

members and having their help and perspectives throughout the research was invaluable. They brought a youth perspective and element to the fieldwork that in turn brought other youth out to volunteer and take interest in the research. It is this knowledge that comes from younger generations, in combination with other knowledge holders in the community that is working to renew traditional ecological knowledge.

My research examined the potential to build community engagement in ethnoecological restoration projects by focussing on an iconic food plant. The research also set out to survey the extent of knowledge of *lhásem* within the Squamish Nation and explore how that knowledge has been transmitted and renewed.

Interviews with a range of participants showed that organizing ethnoecological restoration organized around iconic species is an effective way to engage communities in cultural knowledge revitalization. In the community of Squamish the people interviewed were very interested in restoring *lhásem* to improve community health by renewing traditional diet. *Lhásem* acted as a flagship species that represented healthy alternative dietary choices for Squamish People. The cultural connection to *lhásem* also made the restoration much more meaningful to the community. To project participants this plant represented a connection to family, history and to the land. When I spoke with people about *lhásem* many memories of other plant foods also surfaced and these memories were often connected to family members and meaningful times and experiences in their lives. Knowledge renewal was another important theme that emerged from this research. Much of the knowledge renewal that took place during this research was inspired by conversations that took place during the interviews which brought back memories that

contributed to the renewal of traditional plant knowledge. Often the participants held much more knowledge than they initially thought, and once they started thinking about traditional plant foods many memories resurfaced. It also became clear that youth engagement was a vital contributor to knowledge renewal. As youth learn about plant foods such as *lhásem* they carry this information on with them and share it with their family and friends and this results in knowledge being transferred from younger generations to older ones.

3.5 Conclusions

My project was an ethnoecological case study of the culturally important plant food *lhásem*, also known as northern riceroot, or *Fritillaria camschatcensis*. *Lhásem* was cultivated in estuarine root gardens and eaten by many Indigenous Peoples in the Pacific Northwest and was a nutritious source of carbohydrates in a traditional diet rich in protein, oil and fibre.

The focus of this research was to begin to restore *lhásem* back into the Squamish Estuary environment. This plant was used historically by the *Sḵwx̱wú7mesh* People as an important plant food and although few memories of *lhásem* exist in Squamish today, the Squamish People have a strong interest in restoring *lhásem*, with the aim of reinstating it into the Squamish diet in the future. Certain characteristics of *lhásem* make it an ideal candidate for restoration. The structure of the bulb allows for this plant to thrive under a certain level of disturbance, which was provided traditionally by tilling, weeding and replanting as a part of Indigenous management practices. It is also a beautiful plant that has caught the imagination of Squamish People as a symbol that represents a link

between traditional foods, physical health and cultural renewal.

Chapter 4 Conclusions: Bringing The Threads Together

4.1 Summary

My MSc research focused on the ethnoecological restoration of an iconic plant food in the territory of the *Sḵwx̱wú7mesh* First Nation: *lhásem,* (commonly known as northern riceroot (*Fritillaria camschatcensis* (L) Ker-Gawl)). The Squamish Estuary has been highly impacted by industrial activity over the past century and much of the original habitat for *lhásem* was lost on the east side of the Squamish estuary, bordering the town of Squamish. As a consequence of this degradation and a number of other cultural and environmental factors, few memories of *lhásem* exist in Squamish today. Despite this, many Squamish people have a strong interest in restoring *lhásem* as a plant food that can be used in the future. This research, therefore, had two primary goals: firstly, I set out to survey the interest and existing knowledge of *lhásem* in the Squamish community, and to re-familiarize the Squamish people with this former food plant so that eventually *lhásem* can be reintroduced into the Squamish diet (Chapter 3). Secondly, I sought to assess the ecological requirements of *lhásem* and to examine the potential to re-establish this species in impacted areas of the Squamish Estuary (Chapter 2). This chapter brings together the key findings from each chapter, reflects on the current research and suggests areas for future research.

4.2 Key finding of Chapter 2

In order to better understand the ecological requirements of *lhásem*, I undertook an ecological survey in impacted eastern areas and less impacted western areas of the Squamish River estuary. During my field surveys I measured soil moisture, salinity, pH

and percent composition of plant species. The analysis of the data collected during the ecological survey showed that salinity was the abiotic factor most strongly associated with *lhásem* presence / absence. My surveys suggested that *lhásem* abundance may be controlled by salinity and moisture thresholds, but further investigation is needed to clearly define the respective roles of these factors. Each of the four site types surveyed were characterized by certain dominant plant species. The terrestrial west region had a variety of herbaceous plants with the dominant species identified as *Maianthemum dilatatum, Agrostis* sp.*, Carex lyngbyei* and *Fritillaria camschatcensis*. *C. lyngbyei* was also dominant in less-impacted western estuarine sites. In eastern estuary regions *Typha latifolia* was the dominant species and in terrestrial east regions *Argentina egedii* and *Aster subspicatus* were dominant.

Several species were also identified as being significant predictors of *lhásem* habitat in the Squamish Estuary. False lily-of-the-valley, *Maianthemum dilatatum*, was found to be the most important indicator plant for *lhásem* in the terrestrial west region. Aster, *Aster subspicatus,* was found to be a good indicator for the presence of *lhásem* in terrestrial east. These vegetation patterns will be useful in future *lhásem* monitoring and restoration efforts as they will help to identify regions where *lhásem* may already be growing, will help to characterize sites where it potentially could grow, and to offer suggestions for companion planting.

As noted, this study required significant time working with and learning from Squamish community members, as well as undertaking ecological studies of *lhásem*.

Time was a limiting factor in the work; given the nature of conducting graduate research in a timely fashion it was not possible to pursue the long-term monitoring required in a successful long-term restoration project. It is also worth noting that the ecological component of this work was conducted in a dynamic and uncontrolled field setting. Factors that could not be controlled for included tide height, rainfall, wind effect, past disturbances and time of year. Additionally, my fieldwork also fell in the late spring/early summer field season and thus took place during the spring freshet, which altered the river levels, and in turn may have altered the soil moisture. The river levels also changed on a daily basis based with the tides and it was not possible to visit the sites on the same tide cycles daily. These factors thus affected my ability to recreate the exact same field conditions day to day.

