

Renewing Central Coast Salish Camas (*Camassia leichtlinii* (Baker) Wats., *C. quamash*
(Pursh) Greene; Liliaceae) Traditions Through Access to Protected Areas:
An Ethnoecological Inquiry

by

Katherine Yvonne Proctor
B.A., The Evergreen State College, 2003

A Thesis Submitted in Partial Fulfillment
of the Requirements for the Degree of

MASTER OF SCIENCE

In the School of Environmental Studies

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University of Victoria

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This research examined the potential for protected areas with camas (including tall camas, *Camassia leichtlinii* (Baker) Wats., and common camas, *C. quamash* (Pursh) Greene; Liliaceae (Agavaceae)) habitat to support the renewal of Central Coast Salish camas traditions while at the same time maintaining and even expanding their ecological restoration and conservation goals. For many generations Central Coast Salish Peoples of northwestern North America have cultivated camas plants and harvested, processed, and consumed their edible bulbs in large quantities. Today, after camas use has almost completely disappeared from their lives, some Indigenous peoples are working to restore camas habitats and cultivation practices on southern Vancouver Island and neighbouring areas. Tall camas and common camas can still be found growing in many Garry oak ecosystems, which, due to the decreased range and the large proportion of rare species found within them, are frequently the focus of ecological restoration and conservation efforts.

I interviewed people from the resource management and First Nations communities to gain an understanding of the current interests, opportunities, challenges, and potential approaches for incorporating traditionally based camas harvesting and management into protected areas today. Protected areas were identified as important areas for teaching traditional plant cultivation techniques to younger generations, and as bulb and seed banks for ethnoecological restoration projects. Overall, managers of protected areas and First Nations participants were receptive to collaborating on management of camas populations. Anticipated or existing challenges or concerns included ecological uncertainties of harvesting disturbance, ensuring safety, finding funding, and gaining trust.

I conducted one season of experimental camas harvesting in a Garry oak savannah near Duncan, BC within an ecological preserve and monitored the effects of this harvesting on the extant camas populations, on surrounding plant communities, and on soil porosity. Harvesting of, primarily tall, camas bulbs, at both low and medium intensity, did not affect the weight or abundance of camas bulbs or the quantity, stem height or flowering/fruitlet potential of the camas populations in the following year. Harvesting significantly reduced the abundance of Kentucky bluegrass (*Poa pratensis*) and common snowberry (*Symphoricarpos albus*, but significantly increased the abundance of Scotch broom (*Cytisus scoparius*) common cleavers (*Galium aparine*), hairy cat's ear (*Hypochaeris radicata*), and nipplewort (*Lapsana communis*). Harvesting significantly reduced the level of soil compaction.

Using the insights gained from the interviews and experimental harvesting I have proposed an "Ethnoecological Restoration Support Model". This model explains how

protected areas can support cultural restoration both within and outside of protected areas while maintaining and even expanding upon current conservation and restoration goals.

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Dedication

I dedicate this thesis to all people who are working cross-culturally to restore the Earth's ecosystems and our relationship with those ecosystems. You are my inspiration!

Chapter 1 Introduction to the Ecological, Cultural, and Socio-Political Landscapes of Vancouver Island, British Columbia

Camas is so important because it was one of our main food trade items for our ancestors. And today it's still important to revive in many ways...[We need to] protect what's here to continue to have places we can harvest and manage and take care of and keep that connection as *Lekwungen* (Cheryl Bryce, Traditional Resource Manager, pers. comm. 2011).

1.1 Thesis Overview

Renewal of traditional food knowledge, use, and practices is a major area of interest for many Indigenous Peoples in northwestern North America (CUJ 2008; Devereaux and Kittridge 2008; Jacknis 2006; Krohn and Segrest 2010; VICCIFN 2012). Traditional foods are fundamental to preserving cultural identity and improving the health, food security, and food sovereignty of First Nations communities. Often the ecosystems where culturally important foods grow are the focus of conservation and restoration efforts, rendering them off-limits to harvesters (Alcorn 1993; Beltrán 2000; Peepre and Dearden 2002; Ruppert 2003; Senos *et al.* 2006). While some people regard ecological restoration and conservation efforts as incompatible with the renewal of traditional plant harvesting and management practices, Indigenous communities and ethnoecologists often view these goals as inextricably linked (Anderson 2005; Anderson and Barbour 2003; Deur and Turner 2005; Kimmerer and Lake 2001; MacDougall *et al.* 2004; Martinez 2011; Senos *et al.* 2006). My research is part of the growing field of ethnoecological restoration which seeks to understand how aspects of traditional resource and ecological management (TREM) practices can be incorporated into contemporary ecological restoration and management projects to both enhance ecosystem functioning

and sustain the cultures that are linked with those ecosystems (Anderson 1993, 2005; Anderson and Barbour 2003; Fowler and Lepofsky 2011; MacDougall *et al.* 2004; Martinez 2011; Senos *et al.* 2006).

For this project I worked with the resource management community and with people who are encouraging the renewal of traditional food practices on southern Vancouver Island, British Columbia (BC), to study the ecological and socio-cultural compatibility of edible tall camas (*Camassia leichtlinii* (Baker) Wats.; Liliaceae (Agavaceae)) and common camas (*Camassia quamash* (Pursh) Greene; Liliaceae (Agavaceae)) harvesting and management with the ecological restoration and conservation of protected areas that support the nationally endangered Garry oak ecosystems. Camas plants were cultivated and their edible bulbs harvested in large quantities by Central Coast Salish¹ Peoples (Figure 1.1), likely until the early 1900's (Beckwith 2004; Deur and Turner 2005; Turner and Hebda 2012).



Figure 1.1 Map depicting Central Coast Salish Territory in early 19th-century spanning Washington State and British Columbia (From the Bill Reid Centre Website at Simon Fraser University).

¹ The three major Central Coast Salish groups on Vancouver Island are: Straits Salish (including Songhees and Esquimalt (together *Lekwungen*), Saanich, *T'souke*, and Beecher Bay); *Hul'qumi'num* (including the Cowichan tribes (Cowichan, Chemainus) and *Snuneymuxw* (Nanaimo)); and Comox (Suttles 1990; Turner and Hebda 2012).

Today, camas still can be found growing in many Garry oak ecosystems, which, due to habitat loss and the large proportion of rare species found within them, among other reasons, are frequently the focus of restoration and conservation efforts (Apostol and Sinclair 2006; GOERT 2012; NCC 2012).

For First Peoples interested in renewing, continuing, and sharing camas and associated food traditions with the next generation, gaining safe access to areas where they can interact with Garry oak ecosystems containing significant populations of camas bulbs is essential (Corntassel and Bryce 2012; Turner 2005a). Though there are some patches of camas growing on Indigenous reserve lands, such as Discovery and Chatham Islands (*Tl'ches*), BC (Gomes 2012; Higgs 2003), protected areas are some of the only places where camas species can still be found in relative abundance (GOERT 2012; NCC 2012; Senos *et al.* 2005). While learning about the history of traditional camas management and the current efforts to restore Garry oak ecosystems, I became interested in how protected areas could support the renewed use and management of camas in Central Coast Salish communities, while maintaining, and even expanding upon, ecological restoration and conservation goals. This question is central to my research.

1.1.1 Methods and Thesis Objectives

This ethnoecological study used two modes of investigation—semi-structured interviews and ecological field research—to pursue four research objectives that consider how protected areas might support the renewal of camas use and cultivation for Central Coast Salish communities and, at the same time, maintain their conservation function. These objectives are:

- 1) To document the current interests, challenges, and efforts in restoring camas harvesting, management, and use in Central Coast Salish communities;
- 2) To document how Indigenous and non-Indigenous resource managers imagine camas harvesting and management might be integrated within current restoration and conservation efforts in parks and protected areas;
- 3) To assess the effects of one season of camas bulb harvesting on a camas population and its wider plant community in a Garry oak ecosystem protected area, with specific attention to the effect on both rare native and exotic plants; and
- 4) To develop a model for integrating camas harvesting and management in protected areas.

More broadly, this research seeks to contribute to the dialogue around ethnoecological restoration and the integration of traditional harvesting and land management practices both inside and outside of protected areas.

1.1.2 Thesis Organization

This thesis is organized into four chapters. The remainder of Chapter 1 provides background and context for this study, including a summary of the botany and autecology of camas, ecology and decline of Garry oak ecosystems, significance of camas bulbs for Central Coast Salish communities, traditional management of Garry oak ecosystems and camas, the history of colonization on Vancouver Island, traditional foods renewal, the changing approaches to ecological restoration and management in parks and protected areas, restoration and management of Garry oak ecosystems, and studies of geophyte² harvesting.

In Chapter 2, I present the interview methods and findings associated with Objectives 1 and 2 (see above). In Chapter 3, I describe the methods used in my

² A geophyte is a plant with a modified stem that acts as an underground storage organ, such as a bulb or corm (Raven *et al.* 2005).

experimental camas harvesting study, and present and discuss my results related to Objective 3. In Chapter 4, I propose a model (Objective 4) for the support of both cultural and ecological restoration in protected areas using the findings from my interviews and experimental harvesting study. Additionally, in Chapter 4, I suggest future studies for camas harvesting and management within protected areas.

1.2 Ecological Context

This project occurred in the Garry oak ecosystems of southern Vancouver Island, British Columbia (BC), where two species of edible camas, tall camas (*Camassia leichtlinii*) and common camas (*Camassia quamash*) grow. Garry oak ecosystems are known for their gnarled and stately oak trees and their displays of spring wildflowers, with camas being two of the prominent species (GOERT 2012) (Figure 1.2). In the next sections, I will describe the two camas species and Garry oak ecosystems in the context of this research.



Figure 1.2 (a) Tall camas (*Camassia leichtlinii*) and (b) Garry oak (*Quercus garryana*) savannah at the Nature Conservancy of Canada's Cowichan Garry Oak Preserve near Duncan, BC (Photos taken by Kate Proctor).

1.2.1 Tall Camas (*Camassia leichtlinii*) and Common Camas (*Camassia quamash*)

Camas species (*Camassia spp.*) (Figure 1.3) are perennial monocotyledons³ that are considered to be part of either the Lily (Liliaceae) or Agave (Agavaceae) Family⁴ (Klinkenberg 2013). There are six camas species that are all native to North America (McNeal 2013). Tall camas (*Camassia leichtlinii*) and common camas (*Camassia quamash*) are the two dominant species of camas found in northwestern North America (McNeal 2013). Both species have long grass-like basal leaves, a terminal raceme with multiple bluish/purple (rarely white or light blue) flowers, and white bulbs with a chestnut brown tunic (McNeal 2013).

The best way to distinguish between tall camas (Figure 1.3a) and common camas (Figure 1.3b) is by flower morphology; tall camas has six tepals⁵ that spread radially around the ovary, whereas common camas has five of the six tepals curving slightly upward, while the sixth points downward (Klinkenberg 2013). After maturity, the tepals of a tall camas flower twist together over the ripening fruiting capsule while the tepals of a common camas flower splay outward (Klinkenberg). Another factor that sets these two species apart is their flowering time (Hebda 1992). Depending on elevation and other factors, on southern Vancouver Island common camas usually blooms from early April through early May, whereas tall camas blooms from late April through late May (Beckwith 2004).

³ A monocotyledon (e.g. monocot) is a plant whose embryo has one cotyledon (e.g. seed leaf). Lilies and grasses are two examples of monocotyledons (Raven *et al.* 2005).

⁴ Recent molecular studies in the United States have led some taxonomists to question the designation of camas to the Lily Family, and instead have assigned camas to the Agavaceae family in the order Asparagales (Calflora 2013; McNeal 2013).

⁵ Tepals are elements of the perianth, or outer part of a flower, which includes the petals or sepals. The term "tepal" is applied when all the segments of the perianth are of similar shape and color, or are undifferentiated (Raven *et al.* 2005).

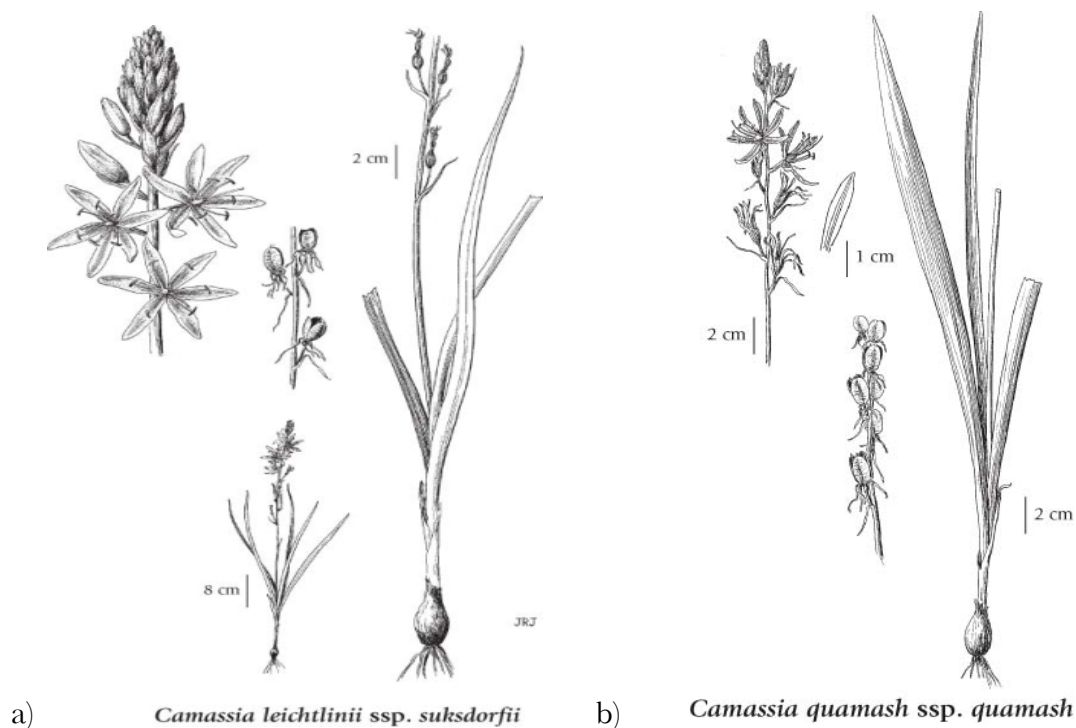


Figure 1.3 Sketches of (a) tall camas and (b) common camas, depicting bulb, leaf, flower, and seed pod morphology. Note the tepals of tall camas that spread evenly around the ovary, as compared to the tepals of common camas which are unevenly spread (five pointing upward, and the sixth pointing downward) (Douglas *et al.* 2001).

Habitat and Range

Although both camas species occur in a range of habitats found throughout the Coastal Douglas-fir Biogeoclimatic Zone⁶, including estuarine savannahs and bogs, it is most commonly associated with Garry oak savannah and prairie ecosystems (Beckwith 2004; Klinkenberg 2013). An annual dry summer period, preceded by wet conditions through the spring growing season, is an important requirement for their growth and development (Beckwith 2004).

Tall camas typically grows in moist savannahs, ditches, and rocky areas with

⁶ The Coastal Douglas-fir Biogeoclimatic zone has a Mediterranean-like environment that is characterized by warm, sunny summers and mild, wet winters. Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*) trees are the dominant species throughout this zone (BECWeb 2013).

seepages on southern Vancouver Island and the adjacent Gulf and San Juan islands (Washington State), and continuing south through Washington, Oregon, and California (Figure 1.4a) (Hitchcock and Cronquist 1978; Pojar and Mackinnon 1994). Its range is restricted to the west side of the Cascade Mountains (Pojar and Mackinnon 1994).

Common camas is found most often in moist savannahs, rocky outcrops, and grassy bluffs in southwestern British Columbia, mainly on southwestern Vancouver Island and the neighbouring islands (Hitchcock and Cronquist 1978; Pojar and Mackinnon 1994). Its continental range extends from the central interior of British Columbia and southwestern Alberta, down into the states of Washington, Oregon, Idaho, California, Montana, Wyoming, Utah, and Nevada (Figure 1.4b) (Ranker and Hogan 2013).

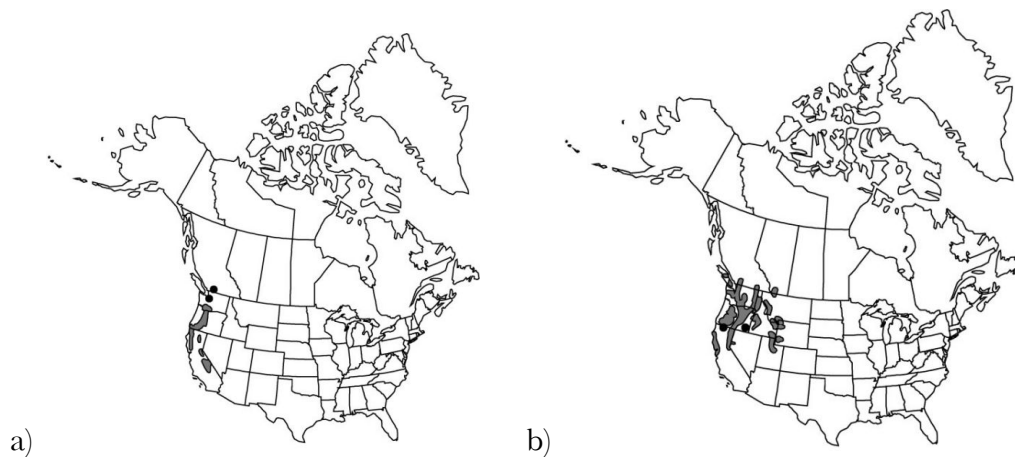


Figure 1.4 (a) Range of tall camas (*Camassia leichtlinii*), and (b) common camas (*Camassia quamash*) in North America (Ranker and Hogan 2013).

Blue Camas Growth and Development

Camas species are bulbous geophytes, or perennial plants with underground storage structures (Ranker and Hogan 2013). Camas reproduces both from seed and asexually through bulb division (Beckwith 2004; Thoms 1989). Bulb division, which

occurs only in mature or flowering bulbs, is common in garden or nursery settings though is less common in more natural sites (Beckwith 2004). Camas has a lengthy maturation period, taking six years or longer for seeds to grow into mature, flowering plants with sizeable bulbs (Beckwith 2004; Thoms 1989). Camas bulbs move deeper into the soil as they mature, and flower when they become large enough, as well as when they reach a certain soil depth, typically when they reach a nonporous layer (e.g., bedrock or clay) and hence the summer water table (Beckwith 2004).

The camas bulb is composed of two developmental sections: the mature “mother” bulb and the developing “daughter” bulb (Thoms 1989). Growth begins in early spring with the development of new leaves from the terminal bud (Thoms 1989). During the spring and summer growing season, the daughter bulb uses the carbohydrates stored in the mother bulb and increases in size (Thoms 1989). This developing daughter bulb becomes the new mother bulb and will reach its maximum size just before the seed pods are fully developed (Beckwith 2004; Thoms 1989). En route to flowering size camas bulbs undergo numerous changes in morphology. Beginning early in their development the bulbs are a small teardrop shape. As they mature they become elongated and form contractile roots that help to pull them deeper into the soil, eventually growing into a larger version of the teardrop shaped bulb (Figure 1.5) (Beckwith 2004). The average size of a camas bulb appears to vary depending on growing conditions and location. Beckwith (2004, p. 102) noted that mature “[common camas] *C. quamash* has been recorded from...1.4 to 3.0 cm in diameter on Vancouver Island,” whereas “[tall camas] *C. leichtlinii* bulbs taken from wild populations ranges from 1.5 to 3.9 cm”. Bulb measurements in my study, taken from a wild population on southern Vancouver Island of almost exclusively

tall camas (*C. leichtlinii*) bulbs, ranged in diameter from 0.2 cm to 3.7 cm.



Figure 1.5 Tall camas (*Camassia leichtlinii*) bulbs of different ages showing variation in morphology. The grid in the background measures 1.0 cm x 1.0 cm (Photo taken by Kate Proctor).

Flowering of camas bulbs tends to occur more slowly in uncultivated settings compared to well-maintained gardens or nurseries (Beckwith 2004; Hebda 1992). Camas bulbs can remain dormant during the growing season, regardless of size, due to factors such as drought and limits on other resources (Beckwith 2004; Hebda 1992; Thoms 1989). Overcrowding within the camas population, resulting in intraspecific competition, can negatively affect the growth and flowering potential of camas (Beckwith 2004; Hebda 1992). Seedling establishment also can be impaired by excess litter accumulation (Beckwith 2004). Camas germination, growth, and flowering potential in natural settings is improved by cultivation which reduces competition, increases soil nutrients and moisture, and provides seeds greater access to bare soil (Beckwith 2004; Hebda 1992; MacDougall and Turkington 2007; Thoms 1989).

1.2.2 Garry Oak Ecosystems

The range of Garry oak and associated ecosystems extends from northern

California through to the southwestern corner of British Columbia, mainly southeastern Vancouver Island and the Gulf Islands (Erickson 2008) (Figure 1.6). This suite of ecosystems is characterized by a semi-Mediterranean climate, with wet, cool winters and a summer drought period from June to September (MacDougall 2005; MacDougall and Turkington 2007). Garry oak ecosystems are home to more plant species than any other terrestrial ecosystem in coastal British Columbia, making them biologically critical habitat (Apostol and Sinclair 2006; GOERT 2012; NCC 2012; Ward *et al.* 1998). Sixty-one plant taxa in Garry oak ecosystems are listed as being ‘at risk’, including eleven designated by the federal Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as being ‘at risk’ on a national scale (GOERT 2012).



Figure 1.6 Present distribution of Garry oak and associated ecosystems in Canada and the United States (Erickson 2008, p. 2).

Garry oak ecosystems are considered to be a subcomponent of the Coastal Douglas-fir Biogeoclimatic zone (See Footnote # 6) (Klinka 1996). Where fire, or other

large-scale ecological disturbance, is suppressed, the deep soil Garry oak savannah communities will not persist in this zone (Erickson 2002; Sinclair *et al.* 2006). Landscapes within this zone will first undergo succession to Garry oak woodland, then to Douglas-fir forest as shrubs and trees encroach upon open areas (Erickson 2002, 2007; Sinclair *et al.* 2006). Deep soil Garry oak ecosystems can be thought of as ‘anthropogenic ecosystems,’ or ecosystems that were historically maintained by humans in an earlier state of ecological succession (discussed in Section 1.3.2), and require ongoing management to remain within the landscape (Sinclair *et al.* 2006). It should be noted, however, that there are shallow-soiled sites where Garry oaks, and associated species, dominate the landscape. In these isolated patches—often on the summits and southern and western slopes of hills—a hotter and drier microclimate, in combination with the shallow soil, works as a limiting ecological factor, keeping other species such as Douglas-fir (*Pseudotsuga menziesii* var. *menziesii*) at the fringes (Beckwith pers. comm. 2012; Erickson 2008).

These ecosystems often, though not always, contain Garry oak trees at some level of canopy cover. Garry oak ecosystems range from prairie, parkland, meadow, and rocky outcrops without oak trees or with trees only along the margins, to savannahs with scattered oak trees, to oak woodlands with a shrub dominated understorey (Erickson 2007). Sometimes interspersed with these oaks are other native tree species such as arbutus (*Arbutus menziesii*) and Douglas-fir. The understorey may include native shrubs such as snowberry (*Symphoricarpos albus*), wild rose (*Rosa nutkana*), and Indian plum (*Oemleria cerasiformis*), to name a few (Erickson 2007).

Common native herbaceous plants growing within the prairie or savannah components of the ecosystem include tall camas, common camas, shooting star

(*Dodecatheon hendersonii*), chocolate lily (*Fritillaria affinis*), white fawn lily (*Erythronium oregonum*), nodding onion (*Allium cernuum*), western buttercup (*Ranunculus occidentalis*), red columbine (*Aquilegia formosa*), sea blush (*Plectritis congesta*), yellow montane violet (*Viola praemorsa* ssp. *praemorsa*), deltoid balsamroot (*Balsamorhiza deltoidea*), wild caraway (*Perideridia gairdneri*), Pacific sanicle (*Sanicula crassicaulis*), and native clovers (*Trifolium* spp.) (Erickson 2007; GOERT 2012). Native grasses include California brome (*Bromus carinatus*), California oatgrass (*Danthonia californica*) blue wildrye (*Elymus glaucus*), Idaho fescue (*Festuca idahoensis*), and Junegrass (*Koeleria macrantha*) (Erickson 2007; GOERT 2012).

Decline of Garry oak ecosystems

Garry oak and associated ecosystems are threatened in Canada because most of their historical range has been destroyed since the time of colonization (e.g. 1843), largely due to the encroachment from agricultural, residential, industrial, and urban development (Apostol and Sinclair 2006; Erickson 2008; GOERT 2012). Once relatively widespread in coastal areas of southwest British Columbia, ecologists believe that less than five percent of these ecosystems remain in a ‘near-natural’ condition in Canada (Apostol and Sinclair 2006; GOERT 2012) (Figure 1.7). In Canada, most of the remnant Garry oak habitats are found in isolated and fragmented communities and are primarily characterized as shallow-soil ‘scrub oak’ ecosystems, (Lea 2008; Velland *et al.* 2008). Only a small portion (~1%) of the pre-European contact deep-soil sites remains as these locales likely were first to be developed for colonial agriculture and settlement (Beckwith 2004; Lea 2008) (See Section 1.4). The remaining fragments of Garry oak ecosystems have been degraded by the introduction of exotic species and, in some areas, fire suppression (Apostol and Sinclair 2006; Erickson 2008; Gedalof *et al.* 2006; GOERT 2012).