Certain characteristics of *lhásem* make it an ideal candidate for restoration. In particular, each mature *lhásem* bulb is surrounded by many smaller bulblets, each capable of growing into a new plant, which makes this species very successful in reproducing vegetatively. With a certain level of disturbance, provided by tilling, weeding and replanting, it is possible for the plant population to be increased through this reproduction strategy, as well as from seeds. This capacity for vegetative reproduction makes *lhásem* an ideal candidate for cultivation historically and for restoration today.

4.3 Key Findings Chapter 3

My overall project focused on renewing knowledge of a single culturally iconic food plant, *lhásem,* into the Squamish River Estuary. Historically this plant was eaten by Squamish People and other Indigenous peoples of the Northwest Coast region and was a

nutritious source of carbohydrates in a traditional diet rich in protein, oil and fiber (Turner and Kuhnlein, 1991). Because of this and because of some people's memories of the bulbs that formerly sustained them, *lhásem* is a plant that has caught the imagination of contemporary Squamish People, representing a link between traditional foods, physical health and cultural renewal. During this research, I worked with colleagues and community members to establish *lhásem* in experimental and educational estuarine root gardens.

Through learning how to cultivate and harvest *lhásem* the Squamish People have been able to begin the restoration of an iconic plant food onto the land and to renew knowledge about its use in the community. The community's interest in this research was rooted in the broader context of renewing and reestablishing knowledge of culturally important plants with the ultimate aim of addressing dietary related health concerns as well as cultural identity. Our restoration efforts were based on the hope of eventually incorporating *lhásem* back into the Squamish diet. It is my hope that this research will serve as a model and a beginning for a broader renewal of nutritious traditional food species into people's diets and cultures within a contemporary context (Kuhnlein et al. 2009).

Prior to this project *lhásem* had not been harvested in Squamish territory in over 70 years. This estimate is based on approximations of contemporary elders who remember their own parents and grandparents harvesting it and is supported by written documentation (Bouchard and Turner, 1976; Matthews, 1955). Of the elders I interviewed only a small number remembered hearing about the plant from family members and only one elder recalled going out to harvest this plant with family members.

The restoration of *lhásem* in this project created significant opportunities for Squamish People, from elders to children and youth, to become familiar with this plant again in a variety of ways, including how to identify it at different stages of its lifecycle, how it was eaten by their ancestors, and how to tend to the gardens where it grows to promote its growth and potentially to increase its populations to a point where this root vegetable might be eaten again by numbers of people, along with other healthy indigenous foods.

I was able to ensure that the community was engaged and interested in continuing on with the next steps of the project. The Squamish Nation Education Department is developing ways to continue the efforts begun with my work to manage the restoration gardens we established through involvement with the youth and culture camp and through other community based educational programs to promote knowledge revitalization and continue to support the restoration of traditional culturally important plants onto the land.

4.4 Major Findings

My results show that *lhásem* is a culturally significant plant that Squamish Nation members are very interested in restoring onto the land and into their diets. One of the major reasons why Squamish People are interested in *lhásem* as a food is the link between traditional foods and dietary related health concerns. The restoration of *lhásem* served as a positive and effective way to re-connect Squamish People with their land, and to build awareness of and provide hands-on experience with traditional plant foods that connect Squamish People with their ancestors, their lands and their language.

4.5 Future Research

This research project should be considered the beginning of ongoing efforts to renew Squamish traditional foods plant foods through ethnoecological restoration. There was great interest on the part of the Squamish community to continue efforts to restore *lhásem* as well as other important plant foods. Further research could aim to characterize *lhásem* habitat further so that future restoration gardens for *lhásem* could be effectively situated and *lhásem* restoration could continue more intensively. One way to do this might be to take abiotic measurements at sites with *lhásem* present and sites without and compare the differences in abiotic factors at these sites. Additional ecological work could also be conducted on other estuarine plants of cultural importance, such as spring bank clover (*Trifolium wormskioldii*). It would also be very useful to work with interested Squamish Nation members to develop a long-term restoration and monitoring plan for the *lhásem* gardens as well as other culturally important species and places in the Squamish Estuary. It is my hope that my collaborative community-based research provides a useful foundation for this future work.

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Appendix

APPENDIX 1
Section I Recruitment Materials

Script – Phone Call

Joy Joseph McCullough or another staff member at the Squamish Nation Education Department will contact the possible participants before I have direct contact with them.

Potential Interviewee: Hello

Leigh: Hello, may I speak with (name of potential interviewee)

Potential Interviewee: This is (name)

Leigh: Do you have a few minutes to talk?

Potential Interviewee: Sure

Leigh: Great, I am a graduate student in Environmental Studies at the University of Victoria. I will be conducting my research on a traditional plant food of the Squamish People in collaboration with the Squamish Nation Education Department. I will be researching the restoration of *lhásem*, also called chocolate lily or northern riceroot, in the Squamish Estuary. Joy Joseph-McCullough gave me your name because she has spoken with you and feels that you might be interested in helping me with this project.

Potential Interviewee: OK

Leigh: I am hoping to learn more about what Squamish Nation members know or remember about this food so if you have any memories or information about this food I would be interested in interviewing you. But I'm also interested in interviewing people who don't necessarily know about this food but are interested in traditional plant foods in general.

Potential Interviewee: I am interested in being interviewed.

Leigh: Great. Would it be all right if I send you an informed consent form that includes a one page informational letter about my project at the beginning to give you background information? We can go over these when we meet if you decide you would still like to participate. Thank you very much.

Youth Script: In Person

Leigh: Hello, my name is Leigh Joseph and I'm studying our traditional plant foods here in Squamish. Can I talk to you about this for a few minutes?

Potential Interviewee: Yes

Leigh: Great, I am a university student and a Squamish Nation member and I'm studying the traditional plant foods that our Squamish ancestors used to eat. I will be planting a garden with a special plant called riceroot or *lhásem* in Squamish. As part of the Squamish Culture and Science Camp you will have the opportunity to be interviewed about how you feel about traditional foods at an event at the garden. Are you interested in hearing more about this?

Potential Interviewee: Sure

Leigh: I am hoping to learn about what Squamish Nation youth know about traditional foods and how they feel about growing some of these foods and even eating them again someday. I would like to ask you some questions during the camp about this topic. Would you be interested in talking with me about this?

Potential Interviewee: Yes, I'm interested.

Leigh: Great. I will give you a one page informational letter about my project and an informed consent form which give you all of the details on what kind of questions I will ask and if you are OK with being photographed and video taped. If you or your parents have any questions about this you can contact me through Totem Hall. Thank you very much.