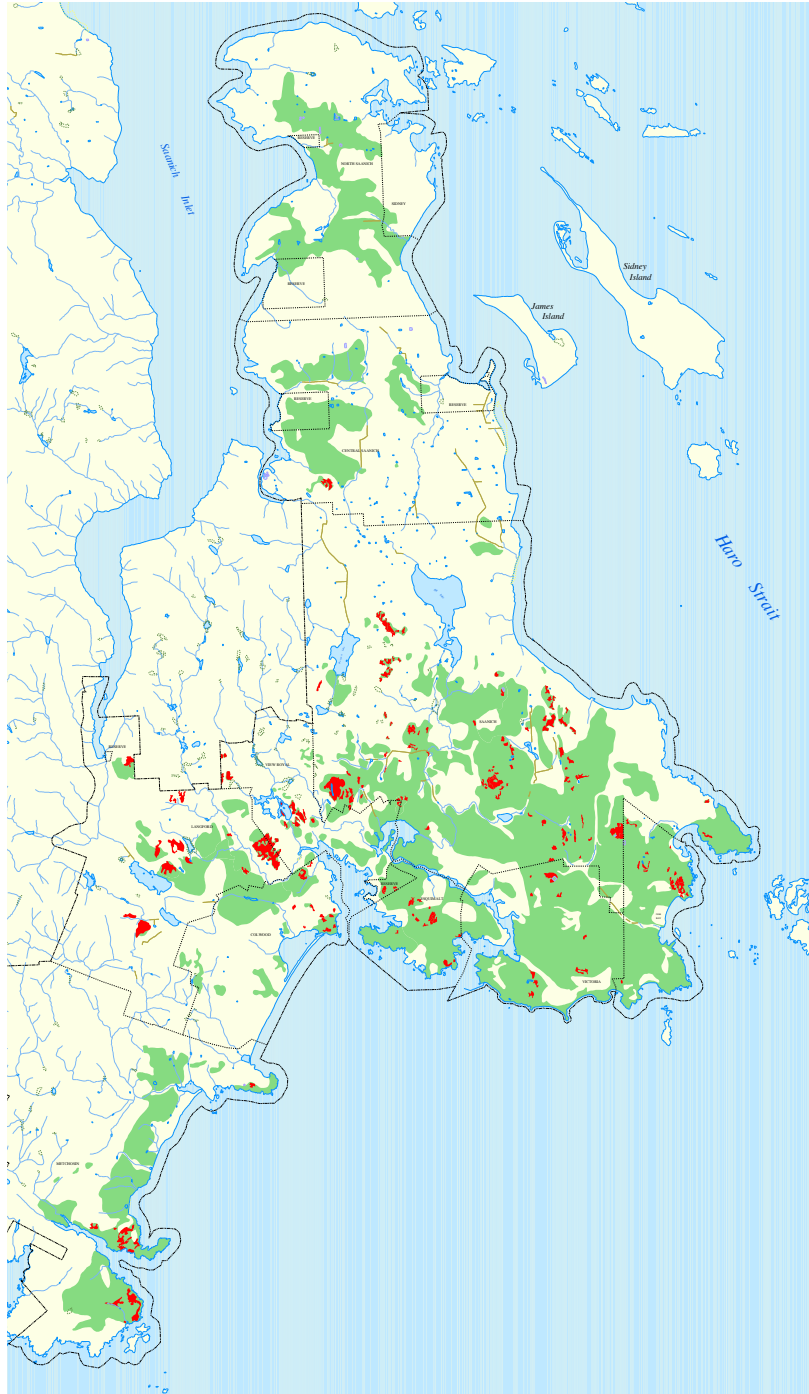


Figure 1.7 Historical extent (1800) (shown in green) compared to current distribution (shown in red) of Garry oak ecosystems in greater Victoria and on the Saanich Peninsula, British Columbia (GOERT 2012).

1.3 Ethnoecological Context

Central Coast Salish cultivation and use of camas likely evolved over thousands of years, with an intensive “camas culture” starting to take shape approximately 2000 years ago (Beckwith 2004). Dr. Brenda Beckwith first developed this concept of a “camas culture” (2004, pp. 208-210, 213) and defines the Central Coast Salish “camas culture” as,

a root production system, with multi-scale cultivation activities and an adaptive economic framework that includes social patterns of inherited resource tenure and decision-making mechanisms, intensive horticultural practices, and regular fire use to ensure a predictable and abundant supply of camas bulbs for food.

These next sections describe this Central Coast Salish camas culture.

1.3.1 Camas Bulbs as a Traditional Food Resource

Camas bulbs played an important role in the cultures of Indigenous Peoples throughout their range in western North America (Anderson and Rowney 1998; Beckwith 2004; Gunther 1973; Thoms 1989; Turner and Kuhnlein 1983). They were a staple food and a major trade item for the Central Coast Salish Peoples of Vancouver Island (Beckwith 2004; Turner and Hebda 2012; Turner and Kuhnlein 1983). As Beckwith (2004, p. 85) stated, “the role of camas bulbs in Straits Salish cultures could be considered as significant as that of cedar or salmon”. Bulbs were typically dug in the late spring when the flowers were fading but the stalks were still present, to avoid the toxic death camas⁷ (*Zigadenus venenosus*) (Beckwith 2004; Brown 1868; Turner and Hebda 2012;

⁷ **Warning:** Death camas (*Zigadenus venenosus*) grows in the same habitat as both edible camas species, and has a very similar looking bulb. The entire plant (including the bulb) of death camas is highly toxic and potentially fatal. The flowers, cream-coloured with more compact heads, are quite different in appearance

Turner and Kuhnlein 1983). Camas bulbs growing in deeper soil were removed using wooden digging sticks, typically made from Pacific yew (*Taxus brevifolia*), oceanspray (*Holodiscus discolor*), or another hardwoods (Beckwith 2004; Turner and Hebda 2012; Turner and Kuhnlein 1983). In shallow soil sites the sod was lifted out systematically in small sections, the bulbs were removed, and the sod was replaced (Turner and Hebda 2012; Turner and Kuhnlein 1983). Camas harvesting was done primarily by women, with the support of their children, and often lasted for several days to weeks (Beckwith 2004; Turner and Kuhnlein 1983). Bulbs were cooked soon after harvesting (to avoid spoilage), dried and stored, and gifted or traded with neighbouring First Nations groups (Beckwith 2004; Gunther 1973; Turner and Kuhnlein 1983). Dried camas bulbs were a common food at large feasts, dances, and potlatches (Beckwith 2004; Turner and Kuhnlein 1983).

Camas bulbs provided a consistent and much needed source of carbohydrates, as well as essential vitamins and minerals in a diet rich in seafood and other high protein foods (Turner and Hebda 2012; Turner and Kuhnlein 1983). Because the majority of its long-chain carbohydrates are in the form of inulin, which is not digestible nor very palatable for humans in its raw form, prolonged cooking is necessary (Konlande and Robson 1971; Turner and Kuhnlein 1983). Bulbs were traditionally cooked for 24-48 hours (depending on the cultural group) in large pit-ovens using heated rocks, water and vegetation (Suttles 2005; Turner and Bell 1971; Turner and Kuhnlein 1983). This extended steaming time—along with certain volatile organic compounds released when the layering vegetation is heated—ensured the complete hydrolysis of inulin into digestible fructans and fructose (Crawford 2007; Konlande and Robson 1971; Turner

than camas. Anyone harvesting edible camas (*Camassia* spp.) should be extremely careful not to confuse them with death camas (Pojar and MacKinnon 1994; Turner and Szczawinski 1991).

2005; Turner and Kuhnlein 1983).

The basic pit-cooking method used today involves digging a circular pit in the earth approximately 1.0-1.5 metres across by 0.75-1.0 metre deep, making a hot fire in the pit, and adding rocks (most often cobbles) to the fire (Suttles 1951; Turner *et al.* 1983; Turner and Hebda 2012). When the rocks are glowing red, the coals and unburned wood are removed, and a layer of moistened vegetation is added. This vegetation might include branches of salal (*Gautheria shallon*), leaves of skunk cabbage (*Lysichiton americanus*), fronds of sword fern (*Polystichum munitum*), the vines of trailing blackberry (*Rubus ursinus*), boughs of grand fir (*Abies grandis*), and seaweed (such as bull kelp fronds) or various kinds of grasses (Suttles 1951; Turner *et al.* 1983; Turner and Hebda 2012; Turner and Kuhnlein 1983). Camas bulbs can either be laid directly on top of the vegetation or placed within woven bags and then covered with another layer of moistened vegetation. Before the food and vegetation are added to the pit, a long pole is placed vertically in the centre. Just before closing the pit this pole is removed to create a passage for water, which, when poured into the hole, directly hits the hot rocks at the bottom, creating large quantities of steam. Woven bags or a large mat is quickly placed over the steaming vegetation and the pit is covered with soil or sand until no steam is escaping. Sometimes another fire is built on top to maintain the heat within the pit (Turner and Hebda 2012; Turner and Kuhnlein 1983).

Great quantities of camas likely were harvested each year to sustain consumption and trade amongst First Nations (Beckwith 2004). According to Margaret Babcock (1967 [unpublished study], in Turner and Kuhnlein 1983, p. 211) “A Saanich man stated that each year his family used to collect four or five (23 kg) potato-sacks full of bulbs at a single

harvest”. Dr. Beckwith (2004, p. 200) calculated that a family on lower Vancouver Island might have consumed 260 kg of camas bulbs each year. This could mean that anywhere from 8,000-10,000 bulbs were harvested, consumed and traded by one family each year (Beckwith 2004). With such a large volume of bulbs being harvested, careful management of the camas habitat was essential to ensuring the sustainability of future harvests (Beckwith 2004; Deur and Turner 2005).

1.3.2 Traditional Management of Garry Oak Ecosystems and Camas Gardens

Prior to European colonization of Vancouver Island, Indigenous peoples, especially the Straits Salish, *Hul’qumi’num*, and Comox, participated routinely in the maintenance of Garry oak ecosystems and the cultivation of camas populations (Beckwith 2004; Deur and Turner 2005; Turner and Kuhnlein 1983). This management was part of a tending and cultivation⁸ system that was carried out on multiple scales: population, community, and landscape, in order to maintain and enhance a specific resource (e.g. camas) in time and space (Beckwith 2004; Peacock and Turner 2000; Turner and Peacock 2005). Dr. Beckwith (2004, p. 170) provided a visual model that helps to explain the complexity of root management systems (Figure 1.8). Similar practices—including selective harvesting, weeding of resource sites, removal of large rocks and shrubs, and use of fire—existed for the harvest and management of camas and other root vegetables throughout North America (Anderson 2005; Beckwith 2004; Deur and Turner 2005; Peacock and Turner 2000; Turner and Peacock 2005).

⁸ “Plant tending...involves the minor modification of environments to encourage the growth of naturally occurring plants in situ, while plant cultivation involves a more intensive and extensive pattern of environmental modification. Cultivation...is now commonly associated with such activities as the seeding or transplanting of propagules,...the intentional fertilization or modification of soils, improvements of irrigation or drainage, and the clearing or “weeding” of competing plants” Deur and Turner (2005, p.15).

Population Level Camas Management

Population level management was characterized by direct interaction between the harvester and camas population at a specific harvest site. Management at this level required knowledge such as harvest timing, cultural guidelines, and cultivation

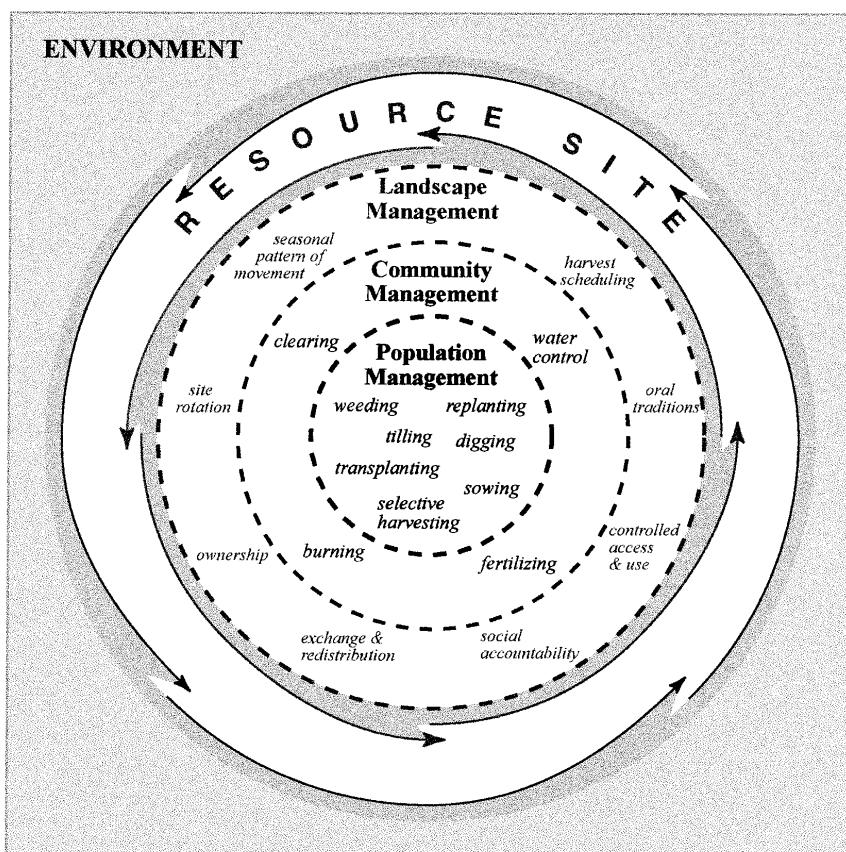


Figure 1.8 Cultural management model for root vegetables showing three integrated dimensions of resource management practiced by Indigenous peoples (Beckwith 2004, p. 170).

techniques. As mentioned above, camas bulbs were harvested commonly after they had finished flowering, (Beckwith 2004; Turner and Peacock 2005), although there are some accounts of harvesting during flowering (Suttles 2005). Large, mature camas bulbs were selectively harvested, and smaller, younger bulbs were replanted or left in the soil for future harvests (Beckwith 2004; Turner and Hebda 2012; Turner and Kuhnlein 1983).

The oldest, largest bulbs, which likely have a greater capacity for reproducing both sexually and asexually, probably were spared as well (Beckwith 2004; Suttles 2005). Unwanted plants (such as death camas and shrub seedlings) and rocks were removed (Beckwith 2004; Turner and Peacock 2005). During harvesting, camas seeds from ripe fruiting capsules would be intentionally or incidentally dispersed into the loosened soil (Beckwith 2004, Turner and Peacock 2005).