APPENDIX 2
SAMPLE INTERVIEW QUESTIONS

Adults and Elders (Riceroot and traditional plants)

1) Do you still harvest any traditional plant foods or know of plants that were used as foods?

2) Have you noticed a change in the amounts of plant foods being used by Squamish people?

3) Are you familiar with northern riceroot, also called *lhásem* in our Squamish language? Sometimes this plant is called chocolate lily but this is the common name for another similar plant. If you are familiar with riceroot can you tell me what you know about it?

**If the interviewee is not familiar with this plant then I will have photos of the plant in its various life-stages and in its habitat to show them.

4) Please tell me who taught you about this plant and explain what knowledge they shared with you? Or if you have learned about this plant in another way please tell me the story of how you learned about it.

5) This plant was an important plant food to the Squamish People. What are your thoughts on bringing this plant back as a part of the Squamish diet? What suggestions do you have for doing this in a good way?

6) Many First Nations communities are renewing their traditional plant foods, do you think this is something that the Squamish Nation should focus on? Please explain.

7) Are there other plant foods that you are familiar with that you think would be good to focus on for renewing knowledge of traditional plant foods?

8) Ethnoecological restoration brings people out on the land to actively restore their environments in ways that were important culturally. Do you think that this is a good approach to renewing knowledge and practice linked to traditional food plants? Please explain.

9) Do you think bringing riceroot back to the Squamish estuary will be important to the community?

10) What does the phrase "Renewing Traditional Foods" mean to you?

11) Do you have any advice for the younger generations for the use of traditional foods?

Youth Questions

1) Can you tell me what traditional foods are?

2) Have you learned about any traditional plant foods here in Squamish? Have you eaten any? If so what plant foods have you tried?

3) Have you heard of the plant northern riceroot before? If you have where did you learn about it?

**If the interviewee is not familiar with this plant then I will have photos of the plant in its various life-stages and in its habitat to show them.

4) This plant used to be an important plant food to the Squamish people and now it is not very common because so much of its habitat has been damaged. Do you think that it is important to have northern riceroot growing in the Squamish estuary again? Why?

5) Why do you think it is important for us to learn more about the plants that our ancestors used to eat?

6) What can we learn from what our ancestors knew about plants that can be eaten?

7) Have you learned about other traditional plant foods in school? If yes, please tell me about what you have learned.

8) Do you have any advice for adults about traditional foods and the future?

List of Interviewees

Chief Alana Andrews, Squamish Elder
Bob Baker, Squamish Elder
Shaelyn Baker, Squamish Youth
Anna Billie, Squamish Youth
Vera Douglas, Squamish Nation Education Department
Chief Floyd Joseph, Squamish Hereditary Chief
John Joseph, Squamish Youth
Damien Joseph, Squamish Youth
Ronald “Chum” Newman, Squamish Elder
George Moods, Squamish Elder
Laverne Baker, Squamish Elder
Shirley Towman, Squamish Elder
Charlene Williams, Squamish Nation Education Department
Phillip Williams, Squamish Youth
Jonny Williams, Squamish Youth
Jasmine Williams, Squamish Youth

APPENDIX 3
Free and Informed Consent

Section M, Free and Informed Consent For **Parents of Youth Interviewees Age 8-11yrs**

Ecological and Cultural Restoration of an iconic Plant Food (*Fritillaria camschatcensis*) in the Squamish River Estuary, British Columbia

My name is Leigh Joseph and I am a member of the Squamish Nation. My ancestral name is *Styawat*, and was given to me by my *Snuneymuxw* or Nanaimo side of my family. My parents are Chief Floyd Joseph and Eve Joseph and my grandparents were Rose Joseph and Larry Joseph on my father's side and Duna Levy and Bert Levy on my mother's side. I am a Masters of Science student in the School of Environmental Studies at the University of Victoria. I am conducting ethnobotanical research under the supervision of Dr. Nancy Turner that explores the memory and ethnoecological restoration of the important plant food northern riceroot (*Fritillaria camschatcensis*). The *Sḵwx̱wú7mesh* name for this plant is *lhásem*, a name also used for its relative, chocolate lily (*Fritillaria affinis*).

An important part of this project is to interview and collaborate with Squamish Nation youth, such as your child, regarding (A) what they may know already about *lhásem* or other important traditional plants and (B) their interest in the ethnoecological restoration of *lhásem* into an educational garden in the Squamish Estuary. This information sheet is meant to inform you and your child of what to expect in the interview, should you decide to allow your child to participate. This information sheet also informs you of the benefits and risks that may be associated with participation.

A. Knowledge of *lhásem* and or traditional estuary root gardens in Squamish. This interview will take place during the Squamish Youth Culture and Science Camp and will likely last 30 minutes to 1 hour. Your child may choose to be interviewed alone or within a group setting of two or more youth. All of the interviews will take place in close proximity to the larger youth and chaperone group during the camp. If your child is related to me they will be interviewed in a group setting of two or more people to ensure that they feel comfortable and don't feel any pressure to respond to my questions in a particular way. With your consent, I will record all interviews on

audio and/or video. The interview process will involve an informal discussion of your childs past and/or present knowledge of *lhásem* and any associated plants. I may ask questions such as: "Do you remember your family identifying, speaking about or harvesting *lhásem* in the past?", "If not, have you learned about this plant before?", "What have you learned in school about the plants our ancestors used?", "Do you think it is important to learn more about these plants in the future? And why?" Your child will be free to decline to answer any questions asked during the interview. If you give permisstion these interviews will be video taped and footage of your childs interview may be used in a short video that the youth will help to direct and edit that will share the story of what they are learning about local ethnobotany. You and your child will be invited to view the video and inform the final edits before it is presented to the community.

B. The ethnoecological restoration of *lhásem*.

Ethnoecological restoration is the process of bringing a culturally important plant back into the local ecosystem, in this case the plant is *lhásem* and the local site is the Squamish Estuary. This type of work is based largely on local knowledge and insights and it is very important to understand how member of the Squamish Nation feel about this approach to renewing traditional plant foods. In this part of the interview I will show your child pictures of the educational garden site that we built in the estuary and of the plant itself and possibly historical photos of Squamish People gathering the plant. I may ask questions such as: "Why do you think having a traditional foods garden for the Squamish community to learn from is important or not?", "Are you interested in learning about how to identify traditional foods and possibly eating them in the future?", "Would you be interested in helping out with the traditional garden in the future?"

Your child will be given a thank you card and a gift certificate to a local business in appreciation for their involvement with the research. They will also be given a copy of the video that is produced.

All of the information that is recorded in your, or your childs, interview will be kept confidential until you have had a chance to review it, and if you give your permission, it may be included in my Masters thesis, and in publications and presentations relating to this research. If you agree, a permanent record of your interview including the manuscripts,

audio-tapes and video-tapes generated from your childs interview will be kept at the Squamish Nation Education Department and will only be released with the permission of the education director. However, you are free to keep the manuscripts, audio-tapes and video-tapes generated from the interview completely confidential (that is, not available to either Dr. Nancy Turner and/or other members of the Squamish First Nation).

If I use information that your child has provided in their interview in publications or presentations, I intend to give them full credit for thier contributions. If your child would prefer to remain anonymous please inform me verbally or in writing and I will gladly protect thier identity.

After I complete this project, I will send you all of the original audio recordings, videos and written manuscripts from your childs interview. With your consent, I will submit a copy of the interview (on audiotape, video and/or in written form) to my academic supervisor Dr. Nancy Turner and to the Squamish Nation Education Department. I will also provide you with a summary of the research, as well as photographs and other materials from our work together.

Your childs participation in this study is entirely voluntary. If you do decide to allow your child to participate, your child will be free to withdraw participation at any time without. Some examples of ways that they can choose to withdraw participation include:

a. If, at any time during an interview you feel stressed or upset, you can choose to take a break from the interview or end the interview. If you need to end an interview for any reason, we can always schedule another interview at another time or another location.
b. If, at any time you decide you no longer wish to participate with the project, you can choose to withdraw your participation from all or some of the interviews or activities associated with the project.
c. If, at any time, you decide that you do not want some of the information that you have already contributed to be used in the project then I will withdraw any information from the project at your request.
d. Before any of your responses are published you will have a right to review the transcripts and request the removal of any or all of your responses.

If you decide to withdraw participation or withdraw all or part of your contributions please inform either Dr. Nancy Turner or myself of your decision either personally or through the Squamish Nation Education Office.

Your childs participation with this project will provide me with valuable guidance towards:

a. The specific research question regarding the effectiveness of restoring a traditional plant food through the use of traditional management techniques to bring *lhásem* back to the Squamish Estuary.
b. Understanding more about the interests and motivations for the renewal of traditional plant foods from a contemporary Squamish Nation youth perspective.
c. Understanding what the next steps to take in renewing ethnobotanical knowledge in Squamish are.

I hope that the collaboration in this project will benefit your child by offering them an opportunity to learn more about *lhásem* and other traditional plant foods and to contribute to the present and future generations of Squamish youth by sharing their perspectives and knowledge of the importance of traditional foods.

Please feel free to contact me at any time if you have any questions or concerns about this research project:

Leigh Joseph (250) 857-1754
ljoseph@uvic.ca

If you have any questions or concerns about this research project that you are uncomfortable discussing with me, please contact my academic supervisor:

Dr. Nancy Turner
(250) 384-5568
nturner@uvic.ca

In addition, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Human Research Ethics Office at the University of Victoria.

250-472-4545
ethics@uvic.ca

After this consent form is signed, you will receive one copy and I will retain the other copy.

I, _____ CONSENT FOR MY CHILD TO PARTICIPATE IN THE RESEARCH on this ____ of _____:

(Legal guardians full name) (day) (month and year)

have read and understood the information sheet provided by Leigh Joseph titled, Ecological and Cultural Restoration of an iconic Plant Food (*Fritillaria camschatcensis*) in the Squamish River Estuary, British Columbia.

a. am aware that my CHILDS participation in one or more interviews with Leigh Joseph is completely voluntary, that THEY can withdraw participation at any time without consequences.

b. am aware that the information that MY CHILD provides in this interview with Leigh Joseph is completely voluntary. I am aware that THEY can withdraw information at any time and that THEY have the right to review and edit all publications and presentations pertaining to the specific information that IS provide in the interview.

c. ☐ consent / ☐ do not consent (*please check one box*) that this interview with Leigh Joseph be recorded on digital audio recorder. I am aware that the interview can proceed without the audio of the interview being recorded. Even if I do consent to have MY CHILDS interview audio-recorded, I am aware that THEY ARE free to request that the audio recording be turned off at any point during the interview.

d. ☐ consent / ☐ do not consent (*please check one box*) that this interview with Leigh Joseph be recorded on video. I am aware that the interview can proceed without the interview being recorded on video. Even if I do consent to have MY CHILDS interview video-recorded, I am aware that MY CHILD IS free to request that the video recording be turned off at any point during the interview.

e. ☐ consent / ☐ do not consent (*please check one box)* that this interview with Leigh Joseph be photographed and that photographs from this interview may be used in publications and presentations pertainting to the specific information that MY CHILD provides in the interview. Even if I do consent to have MY CHILDS interview photopraphed, I am aware that THEY ARE free to request that photographs not be taken at any point during the interview.

f. ☐ consent / ☐ do not consent (*please check one box)* to having my childs name associated with the information they provide in publications and presentations prepared by Leigh Joseph.

g. ☐ consent / ☐ do not consent (*please check one box)* that information from this project may be used for future projects conducted by Leigh Joseph that are related to traditional preparation, harvest, and management of culturally important resources.

h. ☐ consent / ☐ do not consent (*please check one box)* that information from my CHILDS interview may be permanently archived at the Squamish Nation Education Department and may be accessed by other Squamish Nation members in the future.

i. ☐ consent / ☐ do not consent (*please check one box)* that information from my CHILDS interview may be archived at the University of Victoria under the care of Dr. Nancy Turner.

Visually Recorded Images/Data *[IF APPLICABLE]* Participant or parent/guardian to provide initials:

- Photos may be taken of my child for: Analysis _____ Dissemination* _____
- Videos may be taken of my child for: Analysis _____ Dissemination* _____

*Even if no names are used, you [or your child] may be recognizable if visual images are shown in the results.

I agree that my child can be identified by name / credited in the results of the study.

_____ (Parent to provide initials)

Name of Participant	*Signature*	*Date*

A copy of this consent will be left with you, and a copy will be taken by the researcher.