These activities (e.g., camas seed dispersal, and weeding of other species) likely enhanced the size, number, and accessibility of camas bulbs, and reduced intra- and interspecific competition (Beckwith 2004; Turner and Peacock 2005). Through harvesting and weeding, the soil conditions (e.g., porosity, aeration, and water-holding capacity) were also enhanced (Beckwith 2004; Turner and Peacock 2005). Sparing of smaller bulbs as well as transplanting of bulbs into new locations would have ensured the longevity of camas patches, and potentially expanded the range of camas (Peacock and Turner 2000; Turner and Peacock 2005).

Community Level Camas Management

Indigenous managers, primarily women, sustained the extensive patches of camas on southern Vancouver Island and the offshore islands by burning and clearing brush on a regular or periodic basis (Beckwith 2004; Deur and Turner 2005; Suttles 1951).

Harvesting sites possibly would have been burned every few years (*Luschiim* pers. comm. to Nancy Turner 2011), however the recurrence of fire may have varied greatly by site (Beckwith 2004). Central Coast Salish Peoples typically burned their camas patches after harvesting in the late summer or early fall (Beckwith 2004). Sometimes fires were set in the early spring, or even in the winter, when there was sufficient ground moisture and

cool temperatures to maintain a low intensity surface fire (Beckwith 2004; Beckwith pers. comm. 2012; *Luschiim* pers. comm. to Nancy Turner 2011).

The primary reason for burning was most likely the maintenance of the open structure of Garry oak ecosystems to promote favoured resources (Beckwith 2004; Boyd 1999; Weiser and Lepofsky 2009). As mentioned in Section 1.2.2, without a large-scale disturbance like fire, species such as Douglas-fir and snowberry readily encroaches into deep soil habitat in the Coastal Douglas-fir zone (Beckwith 2004; Boyd 1999; Deur and Turner 2005; Erickson 2008; Turner *et al.* 2003). Central Coast Salish Peoples used fire to maintain an early successional habitat in some areas and allowed later successional habitat to persist in other areas (Turner *et al.* 2003; Weiser and Lepofsky 2009). As Turner *et al.* (2003, p.451) explain:

The tending of the successional habitat mosaic provided the best possible conditions, not only for camas, but also for other root vegetable species, for wild strawberries (*Fragaria* spp.) and other berries, and for deer and other game at the edges of the woodlands, thus increasing the diversity of resources available in a limited geographic space.

In addition to maintaining an open ecological structure, burning likely enhanced the availability, productivity, and yields of camas by reducing inter and intra-species competition, and aiding seed germination through the creation of bare micro soil (Beckwith 2004; Suttles 2005). Moreover, burning likely increased available soil nutrients for the growing camas plants (Beckwith 2004). Other culturally important plant species that probably benefitted from camas cultivation practices include chocolate lily, Hooker's onion (*Allium acuminatum*), fools onion (*Brodiaea hyacinthina*), bracken fern (*Pteridium aquilillum*), tiger lily (*Lilium columbianum*), wild caraway (*Perideridia gairdneri*), wild strawberries (*Fragaria virginiana*), trailing blackberry (*Rubus ursinus*), and blackcap raspberry

(*Rubus leucodermis*) (Turner and Peacock 2005).

Landscape Level Camas Management

Successful long-term management of camas as an abundant food resource was possible within a cultural context governed by planned seasonal rounds, the rotation of harvesting sites, and a land ownership and stewardship system that encouraged sustainable management and social reciprocity (Beckwith 2004; Turner and Atleo 1998; Turner and Peacock 2005; Turner *et al.* 2005). Central Coast Salish plant harvesting and management strategies were guided by spiritual and moral ideologies, and ceremonies that reinforced respectful relationships between humans and their environment (Turner and Peacock 2005).

The time to begin gathering a particular resource was determined by the chief, and often was celebrated with first foods ceremonies signalling the start of the harvest for the community (Turner and Peacock 2005). As groups or families frequented their harvest sites, they harvested, fished, and hunted a range of cultural resources, including seaweeds, barks, berries, shoots, roots, seafood, birds and mammals, and undertook various management practices (Peacock and Turner 2000; Turner and Peacock 2005). Camas ecosystems were only one stop along the diverse seasonal harvesting round, making overharvesting of this resource less likely since the camas beds would get a break during part of the year (Beckwith 2004; Turner and Peacock 2005). As explained by Beckwith (2004, p. 176): “In all likelihood, the seasonal round was developed as a purposeful strategy to reduce or control over-harvesting and limit the effects of repetitive and intensive human activities in resource locales”. Another mechanism limiting the overharvesting of camas was the rotation of harvesting sites (Beckwith 2004; Turner and

Peacock 2005). Rotation allowed for some camas populations to lie fallow and regenerate for future harvesting while other sites were being utilized (Beckwith 2004).

Productive camas sites were owned by individuals or families and rights to harvest were passed down through familial lines (Turner *et al.* 2005; Turner and Hebda 2012). If other people wanted to harvest camas at those sites they would need to ask permission (Suttles 2005; Turner *et al.* 2005). Ownership of a camas bed implied a responsibility to steward the plant population for ongoing production and to share the harvest with the community (Beckwith 2004; Turner and Peacock 2005). Ownership and rights to use camas sites were acknowledged at feasts, potlatches, and other ceremonial occasions (Beckwith 2004; Turner and Peacock 2005).

Respectful and sustainable management of a resource site (reflected in the sharing of harvests back to the community) ensured continued ownership, and conservation of the camas populations (Beckwith 2004). To honour the resources, harvesters often would offer words of praise and deep respect to the plants they were harvesting (Turner and Peacock 2005). Reverent acknowledgement of the resources they depended upon, along with careful management and cultural restraints allowed Central Coast Salish Peoples a reliable and predictable abundance of camas over time (Beckwith 2004; Peacock and Turner 2000; Turner and Peacock 2005).

1.4 Colonization of Vancouver Island

Within decades after the European colonization of southern Vancouver Island in 1843, much of the land that was carefully tended by First Peoples became settled, and the production and use of camas, and many other traditional foods, was significantly reduced

(Beckwith 2004). The principal causes for this decline in traditional foods use included: a European self-perception of cultural superiority, new diseases, introduced foods, economic changes, land appropriation, ecological degradation, and cultural repression (Beckwith 2004; Lutz 2008; Turner and Turner 2008). In this next section, I discuss the circumstances that contributed to a decline in the Central Coastal Salish camas culture.

1.4.1 Overlooking the Camas Gardens

When Europeans arrived in northwestern North America, the Central Coast Salish camas culture was probably thriving (Beckwith 2004). As Beckwith (2004, p. 204) explains: “By the beginning of the nineteenth century, camas bulbs were likely the salmon of the vegetable world: a staple food associated with complex management activities and social systems of production, preservation, exchange, and redistribution”. European colonists, however, did not understand or acknowledge the existence of Indigenous cultivation practices and land management systems (Deur and Turner 2005). There was a general misconception among some anthropologists that First Peoples in North America were “hunter-gatherers” and were not actively managing or cultivating their resources (Anderson 2005; Deur 1999; Deur and Turner 2005). These anthropologists assumed that Central Coast Salish Peoples were effortlessly subsisting primarily off an abundance of seafood and berries (Deur 1999). Somehow most early explorers and ethnographers managed to overlook the camas gardens, along with the many other systems of food cultivation of coastal First Peoples (Beckwith 2004; Deur and Turner 2005; Suttles 2005). The Europeans likely used this perceived lack of land management to justify the appropriation of the Central Coast Salish lands for the “higher goal” of agricultural production (Deur and Turner 2005; Turner 2005).

1.4.2 Disease, Potatoes, and a New Economy

Perhaps the greatest initial negative effect on camas cultivation practices was the devastating disease epidemics introduced by traders and explorers, and spread through Indigenous trade routes, prior to and during the early colonial period (mid 1700s through mid 1800s) (Beckwith 2004; Lutz 2008). When the Hudson's Bay Company established Fort Victoria on Vancouver Island in 1843 in the territory of the *Lekwungen* Peoples, disease, along with the introduction of firearms and alcohol, already had reduced greatly both the size (perhaps half of pre-contact) and health of the Central Coast Salish population (Beckwith 2004; Duff 1969; Lutz 2008).

In the midst of this difficult period, the introduction of foods that were more easily grown or purchased, prepared, and traded (including potatoes, wheat, rice and sugar) likely were a welcome addition to the Indigenous diet (Beckwith 2004; *Luschium* pers. comm. to Turner 2011; Suttles 1951). The field potato (*Solanum tuberosum*), which was likely brought to Vancouver Island after the establishment of Fort Langley in 1827, was adopted by Central Coast Salish Peoples and cultivated for food and trade with the Europeans (Beckwith 2004; Suttles 1951). Potatoes became a major carbohydrate in many Indigenous communities by the mid to late 1800s, though camas was still sought out and harvested (Beckwith 2004; Suttles 1951; Turner and Hebda 2012).

In addition to growing potatoes for trade, the Central Coast Salish took an active role in the developing economy (Beckwith 2004; Lutz 1992, 2008; Suttles 1951). Indigenous people were given employment building settlers' homes, labouring on farms, and fishing, hunting, and logging for settlers (Lutz 1995, 2004; Turner and Turner 2008). While offering new opportunities to profit from the emerging economy, these jobs took

Indigenous people away from their traditional food harvesting cycle (Turner and Turner 2008). This meant that there was less time overall to manage, harvest, and prepare plant resources like camas (Turner and Hebda 2012; Turner and Turner 2008).

1.4.3 Fort Victoria Treaties and European Settlement

Between 1850 and 1854 James Douglas (Chief Factor of the Hudson's Bay Company), acting on behalf of the British Crown, made a series of fourteen land purchases from First Nations of Vancouver Island (MARR 2012). The Fort Victoria Treaties, also commonly known as the Douglas Treaties, transferred ownership of approximately 570 square kilometres of land around Victoria, Saanich, Sooke, Nanaimo and Fort Rupert (near Port Hardy) to the Crown in exchange for blankets (Duff 1969; Lutz 2008; MARR 2012). All fourteen treaties are worded similarly, as follows (MARR 2012):

Know all men, we, the chiefs and people...who have signed our names and made our marks to this deed..., do consent to surrender, entirely and forever, to James Douglas, the agent of the Hudson's Bay Company in Vancouver Island, that is to say, for the Governor, Deputy Governor, and Committee of the same, the whole of the lands...

The condition of or understanding of this sale is this, that our village sites and enclosed fields are to be kept for our own use, for the use of our children, and for those who may follow after us; and the land shall be properly surveyed, hereafter. It is understood, however, that the land itself, with these small exceptions, becomes the entire property of the white people forever; it is also understood that we are at liberty to hunt over the unoccupied lands, and to carry on our fisheries as formerly.

These treaties established a legal precedent for the British take-over of the lands on southern Vancouver Island formerly owned by the *Lekwungen* (Songhees and Esquimalt), *Scia'new* (Beecher Bay), *T'Sou-ke* (Sooke), *Tsawout*, *Tsartlip*, *Pauquachin*, *Tseycum*, *Snaw-naw-AS* (Nanoose), *Snuneymuxw*, and *Kwakwaka'wakw* (Southern Kwakiutl), with the exception of

village sites and enclosed fields' (Duff 1969; MARR 2012). However, it is doubtful that the exact terms of these treaties were made clear to the First Nations signatories and likely that they were signed under a great deal of pressure (Duff 1969).

With treaties in place, the Fort Victoria colony was secured for European settlement (British Columbia Government 1875). The areas with deep rich soil (associated with huge Garry oak trees) tended to become prime sites for British and Euro-Canadian settlers' agricultural fields and homesteads (Beckwith 2004; Lutz 2008; Turner and Turner 2008). This meant that the First Peoples of southern Vancouver Island became quickly excluded from some of their best camas harvesting sites, including *Meegan*, an important camas harvesting savannah in the *Lekwungen* territory, which became part of Beacon Hill Park near downtown Victoria, BC, in the 1850s (Cheryl Bryce pers. comm. 2011; Duff 1969; Lutz 2008).

1.4.4 Destruction of Camas Habitat

Along with the changes in land ownership came a shift in approach to resource management, causing the inevitable degradation of Garry oak ecosystems and associated camas habitat (Beckwith 2004; Lutz 1995). This shift involved conversion of both open and forest ecosystems to agricultural fields, introduction of domesticated livestock and agricultural crops, mining, and industrial scale logging and fishing, and eventually the suppression of Indigenous burning practices (Beckwith 2004; Boyd 1999; Lutz 1995). Many of these practices led to habitat destruction through the over-exploitation of resources and intentional removal of native species (Boyd 1999).

Farmers systematically cleared away native vegetation to make room for their

introduced crops, removing camas like a weed (Beckwith 2004; Boyd 1999). Many invasive species, including gorse (*Ulex europaeus*), scotch broom (*Cytisus scoparius*), and European grasses, were introduced likely both intentionally and unintentionally, and their naturalization in this region has had lasting ecological impacts (Beckwith 2004). As British colonists established cattle, pig, and sheep pastures, the animals (especially the pigs) rooted up and feasted on the camas bulbs (Beckwith 2004; Lutz 1995). The settlers' activities contributed to substantial changes in the soil structure, patterns of hydrology, composition of vegetation in Garry oak and other ecosystems, and destruction of camas populations across the landscape (Beckwith 2004).

1.4.5 Cultural Repression

Starting in 1871, the Indigenous people of British Columbia were subject to the Indian Act (Duff 1997). The goal of this federal legislation was to directly repress Indigenous cultural practices by making traditional feasts and ceremonies, like the potlatch, illegal (Duff 1997). Because the knowledge involved with cultivating and preparing traditional foods was shared during these cultural events, countless opportunities to pass on this knowledge were lost during these years (Turner and Turner 2008).