_____ _____
(Participant's guardian) (Date)

_____ _____
(Leigh Joseph) (Date)

Ecological and Cultural Restoration of an iconic Plant Food (*Fritillaria camschatcensis*) in the Squamish River Estuary, British Columbia

My name is Leigh Joseph and I am a member of the Squamish Nation. My ancestral name is *Styawat*, and was given to me by my *Snuneymuxw* or Nanaimo side of my family. My parents are Chief Floyd Joseph and Eve Joseph and my grandparents were Rose Joseph and Larry Joseph on my father's side and Duna Levy and Bert Levy on my mother's side. I am a student at the University of Victoria and I am studying the important plant food northern riceroot (*Fritillaria camschatcensis*). The *Skwxwú7mesh* name for this plant is *lhásem*, a name also used for its relative, chocolate lily (*Fritillaria affinis*). This plant food was very important to our Squamish ancestors. Part of my project is going to be developing a garden and planting *lhásem* in it and I hope to talk to youth about how they feel about the traditional foods our ancestors used to eat. And what Squamish Nation youth have learned about these foods so far.

An important part of this project is to interview Squamish Nation youth, such as yourself, regarding
(A) what you know already about *lhásem* or other important traditional plants and (B) your interest in the restoration of *lhásem* into an educational garden in the Squamish Estuary. This information sheet is meant to inform you of what to expect in the interview, should you decide to participate. This information sheet also informs you of the benefits and risks that may be associated with participation.

B. Knowledge of *lhásem* and or traditional estuary root gardens in Squamish. This interview will take place during the Squamish Youth Culture and Science Camp and will likely last 30 minutes to 1 hour. You may choose to be interviewed alone or within a group setting of two or more youth. All of the interviews will take place in close proximity to the larger youth and chaperone group during the camp. If you are related to me then you will be interviewed in a group setting of two or more people to ensure that you feel comfortable and don't feel any pressure to respond to my questions in a particular way. With your consent, I will record all interviews on audio and/or video. The interview process will involve a relaxed conversation about

your past and/or present knowledge of *lhásem* and other traditional plants. I may ask questions such as: "Do you remember your family identifying, speaking about or harvesting *lhásem* in the past?", "If not, have you learned about this plant before?", "What have you learned in school about the plants our ancestors used?", "Do you think it is important to learn more about these plants in the future? And why?" You will be free to decide not to answer questions asked during the interview. If you give permisstion these interviews will be video taped and footage of your interview may be used in a short video that the youth at the camp will help to direct and edit that will share the story of what they are learning about local ethnobotany. You will be invited to view the video and make suggestions before it is presented to the community.

C. The ethnoecological restoration of *lhásem*.

Ethnoecological restoration is the process of bringing a culturally important plant back into the local ecosystem, in this case the plant is *lhásem* and the local site is the Squamish Estuary. This type of work is based largely on local knowledge and it is very important to understand how members of the Squamish Nation feel about this approach to renewing traditional plant foods. In this part of the interview I will show you pictures of the plant and possibly historical photos of Squamish People gathering the plant and the interveiw will most likely take place at the site of the estuary garden. I may ask questions such as: "Why do you think having a traditional foods garden for the Squamish community to learn from is important or not?", "Are you interested in learning about how to identify traditional foods and possibly eating them in the future?", "Would you be interested in helping out with the traditional garden in the future?"

You will be given a thank you card and a gift certificate to a local business in appreciation for your involvement with the research. You will also be given a copy of the video that is produced.

All of the information that is recorded in your interview will be kept confidential until you have had a chance to review it, and if you give your permission, it may be included in my Masters thesis, and in publications and presentations relating to this research. If you agree, a permanent record of your interview including the manuscripts, audio-tapes and video-tapes generated from your interview will be kept at the Squamish Nation Education Department and will only be released with the permission of the education director. Dr. Nancy Turner

may have access to these records as well. However, you are free to keep the manuscripts, audio-tapes and video-tapes generated from the interview completely confidential (that is, not available to either Dr. Nancy Turner and/or other members of the Squamish First Nation).

If I use information that you prodive in your interview in publications or presentations, I intend to give you full credit for your contributions. If you would prefer to remain anonymous (meaning I won't use your name or photos) please inform me verbally or in writing and I will gladly protect your identity.

<u>After I complete this project, all of the original audio recordings, videos and written manuscripts from your interview will be available to you and/or to your parents if requested.</u> With your consent, I will submit a copy of the interview (on audiotape, video and/or in written form) to my academic supervisor Dr. Nancy Turner and to the Squamish Nation Education Department. I will also provide you with a summary of the research, as well as photographs and other materials from our work together.

Your participation in this study is entirely voluntary. If you do decide to participate, you will be free to <u>stop participating</u> at any time. Some examples of ways that you can choose to withdraw participation include:

a. If, at any time during an interview you feel stressed or upset, you can choose to take a break from the interview or end the interview. If you need to end an interview for any reason, we can always schedule another interview at another time or another location.
b. If, at any time you decide you no longer wish to participate with the project, you can choose to withdraw your participation from all or some of the interviews or activities associated with the project.
c. If, at any time, you decide that you do not want some of the information that you have already contributed to be used in the project then I will withdraw any information from the project at your request.
d. Before any of your responses are published you will have a right to review the transcripts and request the removal of any or all of your responses.

If you decide not to participate or to withdraw all or part of your contributions please inform either Dr. Nancy Turner or myself of your decision either personally or through the Squamish Nation Education Office.

Your participation with this project will provide me with valuable guidance towards:

e. Designing a traditional plant food garden that will be interesting and meaningful to youth and in the future will bring *lhásem* back to the Squamish Estuary.
f. Understanding more about the interests and motivations for the renewal of traditional plant foods from a Squamish Nation youth perspective.
g. Understanding what steps to take next in renewing traditional foods in the Squamish area.

I hope that the collaboration in this project will benefit you by offering an opportunity to learn more about *lhásem* and other traditional plant foods and to contribute to the present and future generations of Squamish youth by sharing their perspectives and knowledge of the importance of traditional foods.

Please feel free to contact me at any time if you have any questions or concerns about this research project:

Leigh Joseph (250) 857-1754
ljoseph@uvic.ca

If you have any questions or concerns about this research project that you are uncomfortable discussing with me, please contact my academic supervisor:

Dr. Nancy Turner
(250) 384-5568
nturner@uvic.ca

In addition, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Human Research Ethics Office at the University of Victoria.

250-472-4545
ethics@uvic.ca

After this consent form is signed, you will receive one copy and I will retain the other copy.