Beginning in the 1880s, and continuing until the mid-1980s, First Nations children were taken from their families and placed in residential schools⁹ (Duff 1997). These schools were set up by the Canadian Government and were run by churches of various denominations (Duff 1997). In residential schools Indigenous youth were

⁹ In addition to this severing of culture, there is a dark history of physical, sexual and emotional abuse for many First Nations, Métis, and Inuit children who attended these schools. This abuse left countless Indigenous people feeling traumatized, isolated, angry, and shamed—leading many down a path of depression, alcohol and substance abuse, cycles of violence and identity confusion (Nagy and Sehdev 2012).

systematically forced to abandon their traditional languages, religions, and cultural practices, including knowledge of native plant use and management (Duff 1997; Nagy and Sehdev 2012; Turner and Turner 2008). They were often prevented from visiting their families for long time periods, resulting in a strained connection to traditional territories and lost intergenerational learning opportunities (Duff 1997).

1.4.6 Socio-Cultural Impacts

European colonial progress—bringing with it disease, introduced foods, economic changes, land appropriation, habitat loss, ecological degradation, and cultural repression—drastically affected the way of life for the Central Coast Salish peoples (Duff 1997; Turner and Turner 2008). Adapting to the pressures of colonization meant trying to squeeze cultural traditions, like camas harvesting and management, into smaller spaces and times or leaving these traditions behind (Beckwith 2004; Turner and Turner 2008). By the 1960s, only a few Indigenous people were harvesting and cooking camas (Turner and Turner 2008). As Turner and Turner (2007, p. 60) explain,

Those peoples who relied on camas as a staple over probably thousands of years were now — for a whole range of reasons — relegated to using it, first only as an occasional ceremonial food, and finally, not at all, until for the most part, in just a few generations, it drifted out of people’s collective memories altogether.

With a loss of camas, and other nutritious foods in the diet, Central Coast Salish Peoples (like other First Peoples across Canada) experienced a substantial shift in diet (Damman *et al.* 2008). Sometimes termed the ‘nutrition transition,’ First Peoples essentially went from eating foods that are low in fat and high in protein, oils, vitamins and minerals to a diet high in sugars, saturated fats, carbohydrates, and processed foods and drinks in less than two centuries (Damman *et al.* 2008; Kuhnlein *et al.* 2009). While

the shift in diet to more processed foods has affected people globally, the negative effects have been experienced to a greater degree in Indigenous communities as is evidenced in a documented rise of diabetes, obesity, heart disease, and other chronic illnesses that is disproportionately higher for Indigenous populations (Damman *et al.* 2008; Kuhnlein *et al.* 2009). These diseases, which were virtually non-existent in First Nations communities prior to colonization, are now quite common (Kuhnlein *et al.* 2009; Waldram *et al.* 2007).

Beyond losing access to and familiarity with nutritious native food plants, the policies and systems of colonization (and more recently the industrial food system) have had a range of significant socio-cultural impacts on First Nations communities (Turner and Turner 2007, 2008; Turner *et al.* 2008). Transmission of culture and language, cultural integrity, food sovereignty¹⁰, and food security¹¹ of Central Coast Salish peoples have all been seriously affected (Damman *et al.* 2008; Turner and Turner 2008). Other outcomes, termed ‘invisible losses’ by Turner *et al.* (2008), include loss of identity, loss of self-determination, loss of lifestyle, and emotional and psychological distress. These impacts are harder to quantify, though they are important to acknowledge and understand especially when working towards equitable cross-cultural solutions for sharing space and resources (Turner and Turner 2007, 2008; Turner *et al.* 2008).

1.5 Reinstating Traditional Foods for Health and Cultural Revitalization

As part of a larger effort to regain personal, spiritual, and cultural health, strength, and sovereignty, Indigenous Peoples worldwide are working to restore their traditional

¹⁰ Food sovereignty is defined as the right of people to choose healthy and culturally appropriate food produced through ecologically sound and sustainable methods (Whitman 2009).

¹¹ Food security exists when all people, at all times have physical and economic access to safe and nutritious food, which meets dietary needs and food preferences, in sufficient quantity to sustain an active and healthy lifestyle (FAO 1996).

food systems¹² (Corntassel and Bryce 2012; Jacknis 2006; Krohn and Segrest 2010; Nabhan 2002, 2006; Turner and Turner 2007; VICCIFN 2012). Many Indigenous peoples, nutritionists, and researchers alike believe that a return to a more traditional diet would help to reverse the nutrition transition's negative effects on First Nations (Damman and Kuhnlein 2008; Kuhnlein *et al.* 2009). Studies of traditional diets in North America and worldwide have demonstrated that many native foods contain higher nutritional levels, and less saturated fat, sodium and carbohydrates (especially sucrose) when compared with market foods (Chan *et al.* 2011; Kuhnlein 2004). Even in cases where low levels of environmental contaminants might be present in traditional foods most studies show that the health benefits of eating these foods outweigh the risks (Chan *et al.* 2011).

While efforts to recover Indigenous food systems are often motivated by health concerns and the potential benefits of native foods, they are also a means of combating the many other 'invisible losses' stemming from colonization (Corntassel and Bryce 2012; Turner and Turner 2007; Turner *et al.* 2008). For many Indigenous people, regaining the roles of resource manager, food producer, processor, distributor, and teacher are all essential elements of re-establishing traditional food systems (Corntassel and Bryce 2012; Turner *et al.* 2008; Whitman 2009).

1.5.1 Restoring Indigenous Food Systems in the Pacific Northwest

There are many Indigenous people in the Pacific Northwest working with their communities, researchers, and nutritionists to restore the knowledge, use, and management of their traditional foods (Beckwith 2004; Bryce 2005; Corntassel and Bryce

¹² The Indigenous food movement is part of a larger food movement that includes issues like fair trade, organic farming, eating local foods, sustainable resource management, food sovereignty, and food security (Fair Trade International 2012; Nabhan 2002; Shiva 2000; Whitman 2009).

2012; Garibaldi 2003; Gomez 2012; Joseph 2012; Krohn and Segrest 2010; Lloyd 2011, Pukonen 2008; Senos *et al.* 2006; VICCIFN 2012). Their efforts involve a range of approaches including: political, educational, ecological, and celebratory events.

Regaining access to traditional sites where cultivation and harvesting of native foods can be practiced and taught to the next generation is one important aspect of this restoration (Corntassel and Bryce 2012; Turner and Turner 2007). This is occurring to some degree in British Columbia where treaty negotiations are determining native rights to own and manage their traditional lands and resources (Claxton vs. Saanichton 1989; Clayoquot Sound Scientific Panel 1995; Turner and Turner 2007; Vodden and Kennedy 2006). However access to resource sites is still an enormous barrier for many Indigenous groups.

Another important aspect of renewing food traditions involves habitat restoration (Senos *et al.* 2006; Turner and Turner 2008). Indigenous projects aimed at restoring and revitalizing traditional harvesting sites are emerging throughout the Pacific Northwest (Senos *et al.* 2006). Some examples from British Columbia include the Squamish Nation who has been working to re-establish a healthy northern riceroot (*Fritillaria camschatcensis*) population in their estuary (Joseph 2012). In a similar project, the late Secwepemc elder Dr. Mary Thomas, worked with then graduate student Ann Garibaldi to bring back wapato (*Sagittaria latifolia*) to the Salmon River Delta (Garibaldi 2003). Taking a broader approach, the Songhees Nation is combining conventional ecological approaches with traditional ecological knowledge to restore the Garry oak ecosystems, camas gardens, and apple orchards on the Chatham islands (*Tl'ches*) off Oak Bay in Victoria (Gomes 2012). Moreover, some communities are creating new native plant gardens associated with

school and community centres to support their cultural education efforts (Joseph 2012; Pukonen 2008; VICCIFN 2012).

Creating venues to share knowledge about traditional food cultures (e.g., stories, songs, harvesting protocol, and preparation) is another important aspect of reinstating food traditions (Turner and Turner 2008; VICCIFN 2012). Celebrating traditional foods through community events (e.g., feasts, ‘culture-camps,’ potlatches, pit-cooking, and traditional canoe journeys) is one approach that many Indigenous groups are engaged in (Krohn and Segrest 2010; Spirit 2012; Turner *et al.* 2007; Turner and Turner 2008; VICCIFN 2012). Other initiatives include articles in Indigenous newspapers, websites, list-serves, films, conferences, courses and college programs revolving around traditional foods renewal (Krohn and Segrest 2010; NWIC 2012; Spirit 2012; Thompson 2004; VICCIFN 2012). In addition to celebrating traditional foods, these venues help facilitate discussion around current issues relating to food security (i.e. environmental contamination) and create networks of support for moving forward (Turner and Turner 2007; VICCIFN 2012; VIHA 2012).

Challenges to Traditional Foods Renewal

Despite positive efforts, there are still many challenges limiting the renewal of traditional food systems (Fediuk and Thoms 2003; Turner and Turner 2008). Some of the largest barriers include lack of access to harvesting sites, ecological degradation of camas habitat, restrictions on land use, poverty, lack of ability to travel to harvesting sites, contaminated harvesting sites, scarcity of resources, privatization of land, time restrictions, and loss of traditional knowledge (Fediuk and Thoms 2003; Krohn and Segrest 2011; Turner and Turner 2008). All of these barriers are important to address for

the successful restoration of traditional food systems (Fediuk and Thoms 2003; Turner and Turner 2008).

1.5.2 Restoring Elements of Camas Culture

After almost completely disappearing from the lives of the Central Coast Salish Peoples, some Indigenous peoples are working to restore aspects of a camas culture and habitats on Vancouver Island and neighbouring areas (Bryce 2005; Corntassel and Bryce 2012; Higgs 2005; Krohn pers. comm. 2012; Turner and Turner 2008). Since consumption of camas bulbs only minimally increases blood sugar due to its content of inulin, substituting camas for other, less-complex, carbohydrates could be helpful in managing blood sugar-related illnesses (Kuhnlein and Turner 1991). More specifically, inulin is known to put less pressure on the pancreas to produce insulin, therefore consumption of foods containing inulin may help prevent diabetes (Kuhnlein and Turner 1991). Other motivations, such as regaining cultural pride, knowledge, and identity, might play an equal or even greater role in renewal of camas harvesting and cultivation traditions in Central Coast Salish communities (Bryce 2005; Krohn and Segrest 2010; Turner and Turner 2008). For example, some Indigenous people, like Cheryl Bryce, traditional resource manager of the Songhees (*Lekwungen*) Nation, see the reclamation of camas as an important step in the decolonization process (Corntassel and Bryce 2012; Turner and Turner 2007).

In 2000, Cheryl Bryce, together with then doctoral student Brenda Beckwith, organized the first community camas harvest and pit-cook in decades on Discovery Island (near Vancouver Island, BC) (Higgs 2005; Senos *et al.* 2006). In the subsequent year Brenda Beckwith, Cheryl Bryce, and volunteers burned the camas meadows and planted

seeds as an initial ethnoecological restoration effort (Beckwith 2004; Higgs 2005; Senos *et al.* 2006). Since this event Cheryl Bryce, and others in the community, have carried out camas harvests and pit-cook events throughout *Lekwungen* traditional territory, including on the University of Victoria and Camosun College campuses (Higgs 2005; Senos *et al.* 2006; Tudge 1996). These events have been portrayed as healing, community building, ceremonial, educational, and political, and they have certainly made people more aware of the traditional importance of camas (Beckwith 2004; Corntassel and Bryce 2012; Higgs 2005, Penn 2006; Senos *et al.* 2005; Tudge 1996).

Restoring Camas Habitat

Due to the reduced extent and wide-scale degradation of Garry oak ecosystems, camas harvesting (and likely the recovery of camas traditions) is limited (Beckwith 2004; Bryce pers. comm. 2011; Turner and Turner 2008). Sites where camas once flourished have been impacted greatly due to agriculture, industry, and residential development, and continue to be degraded or lost (Beckwith 2004; Krohn and Segrest 2011; Turner and Turner 2008). Other environmental factors, including fire suppression, the introduction of exotic species, and chemical or biological contamination have seriously altered the ecological structure, and in some cases the abundance, and safety of remaining camas populations (Beckwith 2004; Krohn and Segrest 2010; MacDougall *et al.* 2004; Turner and Turner 2008).

In an effort to restore the health and abundance of local camas populations, some members of the Indigenous community are carrying out ecological restoration of Garry oak ecosystems on Vancouver Island and surrounding islands (Higgs 2005; Lekwungen Food Systems 2012; Sea Change 2012). For example, ethnoecological restorationists JB

(John Bradley) Williams of the *Tsawout* First Nation, and Judith Arney organize ecological restoration days twice per month in *SNIDCEL* (or Tod Inlet on Saanich Inlet), where exotic plants are removed and native species, such as camas, are planted (Arney 2011). Cheryl Bryce also organizes ecological restoration events in different locations throughout her traditional territory, mainly focused on invasive plant removal and the restoration of the camas food system (Lekwungen Food Systems 2012). The hope is that future generations of *Lekwungen* Peoples will have places where they can manage and harvest camas and other culturally important species (Lekwungen Food Systems 2012).

Parks and Protected Areas with Camas Habitat

Largely due to habitat loss and decline of ecological integrity, concerned scientists, environmental advocates, and non-governmental organizations (NGOs) have placed large areas containing Garry oak ecosystems, a principal habitat for camas, under some form of environmental protection (Apostol and Sinclair 2006; GOERT 2012; NCC 2012). Most of the remaining extensive patches of camas on southern Vancouver Island are therefore now situated in local parks and protected areas, although some habitat still remains on offshore islands, such as *Tl'ches* (Discovery and Chatham islands), which include Songhees Reserve Lands (Senos *et al.* 2006).

Though the protection of Garry oak and associated ecosystems is important to prevent further ecological damage, the establishment of parks and protected areas regulated by western science and conservation policies tends to restrict Indigenous people's access to traditional lands for resource tending and gathering, and may be hindering the recovery of camas food traditions (Alcorn 1993; Anderson 1993; Beltrán 2000; Ruppert 2003). One might ask: given the history of cultural repression, colonial

land destruction, and the promises set forth through the Fort Victoria (or Douglas) Treaties are restrictions on traditional harvesting just (Alcorn 1993; Anderson 1993; Martinez 2003)? Should we be prioritizing ecological restoration over cultural restoration (Anderson 1993; Ruppert 2003)? Are we sure that these two goals are not compatible or complementary (Anderson 1993; Ruppert 2003)?

Although there is frequent mention of Straits Salish ecological and cultural camas restoration efforts in the literature (Beckwith 2004; Higgs 2003, 2005; Turner 2005a; Turner and Turner 2007), I could not find information about collaborative work between Central Coast Salish and non-Indigenous managers of protected areas to support the renewal of traditional camas harvesting and cultivation practices. Given the lack of abundance of camas on the landscape today, parks and protected areas might provide an important space for the restoration of camas traditions.

1.6 Environmental Protection and Ecological Restoration

1.6.1 Evolving Objectives for North American Parks and Protected Areas

A park or protected area, for the purposes of this study, is defined as an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, which is managed through legal or other effective means (IUCN 2012). The initial motivation for the establishment of protected areas in North America arose in the late 1800s from the recognition that the rapid and large-scale alteration of the landscape through intensive use of natural resources, expansion of industry, and urban development was effectively eliminating the presence of “wilderness” (Anderson 1993; Dearden and Rollins 2002; Fox 1981).

From the early days of the conservation movement, the purpose of setting up protected areas was split between two ideologies: regulation of management and use (utilitarianism) and protection of “wilderness” (or perceived wilderness) through the complete exclusion of humans, except as short-term visitors (preservation) (Fox 1981). The various types of protected area systems developed in Canada and the United States reflect this dichotomy. Some areas, such as Crown Lands and national forests, were established with the primary goal of government regulated resource management and extraction (Dearden and Rollins 2002; Fox 1981). Other areas, such as national, provincial, state, and city parks, were set up with the primary purpose of protecting nature and providing recreation opportunities, with human activities being limited to non-extractive activities like walking, biking, and bird-watching (Anderson 1996; Fox 1981).

Some of the original values associated with protecting wilderness included aesthetics or beauty, tourism, recreation, adventure, and wildlife viewing (Dearden and Rollins 2002; IUCN 2012). As the amount of undeveloped land has continued to shrink and our understanding of ecology has grown over the past century, the purposes and methods for creating and maintaining protected areas and parks have shifted (Dearden and Rollins 2002). For example, in Canada there has been a growing interest in establishing and maintaining protected areas that represent a diversity of historic landscapes (Dearden and Rollins 2002). Other goals for protected areas that have grown in the past few decades include education, natural interpretation, and scientific research (Dearden and Rollins 2002; IUCN 2012). The growing centrality of themes such as ecological services, biological diversity, and ecological diversity is reflected in the changing

management plans for parks and protected areas (Dearden and Rollins 2002). Most recently restoring and maintaining the ecological integrity¹³ of representative ecosystems takes priority in many protected areas (Dearden and Rollins 2002; Fox 1981; IUCN 2012).

1.6.2 Protected Areas and Indigenous Peoples

In the past few decades the relationship between the authorities establishing and regulating protected areas in Canada and the United States and the peoples native to those areas has changed substantially (Beltrán 2000; Peepre and Dearden 2002; Ruppert 2003). Historically, protected areas were, for the most part, established and managed without the consent or input of the Indigenous Peoples who previously inhabited and used those lands (Beltrán 2000; Peepre and Dearden 2002). This situation is gradually changing following several important Indigenous rights legal rulings, and amendments to Canada's constitution, which have empowered First Nations communities both politically and socially (Beltrán 2000; MARR 2012; Peepre and Dearden 2002).

In the 1973 Calder Case the Supreme Court of Canada recognized that Aboriginal title existed at the time of colonization for the *Nisga'a* Nation of British Columbia and all recognized First Nations of Canada (MARR 2012). Following this judgement the federal government was willing to negotiate comprehensive land-claim settlements in multiple provinces (MARR 2012). These land-claim settlements, thus far, have stressed Aboriginal rights with regards to protected areas (Peepre and Dearden 2002). In 1990, the Sparrow Case, which up-held the Aboriginal right to fish for the

¹³ "Ecological integrity" is a term used to describe the characteristics of ecosystems that are typical in a certain region, and are self-sustaining and self-regulating. For example, they have complete food webs, a full complement of native species that can maintain their populations, and naturally functioning ecological processes (energy flow, nutrient and water cycles, etc) (Parks Canada 2012).

Musqueam in British Columbia, also directed the government to include Aboriginal people in the co-operative management of natural resources (Peepre and Dearden 2002). As Peepre and Dearden (2002, p. 328) explain: “With respect to parks, it is clear that the [Sparrow Case] ruling reinforced Aboriginal beliefs that they deserve special recognition with respect to management when their traditional territories coincide with park lands”.

Following these legal amendments and rulings in the 1970s, 80s, and 90s, the consultation of Indigenous peoples during the formation and subsequent management of protected areas has become more common (Beltrán 2000; Peepre and Dearden 2002). Out of these consultations emerged a number of co-management projects involving protected area authorities and groups of Indigenous peoples, primarily in Northern Canada (Beltrán 2000; Peepre and Dearden 2002; Ruppert 2003). Tatshenshini-Alsek River National Park and Gwaii Haanas National Park Reserve are two examples of co-management in northern BC (Parks Canada 2013).

Parks Canada and the National Parks Act both put forth a set of guiding principles regarding Indigenous peoples, including provisions for the continuation of renewable resource harvesting activities and explanations about the nature and extent of Aboriginal peoples’ involvement in park planning and management (Parks Canada 2013; Peepre and Dearden 2002). How these principles and policies are interpreted is still evolving and depends largely upon the park planners and managers involved (Peepre and Dearden 2002). Consequently, significant disparities exist in the degree of collaboration between various First Nations groups and protected areas organizations (Peepre and Dearden 2002).

The conservation community increasingly recognizes the involvement of local

Indigenous peoples in both the planning and management of protected areas is essential to ensuring the long-term sustainability of those projects (Alcorn 1993; Beltrán 2000; Peepre and Dearden 2002; Ruppert 2003; Underwood 2003). Indigenous people, in some cases, continue to harvest culturally important resources despite the formation of protected areas (Beltrán 2000; Peepre and Dearden 2002; Ruppert 2003). Protected area officials who acknowledge the desire, intention, and rights of Indigenous people to harvest resources may promote more transparency, communication, and ecological monitoring of harvested areas (Peepre and Dearden 2002; Ruppert 2003). Increased communication and partnership between Indigenous peoples and park officials can lead to better ecological protection and management, as well as improved relations (Alcorn 1993; Peepre and Dearden 2002; Ruppert 2003; Underwood 2003).

In 2006, a new kind of protected area designation inclusive of First Peoples interests, termed “Conservancies,” was established within the BC Parks System (BC Parks 2013; Turner and Bitonti 2011). One significant difference between Conservancies and other protected areas designations is that First Nations work in conjunction with the Province to select the locations that they feel could benefit from protection (Turner and Bitonti 2011). The Conservancy designation was created “expressly to recognize the importance of some natural areas to First Nations for food, social, and ceremonial purposes” (BC Parks 2013). This designation has been widely utilized since its inception, with 156 Conservancies, covering 2,942,705 hectares, being established in BC since March 2013 (BC Parks 2013). Conservancies restrict commercial logging, mining, and large-scale hydroelectric projects and allow local First Nations, and others, to apply for permits for low-impact economic development activities (e.g., fishing, ecotourism, and

small-scale hydro projects for local use) (Turner and Bitonti 2011). In this way Conservancies offer a new tool to protect ecologically important areas, support the creation of local jobs, and include the local Indigenous peoples in conservation and management activities (Turner and Bitonti 2011).

Even with new tools, there still are many challenges to the involvement of Indigenous peoples in protected areas management (Beltrán 2000). For example, some conservationists believe that native land use and resource management practices are not sustainable today and have put pressure on government to prevent the harvesting of culturally important plants within protected areas and penalize those who do not comply with ecological regulations (Beltrán 2000; Martinez 2003). Additionally, due to past conflicts, some Indigenous peoples are deeply sceptical of the goals and motives of both government agencies and the conservation movement and, therefore, have little interest in partnerships with protected areas officials (Beltrán 2000). Despite these challenges, some partnerships are being built, particularly within the realm of ecological restoration.

1.6.3 Restoring Ecosystems with Traditional Knowledge

Over the past 15 years, the field of ecological restoration¹⁴ has expanded to include insights and methods from Traditional Ecological Knowledge (TEK) (Anderson and Barbour 2003; Garibaldi and Turner 2003; Higgs 2005; MacDougall *et al.* 2004; Martinez 2011; Senos *et al.* 2006; Turner *et al.* 2000; Wray and Anderson 2003). Fikret Berkes (2012, p. 7) defines TEK as:

¹⁴ As defined by the Society of Ecological Restoration (SER 2004): “Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed,” with respect to its ecological health, integrity, and sustainability, towards its historical trajectory.

A cumulative body of knowledge, practice, and beliefs, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with the environment.

TEK can contribute valuable information to ecological restoration practice regarding the pre-contact species and ecosystem conditions, ecological succession and disturbance dynamics, sustainable harvesting and resource conservation techniques, plant and animal population enhancement, and ecosystem management systems (Anderson and Barbour 2003; Senos *et al.* 2006; Turner *et al.* 2000; Weiser and Lepofsky 2009; Wray and Anderson 2003).

Building upon the concept of TEK, Catherine Fowler and Dana Lepofsky (2011) propose the term Traditional Resource and Environmental Management (TREM) to explore the ways which Indigenous Peoples tend, steward, and manage their environments. Fowler and Lepofsky (2011, p. 286) define TREM as, “the application of TEK to maintain and enhance the abundance, diversity, and/or availability of resources or ecosystems”. TREM involves resource management activities such as burning, tilling, pruning, weeding, transplanting, selective harvesting and replanting, and the use of enclosures to modify non-domesticated resources or ecosystems (Fowler and Lepofsky 2011). Since TREM systems often develop over many generations, they can offer valuable insights about the effectiveness of particular management strategies in a given location (Fowler and Lepofsky 2011). Some researchers are working with Indigenous Peoples and local knowledge holders to bring aspects of TREM into the current management of protected areas (Anderson 2005; Anderson and Barbour 2003; MacDougall *et al.* 2004; Weiser and Lepofsky 2009; Wray and Anderson 2003).

In their article, “Simulated Indigenous Management: A New Model for Ecological Restoration in National Parks,” M. Kat Anderson and Michael Barbour (2003) propose that simulated Indigenous management could be applied experimentally by managers in certain sections of protected areas. Their reasoning is two-fold:

- (1) Certain landscapes require restoration and ongoing management to resemble their historic state, and TREM systems provide important models to reach and maintain this state; and
- (2) Simulated TREM and ecological monitoring would lead to a greater understanding of the historical and current effects of this management.

In other words, the main purpose of this simulated management would be to increase the resource managers’ understanding of how traditional practices be applied towards restoring and maintaining ecological integrity (Anderson and Barbour 2003). The authors propose that other sites within protected areas could be *co-managed* with local Indigenous peoples with the specific purpose of restoring, maintaining, and enhancing culturally important resources (Anderson and Barbour 2003).

1.6.4 Ethnoecological Restoration

The emerging (e.g., two decade old) discipline of “ethnoecological restoration” combines approaches from the interdisciplinary field of ethnoecology¹⁵ with the science of restoration ecology to support the recovery of degraded ecological and cultural systems (Martinez 2011). Dennis Martinez (2011, p. 4) defines eco-cultural (a synonym to ethnoecological) restoration as,

The process of recovering as much as is recoverable of the key historic pre-contact ecosystem structure, composition, processes, and function, along with traditional, time-tested, ecologically appropriate and sustainable

¹⁵ Ethnoecology is an interdisciplinary field that studies the traditional ecological knowledge, and interactions between humans and the ecosystems they inhabit (Anderson *et al.* 2011).

Indigenous cultural practices that helped shape ecosystems, while simultaneously building-in resilience to future rapid climate disruptions and other environmental changes in order to maintain ecological integrity in a way that ensures the survival of both Indigenous ecosystems and cultures.

Central to this restoration approach are elements of community participation, cultural revitalization, revived connection to place, application of TREM, and social justice for Indigenous peoples (Fowler and Lepofsky 2011; Higgs 2003; Joseph 2012; Martinez 2011).

Ethnoecological restoration in northwestern North America incorporates a range of projects such as watershed restoration, fuel reduction/control as part of Indigenous fire management, wildlife monitoring and restoration, fisheries habitat restoration, and Indigenous foods restoration (Anderson 2009; Garibaldi 2003; Gomes 2012; Joseph 2012; Senos *et al.* 2005; Turner 2005; Weiser and Lepofsky 2009). These projects strive to recover pre-contact ecological conditions, while increasing the health and abundance of plants for social, cultural, and spiritual uses (Anderson and Barbour 2003; Senos *et al.* 2006).