I, _____ on this ____ of _____:

(Youth participants full name) (day) (month and year)

have read and understood the information sheet provided by Leigh Joseph titled, Ecological and Cultural Restoration of an iconic Plant Food (*Fritillaria camschatcensis*) in the Squamish River Estuary, British Columbia.

a. am aware that my participation in one or more interviews with Leigh Joseph is completely voluntary, that I can withdraw participation at any time without consequences.

b. am aware that the information that I provide in this interview with Leigh Joseph is completely voluntary. I am aware that I can withdraw information at any time and that I have the right to review and edit all publications and presentations pertaining to the specific information that I provide in the interview.

c. ☐ consent / ☐ do not consent (*please check one box*) that this interview with Leigh Joseph be recorded on digital audio recorder. I am aware that the interview can proceed without the audio of the interview being recorded. Even if I do consent to have this interview audio-recorded, I am aware that I am free to request that the audio recording be turned off at any point during the interview.

d. ☐ consent / ☐ do not consent (*please check one box*) that this interview with Leigh Joseph be recorded on video. I am aware that the interview can proceed without the interview being recorded on video. Even if I do consent to have this interview video-recorded, I am aware that I am free to request that the video recording be turned off at any point during the interview.

e. ☐ consent / ☐ do not consent (*please check one box)* that this interview with Leigh Joseph be photographed and that photographs from this interview may be used in publications and presentations pertainting to the specific information that I provide in the interview. Even if I do consent to have this interview photopraphed, I am aware that I am free to request that photographs not be taken at any point during the interview.

f. ☐ consent / ☐ do not consent (*please check one box)* to having my name associated with the traditional ecological knowledge I provide in publications and presentations prepared by Leigh Joseph.

g. ☐ consent / ☐ do not consent (*please check one box)* that information from this project may be used for future projects conducted by Leigh Joseph that are related to traditional preparation, harvest, and management of culturally important resources.

h. ☐ consent / ☐ do not consent (*please check one box)* that information from my interview may be permanently archived at the Squamish Nation Education Department and may be accessed in the future by Squamish Nation members.

i. ☐ consent / ☐ do not consent (*please check one box)* that information from my interview may be archived at the University of Victoria under the care of Dr. Nancy Turner.

Visually Recorded Images/Data *[IF APPLICABLE]* Participant or parent/guardian to provide initials:

- Photos may be taken of me for: Analysis _____ Dissemination* _____
- Videos may be taken of me for: Analysis _____ Dissemination* _____

*Even if no names are used, you may be recognizable if visual images are shown in the results.

I agree to be identified by name / credited in the results of the study.

_____ (Participant to provide initials)

Name of Participant	*Signature*	*Date*

A copy of this consent will be left with you, and a copy will be taken by the researcher.

_____ _____

(Leigh Joseph) (Date)

Section M, Free and Informed Consent For Adult and Elder Interviewees

Ecological and Cultural Restoration of an iconic Plant Food (*Fritillaria camschatcensis*) in the Squamish River Estuary, British Columbia

My name is Leigh Joseph and I am a member of the Squamish Nation. My ancestral name is *Styawat*, and was given to me by my *Snuneymuxw* or Nanaimo side of my family. My parents are Chief Floyd Joseph and Eve Joseph and my grandparents were Rose Joseph and Larry Joseph on my father's side and Duna Levy and Bert Levy on my mother's side. I am a Masters of Science student in the School of Environmental Studies at the University of Victoria. I am conducting ethnobotanical research under the supervision of Dr. Nancy Turner that explores the memory and ethnoecological restoration of the important plant food northern riceroot (*Fritillaria camschatcensis*). The *Sḵwx̱wú7mesh* name for this plant is *lhásem*, a name also used for its relative, chocolate lily (*Fritillaria affinis*).

An important part of this project is to interview and collaborate with knowledgeable people from Squamish, such as yourself, regarding (A) any memories or knowledge that you have about *lhásem* and (B) your interest in the ethnoecological restoration of *lhásem*. This information sheet is meant to inform you of what to expect in the interview, should you decide to participate, as well as of the benefits and risks that may be associated with your participation.

A. Knowledge of *lhásem* and or traditional estuary root gardens in Squamish. This interview will take place in a location of your choosing and will likely last one hour. You may choose to be interviewed alone or you may choose to invite one or more people to participate or just be present with you or to help translate if you wish to speak in the Squamish language. If you are one of my family members you will be interviewed in a group setting of two or more people to ensure that you feel comfortable and don't feel any pressure. With your consent, I will record all interviews on audio and/or video. The interview process will involve an informal discussion of your past and present knowledge of *lhásem* and any associated plants. I may ask questions such as: "Do you remember your family identifying, speaking about or harvesting *lhásem* in the past?", "If not, how did you gain awareness of this plant?", "Have you ever tasted this plant?" and if not "Is this a plant you would be interested in tasting*?*" I may also ask you to point out important harvest areas, trails or other important landscape features on a map of the Squamish Estuary area. You will be free to decline to answer any

questions asked of you in the interview. I may ask for a follow up interview in which I would ask for clarification or expansion on the topics we covered in the first interview.

D. The ethnoecological restoration of *lhásem*.

Ethnoecological restoration is the science of bringing a culturally important plant back into the local ecosystem, in this case the plant is *lhásem* and the local site is the Squamish Estuary. This type of work is based largely on local knowledge and insights and it is very important to understand how member of the Squamish Nation feel about this approach to renewing traditional plant foods. In this part of the interview I will show you pictures of the site and of the plant and if you would like to visit the field site I could arrange that. I may ask you questions such as: "Are you interested in the renewal of knowledge and practices of traditional plant food identification, management, harvesting and consumption?", "Do you think that ethnoecological restoration is an important step in renewing traditional plant foods?", "Based on your response to the previous question, could you expand and explain your opinion?"

You will be reimbursed for any personal costs that you incur as a result of your participation in this study. Additionally I would like to compensate you in a culturally appropriate manner that we can discuss at this time.

All of the information that is recorded in your interview will be kept confidential until you have had a chance to review it, and if you give your permission, it may be included in my Masters thesis, and in publications and presentations relating to this research. Only you, I, and with your permission, Dr. Nancy Turner and Squamish First Nation will have access to the manuscripts, audio-tapes and video-tapes generated from your interview. However, you are free to keep the manuscripts, audio-tapes and video-tapes generated from your interview completely confidential (that is, not available to either Dr. Nancy Turner and/or other members of the Squamish First Nation).

If I use information that you have provided in your interview in publications or presentations, I intend to give you full credit for your contributions. In this case, you will have the opportunity to review and edit documents before they are submitted for publication and review and edit presentations before they are presented if this is something that you express interest in. If you would prefer to remain anonymous or would like to have certain

statements that you have made remain anonymous in publications or presentations please inform me verbally or in writing and I will gladly protect your identity and/or the confidentiality of certain information as you request.

After I complete this project, I will send you all of the original audio recordings, videos and written manuscripts from your interview. With your consent, I will submit a copy of your interview (on audiotape, video and/or in written form) to my academic supervisor Dr. Nancy Turner and to the Squamish Nation Education Department. I will also provide you with a summary of the research, as well as photographs and other materials from our work together.

Your participation in this study is entirely voluntary. If you do decide to participate, you will be free to withdraw participation at any time without consequences and without loss of your honorarium. Some examples of ways that you can choose to withdraw participation include:

a. If, at any time during an interview you feel stressed or upset, you can choose to take a break from the interview or end the interview. If you need to end an interview for any reason, we can always schedule another interview at another time or another location.
b. If, at any time you decide you no longer wish to participate with the project, you can choose to withdraw your participation from all or some of the interviews or activities associated with the project.
c. If, at any time, you decide that you do not want some of the information that you have already contributed to be used in the project then I will withdraw any information from the project at your request.
d. Before any of your responses are published you will have a right to review the transcripts and request the removal of any or all of your responses.

If you decide to withdraw participation or withdraw all or part of your contributions please inform either Dr. Nancy Turner or myself of your decision either personally or through the Squamish Nation Education Office.

Your participation with this project will provide me with valuable guidance towards:

e. The specific research question regarding the effectiveness of restoring a traditional plant food through the use of traditional management techniques to bring *lhásem* back to the Squamish Estuary.

f. Understanding more about the interests and motivations for the renewal of traditional plant foods from a contemporary Squamish Nation perspective.

g. Understanding what the next step to take in renewing ethnobotanical knowledge in Squamish.

I hope that your collaboration in this project will benefit you by facilitating the recognition of your knowledge about the use and management of *lhásem*.

Please feel free to contact me at any time if you have any questions or concerns about this research project:

Leigh Joseph (250) 857-1754
ljoseph@uvic.ca

If you have any questions or concerns about this research project that you are uncomfortable discussing with me, please contact my academic supervisor:

Dr. Nancy Turner
(250) 384-5568
nturner@uvic.ca

In addition, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Human Research Ethics Office at the University of Victoria.

250-472-4545
ethics@uvic.ca

Section M, Free and Informed Consent

Ecological and Cultural Restoration of an iconic Plant Food (*Fritillaria camschatcensis*) in the Squamish River Estuary, British Columbia

After this consent form is signed, you will receive one copy and I will retain the other copy.

I, _____ on this ____ of _____:
(participants full name) (day) (month and year)
have read and understood the information sheet provided by Leigh Joseph titled, Ecological and Cultural Restoration of an iconic Plant Food (*Fritillaria camschatcensis*) in the Squamish River Estuary, British Columbia.

a. am aware that my participation in one or more interviews with Leigh Joseph is completely voluntary, that I can withdraw participation at any time without consequences.

b. am aware that the information that I provide in this interview with Leigh Joseph is completely voluntary. I am aware that I can withdraw information at any time and that I have the right to review and edit all publications and presentations pertaining to the specific information that I provide in the interview.

c. ☐ consent / ☐ do not consent (*please check one box*) that this interview with Leigh Joseph be recorded on digital audio recorder. I am aware that the interview can proceed without the audio of the interview being recorded. Even if I do consent to have this interview audio-recorded, I am aware that I am free to request that the audio recording be turned off at any point during the interview.

d. ☐ consent / ☐ do not consent (*please check one box*) that this interview with Leigh Joseph be recorded on video. I am aware that the interview can proceed without the interview being recorded on video. Even if I do consent to have this interview video-recorded, I am aware that I am free to request that the video recording be turned off at any point during the interview.

e. ☐ consent / ☐ do not consent (*please check one box)* that this interview with Leigh Joseph be photographed and that photographs from this interview may be used in publications and presentations pertainting to the specific information that I provide in the interview. Even if I do consent to have this interview photopraphed, I am aware that I am free to request that photographs not be taken at any point during the interview.

f. ☐ consent / ☐ do not consent (*please check one box)* to having my name associated with the traditional ecological knowledge I provide in publications and presentations prepared by Leigh Joseph.

g. ☐ consent / ☐ do not consent (*please check one box)* that information from this project may be used for future projects conducted by Leigh Joseph that are related to traditional preparation, harvest, and management of culturally important resources.

h. ☐ consent / ☐ do not consent (*please check one box)* that information from my interview may be permanently archived at the Squamish Nation Education Department and may be accessed by other Squamish Nation members in the future.

i. ☐ consent / ☐ do not consent (*please check one box)* that information from my interview may be archived at the University of Victoria under the care of Dr. Nancy Turner.

I agree to be identified by name / credited in the results of the study.

_____ (Participant to provide initials)

Name of Participant	*Signature*	*Date*

A copy of this consent will be left with you, and a copy will be taken by the researcher.

(Leigh Joseph)	(Date)

APPENDIX 4
Correspondences With the Squamish Nation

A. Letter of Support from Squamish Nation Education Director

Squamish Nation Education

1380 Stawamus Road ♦ Box 2180 Squamish BC, V8B 0B5 ♦TELEPHONE: 604-892-5166 FAX: 604-892-3486

February 14, 2011 Re: Leigh Jenny Joseph ♦ #201-1126 McClure Street, Victoria BC V8V 3G2 ♦(250) 483-5197

To:
My name is Joy Joseph-McCullough and I am the Associate Education Director for the Squamish Nation. This letter is in reference to Miss Leigh Jenny Joseph's contributions to our community. I have known Leigh Jenny her whole life as she is my niece. I have also been a teacher to Leigh Jenny as well as an employer. Leigh has been working with our department on the revival of plant use in our community. Leigh has come home a few times to help with identifying and documenting plants and their uses. Her **first** visit was for two weeks. She worked on;

- Developing a plant field book of Squamish Nation plant use.
- Did a medicine calendar. On her **second** visit she did an internship with us from May 11, 2009 June 26, 2009. Activities included;
- Interviewed our elders on the traditional use of plants by the Squamish people.
- Upgraded our Squamish Nation Plant field booklet.
- Produced a legacy booklet of our Hereditary Chief and Medicine Man Ronald Newman.
- Start work on identifying the plants the Squamish Nation used in the Estuary.
- Document processing seaweed for consumption.
- Help plan a High school Earth Science course.