There is currently a range of challenges to taking an ethnoecological approach to restoration (Senos *et al.* 2006). Since TREM theory is not taught in most resource management programs or published in natural science journals, restoration practitioners and managers are often unfamiliar with TREM (Senos *et al.* 2006). Furthermore TEK is still viewed incorrectly by some as anecdotal or folklore and is not usually considered to be equal to western-based science (Senos *et al.* 2006). Both the lack of familiarity with TREM and its place as a “folk” science make proposals containing TREM recommendations less likely to get approved or funded (Senos *et al.* 2006). For those who

do attempt to integrate TREM into their projects, honouring the spiritual aspects of TREM can be awkward (Senos *et al.* 2006).

It is important to understand that Indigenous peoples offering their TEK and expertise to ecological restoration projects expect reciprocal support for their cultural restoration efforts (Cortassel and Bryce 2012; Senos *et al.* 2006). As Senos *et al.* (2006, p. 393) explain: “Successful restoration...means not only the capacity of TEK-based restoration to enhance ecosystem functioning but also the ability to sustain Indigenous or local peoples’ economies and cultural practices”. Conducted respectfully, TEK-based ecological restoration offers the important opportunity to restore the presence and diversity of both dwindling habitats and cultures (Anderson and Barbour 2003; Fowler and Lepofsky 2011; Higgs 2005; Ruppert 2003; Senos *et al.* 2006; Turner *et al.* 2000).

1.7 Background for Camas Harvesting Experiment

The proposition of utilizing protected areas to support the renewal of Central Coast Salish camas cultivation practices brings up many questions about the ecological compatibility of camas harvesting with current conservation and restoration objectives for Garry oak and associated ecosystems. This section provides background on the current restoration and management strategies being implemented locally in Garry oak ecosystems, and information learned from studies on geophyte harvesting.

1.7.1 Restoration and Management of Garry Oak Ecosystems

Protecting, connecting, and restoring the remaining fragments of Garry oak ecosystems, throughout their range, are seen as important objectives for federal, provincial, regional, and municipal governments, First Nations, environmental NGOs,

scientists, and concerned citizens in the Pacific Northwest region (Apostol and Sinclair 2006; GOERT 2012; NCC 2012). One of the major objectives of Garry oak ecosystem restoration involves the re-establishment of ecological integrity. Ecological integrity has been defined by Canada's National Park Act (Parks Canada 2013) as:

A condition that is determined to be characteristic of its natural region and is likely to persist, including abiotic components and the composition and abundance of native species and biological communities, rates of change and supporting processes.

In terms of Garry oak ecosystems, having a large enough distribution and size of patches (now too small and fragmented), an absence of exotic species, and the persistence of natural disturbance through processes like fire (and potentially harvesting) are all critical to the restoration and conservation of ecological integrity. Here I provide a summary of the current challenges involved with the restoration of Garry oak ecosystems and the strategies being implemented.

Restoring Species Composition and Ecological Structure

Introduced plants of particular concern for Garry oak ecosystems are Scotch broom, English ivy (*Hedera helix*), Himalayan blackberry (*Rubus armeniacus*), and daphne laurel (*Daphne laureola*) (GOERT 2012; Shaben and Myers 2010). These plants require repeated treatments of hand pulling, root removal, mowing, and/or use of herbicides to eliminate them from a site (Apostol and Sinclair 2006; GOERT 2012; Ministry of the Environment 2012; Stanley *et al.* 2008). Especially challenging to eliminate are the exotic perennial grasses such as orchard grass (*Dactylis glomerata*) and sweet vernal grass (*Anthoxanthum odoratum*) that increase in abundance once invasive shrubs are removed (MacDougall and Turkington 2005). Some research shows that repeated fire or mixed treatments (e.g., mowing and fire, or grazing and fire) is effective in reducing exotic grass

cover, but so far no treatment (or paired treatment) appears to be completely successful in eradicating these species (Dunn 2002; Dunwiddie 2002; Stanley *et al.* 2008).

In addition to exotic plants, sometimes invasive native plants¹⁶ need to be thinned or removed to allow for other less represented native species to thrive (Sinclair *et al.* 2006). Some examples of these aggressive native species include snowberry, wild rose, and Douglas-fir. Current approaches to restoring and maintaining the open structure and biological diversity of the remaining Garry oak ecosystems involve practices such as hand removal plants and seasonal mowing of introduced and some mid- and late-successional native species (Apostol and Sinclair 2006; GOERT 20012; MacDougall and Turkington 2007; NCC 2012). There is growing interest in the use of fire as an ecological restoration tool to eliminate or reduce the abundance of exotic species and increase the diversity of native species (GOERT 2012; NCC 2012; Sinclair *et al.* 2006).

Once invasive exotic and native plants are under control, then absent or under-represented native species can be seeded in, planted, or introduced to the sites. This step can prove challenging for a couple of reasons. Sourcing native seeds or plants can be difficult since plant nurseries often focus on growing non-native horticultural garden plants (Apostol and Sinclair 2006; GOERT 2013). Therefore, ecological restoration practitioners typically need to collect seed and propagate plants for their projects. Finding local sites that allow native seed collection poses yet another challenge (Apostol and Sinclair 2006). Furthermore, when propagules are produced, establishing plants in sites with changed soil conditions or aggressive exotic plants and insects can result in low germination rates or reduced transplant success (Sinclair *et al.* 2006).

¹⁶ Invasive native plants are typically mid- and late-successional species that have the tendency to colonize open areas (Sinclair *et al.* 2006).

Managing and Maintaining Composition and Structure with TREM

After species composition is more or less restored, maintenance is needed to prevent further encroachment of the deep soil sites by invasive native plants (Gedalof *et al.* 2006; MacDougall and Turkington 2007; Sinclair *et al.* 2006). This management can be thought of as re-establishing or mimicking ecological and cultural processes, and could involve the incorporation of TREM (Anderson and Barbour 2003; Sinclair *et al.* 2006). Some common management techniques include manual weed control, mowing, and the introduction of conservation grazing¹⁷ (Sinclair *et al.* 2006). Experimentation with low intensity prescribed fire, mimicking the fires used by First Nations to maintain the Garry oak prairie and savannah ecosystems, is becoming more common in British Columbia (MacDougall 2005; MacDougall and Turkington 2005; NCC 2012; Sinclair *et al.* 2006) and neighbouring areas in the United States (Agee 1996; Apostol and Sinclair 2006; Storm and Shebitz 2006; Wray and Anderson 2003). However, there still are uncertainties regarding the ecological effect fire will have on a significantly altered landscape (e.g., will fire enhance conditions for exotic species?) (MacDougall 2005; Maret and Wilson 2005; Schuller 1997). Despite structural changes to Garry oak ecosystems, some studies show promise for fire as a restoration and management tool in prairie and savannah restoration (Agee 1996; MacDougall 2005; MacDougall and Turkington 2007; Tveten 1997). Aspects such as the timing and frequency of prescribed burning, as well as the combination of prescribed burning treatments with other restoration tools like mowing are all current areas of experimentation (MacDougall and Turkington 2007; Tveten 1997).

¹⁷ Conservation grazing is the use of semi-feral or domesticated grazing livestock to maintain and increase the biodiversity of natural or semi-natural grasslands, wood pasture, wetlands and many other habitats (Romo 2007).

The ecological role that Indigenous harvesting of “root vegetables”¹⁸ played historically, or might play today, relating to ecosystem composition and function, is a subject that has not been greatly explored (Anderson and Barbour 2003; Beckwith 2004; Sinclair *et al.* 2006). The soil disturbance caused by burrowing pocket gophers (*Thomomys* spp.) is believed to enhance conditions for native plant establishment in Garry oak savannahs in Washington State (Dunn and Ewing 1997; Sinclair *et al.* 2006). Did human harvesting of root vegetables have similar effects on ecological processes in Garry oak ecosystems? Could root vegetable harvesting disturbance play an important necessary in the restoration and maintenance of Garry of oak ecosystems today?

Human, or anthropogenic, disturbance¹⁹ such as root harvesting might appear to be incongruous with ecological restoration and conservation goals in protected areas. However, in ecosystems where some degree of human disturbance was historically present this localized soil disturbance might, in fact, be necessary to the survival of some plant species. As Anderson and Barbour (2003, p. 271) explain:

One consequence of species having evolved differential tolerances to, or requirements for, any particular disturbance is that biodiversity is high so long as the disturbance continues to occur. If the disturbance is removed or suppressed, then those species that require disturbance are disadvantaged by competition from other species normally excluded by the disturbance. As a result, disturbance-dependent species become less abundant and eventually drop out of the community.

In the next section, I review some ethnoecological studies that look at the effects of geophyte harvesting on their residual populations and surrounding plant community, and

¹⁸ “Root vegetables” are defined as underground perennial plant organs including roots, rhizomes, corms, and bulbs.

¹⁹ Disturbance, in this context, means a discrete event that changes the physical environment and, by doing so, changes the structure of some ecosystem, plant community, or population (White and Pickett 1985).

more specifically camas harvesting.

1.7.3 Geophytes and Harvesting Disturbance

Many Indigenous North American harvesting techniques have been documented to produce higher yields of native “root vegetables,” such as camas, wild onion (*Allium* spp.), blue dicks (*Dichelostemma capitatum*), Pacific silverweed (*Potentilla anserina* spp. *pacifica*), springbank clover (*Trifolium wormskioldii*), yellow glacier lily (*Erythronium grandiflorum*), spring beauty (*Claytonia lanceolata*), northern riceroot (*Fritillaria camschatcensis*), and prairie turnip (*Pediomelum esculentum*) (Anderson 1997, 2005; Beckwith 2004; Castle 2006; Deur 2005; Lloyd 2011; Loewen 1998; Mellott 2010; Turner and Peacock 2005). Geophytes possess reproductive mechanisms that make them resilient to disturbance (Anderson 1997). For example, many can reproduce by offsets or asexually (Anderson 1997; Beckwith 2004; Lowen *et al.* 2001), and seed production and seedling establishment of some species might be more prolific after harvesting disturbance (Castle 2006).

Traditional Indigenous harvesting of root vegetables creates a low-level disturbance that acts as a form of cultivation (Anderson and Rowney 1998; Beckwith 2004; Deur and Turner 2005). Such practices include tilling of the soil, weeding, replanting, sparing of a portion of the propagules, and seed scattering (i.e. sowing) onto freshly tilled soil (Anderson 1997; Turner and Peacock 2005). Moreover, the digging of edible underground parts thins the population, separates smaller individuals, and stimulates their growth, thus aerating the soil, reducing weed competition, and preparing the seedbed for increased seed germination rates (Anderson 1997; Beckwith 2004; Turner and Peacock 2005).

Two studies of geophyte harvesting demonstrate the sustainability of traditional resource management techniques. For part of her doctoral research in California, National Ethnobotanist of the United States Department of Agriculture's Natural Resources Conservation Service, Kat Anderson (1993) harvested blue dicks at varied harvest intensities (0%, 50%, 100%), and at different growth stages (flowering or seeding). She also replanted cormlets (e.g., smaller corms) in half of her harvest treatments. After carrying out these three treatments she measured the effects on the corm and cormlet production. There was no significant difference in corm or cormlet production between harvesting and replanting combinations, except the combination of 100 percent harvest and no cormlet replanting, which reduced but did not eliminate the population. This study confirms the ability of blue dick populations to sustain a high level of harvesting intensity.

For part of her doctoral studies, Assistant Professor in the Department of Biological Sciences at Southwestern Oklahoma State University, Lisa Castle (2006) researched the effects of harvesting prairie turnips and echinacea (*Echinacea angustifolia*) roots, at three different levels of intensity, on species composition and percent cover. Harvesting yielded an increase in forb species diversity and a decrease in grass cover dominance in conjunction with an increase in harvesting intensity (Castle 2006). Castle (2006) also harvested prairie turnip at different times during its growth cycle, with variation in post-harvest seed dispersal. Seedling recruitment was monitored. Harvesting when the seeds were ripe, followed by scattering or burying the seeds, led to a dramatic increase in seedling recruitment when compared to plots without disturbance or seed scattering. Castle (2006, p. 98) terms this form of resource compensation “harvest induced

compensatory recruitment,” in which the act of harvesting, rather than the removal of ‘con-competitors’, leads to an increase in seedling recruitment. Post-harvest prairie turnip seed dispersal demonstrates how understanding the details of traditional Indigenous management strategies can help sustain a wild plant population while still providing a resource.

1.7.3 Experimental Camas Harvesting and Management

To date there has only been one study that researched the effects of simulated traditional harvesting and management on camas. As part of her doctoral work, Senior Lab Instructor and Adjunct Professor in the School of Environmental Studies at the University of Victoria, Brenda Beckwith (2004) carried out an interdisciplinary ethnoecological study of camas on southern Vancouver Island. Beckwith’s research offered important information about camas growth and management, and points the direction for further research on camas.

One aspect of Beckwith’s (2004) doctoral research involved a five-year nursery study of camas. She planted 270 salvaged camas bulbs into cold frames and monitored their growth and development (Beckwith 2004). Comparisons between below- and above-ground attributes were also investigated. The number of camas individuals increased during the study. Beckwith (p. 120) reported that: “On average, camas bulbs increased in size and weight over time”. Through her study Beckwith was the first to document prolonged dormancy and asexual reproduction for camas through bulb division.