I wanted to share with the committee a conversation I had with Leigh regarding her education. I had talked to Leigh about Post Secondary Students getting their education but not returning home so their education could benefit the community. I further explained that our people throughout our history have always picked up new tools to benefit our community/Nation. However today our Nation members are going off to college and university but they do not return to their village. This touched Leigh Jenny's heart and opened her eyes. She said "I want to come home and share what I have learned. I want to help our people in any way I can". Leigh has been home twice now **and plan's to do her Masters here in Squamish.** I have worked with Leigh and our Land & Environmental Department regarding the construction of an information Kiosk and garden in the Estuary. Our goal is to build an information Kiosk on Plant use of the Squamish People and also to start a garden with the chocolate lily, Camus and other plants our people used. We are going to reintroduce traditional food back into our diet**.**

This research is so vital to our people because it will bring back teachings that were almost lost. It will help build a healthier community because our people will return to traditional foods which are easier to digest. It could help with the diabetes and obesity that is affecting our community members. It will educate the community about plant use of the Squamish People. The garden and Kiosk will become a destination point for learning.

One of Leigh's instructors is Nancy Turner and Nancy co-wrote a book on the Ethno botany of the Squamish People. Nancy is working closely with Leigh on her projects and this is a great benefit to our community. **Our dream will become a reality with Leigh working on something that was almost lost. I am so very excited about Leigh and reintroducing plant use in our community.**

If you require further information please contact me at (604) 892-5166 or Email joy_joseph_mccullough@squamish.net

Thank you,
Joy Joseph-McCullough Associate Education Director Squamish Nation

B. Letter Addressed to Squamish Nation Chief and Council

To: Squamish Nation Chief and Council
321 Seymour Blvd
North Vancouver
V7J 2J3

Attn: Squamish Nation Chief and Council

From: Leigh Joseph/*Styawat*

Hello, My name is Leigh Joseph and my parents are Chief Floyd Joseph and Eve Joseph. My grandparents were Larry Joseph and Marjorie Rose Joseph on my fathers side and Bert Levy and Duna Levy on my mothers side. My ancestral name comes from the Thomas family on my grandmothers *Snuneymuxw*, or Nanaimo, side of the family. I am a member of the Squamish Nation and I am currently enrolled in the first year of a Masters of Science degree at the University of Victoria. Prior to beginning my Masters I was an undergraduate student for four years and majored in biology and environmental studies.

I am studying ethnobotany, which is the study of the traditional uses of plants for food and medicine and my Masters research will involve conducting an ethnoecological restoration project. Ethnoecological restoration is a science that focuses on restoring ecosystems and habitats to a culturally significant state – meaning a state in which people can use the area and plants in a meaningful and traditional way.

My research focuses on the ethnoecological restoration of a traditional Squamish plant food, **Northern Riceroot**, in the Squamish Estuary. The *Sḵwx̱wú7mesh* name for this plant is ***lhásem*** and this plant name was recorded by Louise Miranda Sr. in the 1976, in *Ethnobotany of the Squamish People,* a book that was compiled by Nancy Turner and Randy Bouchard.

My research will address some of the top priorities determined by Squamish Nation members including: education, involving elders and language and culture. I chose to undertake this research specifically within the Squamish Nation in order to contribute and start giving back to my home community through both ethnobotanical and ecological research. The heart of my research and my interest lies within improving the ecological habitat for traditional foods, fostering a cultural connection to the land and promoting physical health through the re-education and re-introduction of traditional plant foods into the contemporary Squamish diet. My research will address the rise in diet-related disease such as Type II Diabetes by promoting the gathering and eating of traditional foods as proactive way to help reduce these illnesses. Diabetes is a disease that was never present in our people until the introduction of the western diet and if we move back towards more traditional food forms we may be able to lessen the impact of diseases like diabetes in the future.

Additionally, this work will build upon ethnobotanical projects that I have been involved with over the past three years that were funded by the Squamish Education Department and the LE'NONET Indigenous research fund. My research has been directly influenced through support and guidance from the Squamish Nation Education Department and I will continue to recognize and honor this by contributing to the Squamish Nation through research and community involvement well into the future.
I have applied to the Squamish Nation Trust for funds to help me to involve members of the Squamish Nation in research for the Squamish community by Squamish people. Thus, this is a capacity building project.

The Squamish members that are trained and gain experience from my research will have a skill set that they can apply to further contributions to the Squamish Nation. I plan to involve community members by employing them and training them in field biology methods and techniques as well as ethnobotanical training. I will also incorporate traditional management practices at a garden plot where we will grow and tend to traditional estuary root vegetables.

Traditional knowledge of the Squamish Estuary and of traditional estuary food plants will be a central driving force behind my research. This research has the potential to benefit the Squamish Nation by providing research evidence that documents land use and cultural significance of the Squamish Estuary to the Squamish peoples. The estuary is a culturally significant site that has been managed for thousands of years as a source of traditional foods and this research will help document this use.

I have years of experience working in ethnobotanical research and community based projects and my training in biology will help me to develop meaningful research that will contribute to the revitalization of traditional ecological knowledge for the Squamish People. I have strong ties to our *Sḵwx̱wú7mesh* territory and wish to contribute in a positive way to the future of these lands. By undertaking my research and by training Squamish Nation members to conduct this kind of field research the land will benefit through renewed cultural practice and knowledge. A hope and intention of mine with this work is to encourage people to live a healthier lifestyle through spending more time out on the land.

I am very experienced in the wilderness and with field research. With this experience, I will be able to lead two Squamish Nation field research assistants through conducting an ecological survey of the Squamish Estuary as well as conducing a field based ethnobotany experiment. I foresee this project taking three months this coming spring/summer.

I have research funds from the Social Sciences Research Humanities Council of Canada Scholarship (SSHRC) secured through my Masters supervisor, Dr. Nancy Turner, to support my research along with a graduate scholarship from the University of Victoria and one from the Chief Joe Mathias Scholarship fund. Of course, my research will only

proceed with the approval of the Squamish Nation Chief and Council and with a permit for conducting ethnobotanical and ecological research within the territory.

Thank you for your time and consideration,

Sincerely,

Leigh Joseph,
Squamish Nation Member,
Masters of Science Candidate, University of Victoria.