For the field portion of her research, Beckwith conducted selective harvesting of camas bulbs, fire treatments, and combined harvesting and fire treatments at multiple

field sites. All sites were considered to be shallow soil sites. She monitored how the camas populations (*C. leichtlinii* and *C. quamash*) responded to these various treatments in relation to control plots over a four-year period. The response of each camas species was analyzed separately.

Beckwith (2004) reported that statistically significant treatment effects were difficult to detect in her study. Harvesting, burning, and combined treatments did not significantly affect tall camas (*C. leichtlinii*) cover or total plant density, but treatments significantly decreased leaf number and flowering plant density (Beckwith 2004). For common camas (*C. quamash*), harvesting caused variable effects on cover, but when combined with fire it negatively affected cover. Treatments did not significantly affect the plant density, or leaf number of common camas (Beckwith 2004). Beckwith noted that the growth patterns in control and treatment plots changed noticeably from year to year, possibly from variation in yearly weather patterns (temperature and rainfall) and degree of disturbance probably from park walkers, and other variables (Beckwith 2004). Camas individuals seemed to respond to unfavourable environmental conditions (e.g., drought) by changing their growth patterns (e.g., dormancy, reduction of number of leaves, abortion of at the flowering stage), though a strong treatment effect was not found (Beckwith 2004).

Beckwith (2004) also demonstrated that camas populations, “remained relatively stable regardless of experimental treatment” (p. 161). Since the effects of the harvesting and burning treatments on the camas population were somewhat inconclusive, however, it is worth reworking the study, incorporating the insights she gained. Beckwith’s study demonstrated a high degree of heterogeneity in the local Garry oak and camas

landscape—particularly shallow soil sites—signifying that future studies on camas harvesting should be carried out at a single field site, or in a more homogenous site (Beckwith 2004). This issue with heterogeneity might be addressed by conducting a study in a deep soil site (Beckwith 2004), as was done in my research project (see Chapter 3).

My research, therefore, aims to advance our existing knowledge base of camas ecology and to understand how other plant species in the community will respond to camas harvesting. This study seeks to provide useful information to both ethnoecologists and resource managers on how camas harvesting might effect ecological integrity of camas habitat. Before resource managers and staff of protected areas are willing to experiment with camas harvesting as a management tool, or allow for Indigenous harvesting, they will likely need to understand how harvesting might affect both native and introduced plant species. This will help to determine the compatibility of camas harvesting with conservation and restoration goals. Another important consideration for managers of protected areas is how harvesting camas might affect soil conditions such as porosity. Gaining this information is valuable for understanding how harvesting historically altered, and might currently change the hydrology and plant community over time. I address these questions through my experimental camas harvesting field study, discussed in Chapter 3. The socio-cultural and ecological compatibility of First Nations' camas harvesting and management in protected areas is the subject of this thesis, and Chapter 2 will focus on the socio-cultural dimensions of this concept.

Chapter 2: Socio-Cultural Dimensions of Camas Harvesting in Protected Areas on Vancouver Island, British Columbia

Bryce continues to harvest *kwetlal* [camas] on parklands and private property despite threats to her and her family's well-being from settlers attempting to deny her access to *Lekwungen* homelands (Corntassel and Bryce 2012, p. 158).

It would be absolutely wonderful to have [camas harvesting in Beacon Hill Park] happen. But the last thing I would want it to do is to have it go awry, and stop it from happening again (Fred Hook, Natural Areas Technician of Victoria City Parks, pers. comm. 2011).

2.1 Introduction

As part of a larger effort to regain personal, spiritual and cultural health, strength, and sovereignty, First Peoples worldwide are working to restore their traditional food systems (Corntassel and Bryce 2012; Jacknis 2006; Krohn and Segrest 2010; Nabhan 2002, 2006; Turner *et al.* 2007; VICCIFN 2012). Regaining access and restoring the ecological health of traditional resource sites where cultivation and harvesting of native foods can be practiced and taught to the next generation are important aspects of this process of cultural renewal (Corntassel and Bryce 2012; Turner and Turner 2007). Because the most intact traditionally important habitats are often the focus of western conservation efforts, this frequently has rendered them off-limits to Indigenous harvesting and traditional management (Alcorn 1993; Beltran 2000; Peepre and Dearden 2002; Ruppert 2003; Underwood 2003). However, the conservation community is becoming increasingly aware that the involvement of local First Nations in both the planning and management decisions regarding protected areas can help to ensure the long-term sustainability of those projects (Alcorn 1993; Beltran 2000; Peepre and Dearden 2002; Ruppert 2003; Underwood 2003). Additionally, acknowledging the desire, intention, and

rights of Indigenous people to harvest resources, can help facilitate ecological monitoring of harvested areas by encouraging transparency and inclusion of Indigenous Peoples' perspectives into protected areas' management plans (Peepre and Dearden 2002; Ruppert 2003; Turner and Bitonti 2011).

After almost completely disappearing from the lives of Central Coast Salish Peoples, some Indigenous people on Vancouver Island and neighbouring areas are working towards the cultural and habitat restoration of their traditional food camas (Bryce 2005; Corntassel and Bryce 2012; Krohn pers. comm. 2012; Turner and Turner 2008). As explained in Section 1.5.2 most of the remaining extensive patches of camas on southern Vancouver Island are now found in local parks and protected areas, which are managed largely by non-First Nations people primarily for ecological and recreational purposes (Senos *et al.* 2006). Central Coast Salish Peoples, in general, still see the remaining parcels containing Garry oak ecosystems as part of their traditional territories and, therefore, still feel connected to these areas (Bryce 2005; Corntassel and Bryce 2012). This ongoing importance of camas habitat to some Central Coast Salish peoples, along with the limited remaining extent of camas habitat, makes protected areas with Garry oak ecosystems potentially important sites for the renewal of camas harvesting and cultivation traditions. I explored the relevance and feasibility of this proposal through interviews with members of the *Hul'qumi'num*, *Lekwungen*, and *Tsawout* First Nations, managers of protected areas with camas habitat, and other people familiar with the efforts to restore a camas culture on southern Vancouver Island. The following questions guided my interview process:

- 1) To what extent are people in Central Coast Salish communities interested in or are already harvesting camas in protected areas (e.g., parks and preserves) on Vancouver Island, and are they interested in managing these areas for enhanced camas production?
- 2) To what extent are the current managers of protected areas interested and able to support prospective camas harvesting and/or collaborative management of camas populations in these protected areas?
- 3) What are the current opportunities for Central Coast Salish communities to engage in the harvesting of camas and/or collaborative management activities of camas populations with resource managers in these protected areas?
- 4) What might collaboration on the management of protected areas for cultivation of camas and stewardship look like today and in the future?
- 5) What are some challenges that First Nations communities encounter, or expect to encounter, with camas harvesting and/or collaborative management activities of camas populations in these protected areas?
- 6) What are some challenges that the current managers of protected areas anticipate with prospective Central Coast Salish camas harvesting and/or collaborative management of camas populations in these protected areas?

2.2 Methods

2.2.1 Interviews

To gain a better understanding of the socio-cultural context for renewing camas harvesting and cultivation in protected areas on Vancouver Island, I conducted nine semi-structured interviews. Appendix 1 summarizes the participants' names, affiliations, titles, and relevance to this study. In addition to these nine interviews, I also sat in on an interview conducted by Dr. Nancy Turner, University of Victoria, with Dr. Arvid Charlie (*Luschiim*) of the *Hul'qumi'num* First Nation in Duncan, BC, in which *Luschiim*'s knowledge of camas management and use was documented.

Participants were chosen for their interest in camas population restoration and

management, their interest in camas harvesting for food in protected areas, or their familiarity with the First Nations communities that are engaging in ethnoecological restoration. I did not seek out people with opposing viewpoints (e.g., people who are openly against the proposition of Indigenous harvesting in protected areas). My reasoning for this decision was that with no existing studies speaking to this issue of camas harvesting in protected areas, first determining if any interest existed within the community was most relevant at this time.

I secured approval from the Human Research Ethics Board at the University of Victoria prior to beginning this study (research ethics application # 10-073). Before commencing an interview, all participants were given a letter of information about the project and, if they had agreed to participate, a consent form that outlined the constraints around ongoing consent, anonymity of data, confidentiality, rights to withdraw from the study, potential risks, dissemination of results and disposal of data. My phone script, initial contact letter, and informed consent form are included in Appendix 2. All of the individuals I interviewed provided consent to use their name in my research. Therefore, I have included the names of individuals interviewed in the text to credit the sources of the information.

Before each interview, I developed a refined list of questions based on the participants' specific expertise. I used a semi-structured interview technique where I asked general questions and then allowed the participant to elaborate on the topics they felt were the most important (Denzin and Lincoln 2011). Appendix 3 provides a sample of the questions that I used in these interviews. Interviews took place at participants' homes, workplaces, coffee shops or parks, and were between one to two hours in length. With the

approval of participants, I recorded all interviews using a digital voice recorder.

I transcribed the interviews myself, and once they were transcribed I sent them to the participants for review (i.e., to catch mistakes and provide updates). Following the transcription, I read through the text (approximately 150 pages in total) and assigned each paragraph or sentence to a theme (e.g., barriers and challenges to camas harvesting, camas harvesting events). Initial coding was reviewed and regrouped into four broader categories. These categories included:

- 1) Cultural Renewal;
- 2) Protected Areas as Sites for Cultural Renewal;
- 3) Support for Renewal of Camas Culture in Protected Areas; and
- 4) Existing and Anticipated Challenges.

Utilizing these four broader themes as my headings, I arranged the experiences, thoughts, and suggestions of my interviewees into an account that explains the complex nature of modern day camas harvesting in protected areas.

This account does not reflect the full spectrum of perspectives on this topic, nor does it answer all of the potential questions that might arise from this topic. However, it provides a starting point for a more in-depth discussion around camas harvesting and management in protected areas today. While the information documented in this study will be most applicable to the plant and human communities on, or near, Vancouver Island, I hope it will offer some ideas for a broader exploration of the reintegration of traditional harvesting and management practices into conservation and restoration projects more generally.

2.2.2 Participant Observation and Community Engagement

Throughout this study, I attended numerous Indigenous food events and cultural celebrations hosted by various local First Nation groups, sometimes with the support of groups like the Vancouver Island and Coastal Communities Indigenous Foods Network (VICCIFN) and the Vancouver Island Health Authority's "Feasting For Change" program. Engagement with local traditional foods renewal efforts helped me to place my interviews in context and helped to inform my analysis. These events involved traditional pit-cooks, salmon bakes, storytelling, music and dancing in the longhouse, and traditional foods conferences. At these events I assisted with details such as the gathering of materials for the pit-cooks, preparation of the pit, and serving of food to elders. On a few occasions, I brought cooked camas bulbs to these events for people to try, and presented a poster about my camas research to help facilitate casual conversations about the current interest in camas.

During my field research I spent approximately eight months over the course of two years camping at, or making weekly visits to, the Nature Conservancy of Canada's Cowichan Garry Oak Preserve (CGOP). This provided me an opportunity to engage with the proposal of camas harvesting in a protected area directly. Over the course of my ecological fieldwork, approximately thirty volunteers from various backgrounds, including First Nations, resource managers, academics, and the local community members, assisted me with data collection. I was able to discuss the relevance, potential approaches, and challenges of this proposal, with these volunteers, as well as the staff at the CGOP (e.g., Site Manager and Restoration Technician Irvin Banman) and other researchers on site. After my field research was completed, I returned to the CGOP on multiple occasions to

observe and assist with prescribed burn efforts. This ongoing interaction with resource managers and volunteers involved with the CGOP has allowed for additional conversations and provided valuable insights from people that I was not able to interview. Though I did not use these informally collected perspectives directly in my analysis, they helped me to shape the questions used in my interviews.

2.3 Interview Themes and Findings

The interview portion of this study set out to understand the socio-cultural relevance and feasibility of parks and protected areas as spaces that may support the renewal of Central Coast Salish camas harvesting and management traditions. This section details the four major themes, or categories, introduced above. A summary of the themes and sub-themes that emerged from my interviews, along with the major findings can be found in Appendix 4.

2.3.1 Cultural Renewal

Current Knowledge and Use of Camas by Central Coast Salish

According to Dr. Nancy Turner (Ethnoecological Researcher and Professor in the School of Environmental Studies, University of Victoria) the late 1960's and early 1970's were, perhaps, a low point for native plant use and cultivation in British Columbia, with camas being no exception (Turner pers. comm. 2011). As Nancy Turner (pers. comm. 2011) explained:

People like [*Tsartlip* late elder] Chris Paul...were growing camas and serving it at their traditional days gatherings in the fall. But he was the main one who knew about camas at that time. There were a few people, just before that, who talked about serving camas at potlatches.

Christopher Paul shared his plant knowledge with Turner (and anthropology student

Marguerite Babcock) who documented this knowledge helping to build a bridge for the next generation of indigenous people to learn about camas traditions. Had it not been for knowledge holders like Christopher Paul being willing to serve as mentors and teachers both inside and outside of their communities, the culture of camas might have been completely lost and forgotten (Garibaldi 2003; Turner and Turner 2008). Briony Penn (2006, p. 4) describes how Cheryl Bryce, a Traditional Lands Manager of the Songhees (*Lekwungen*) Nation, learned about her ancestors' traditional use of camas through Nancy Turner's work:

It was only as a student and contract employee of her nation in doing research [that Cheryl Bryce] came across work by ethnobotanist, Dr. Nancy Turner of UVic, and that she began to discover the relationship Songhees women had forged with [camas] for thousands of years.

Cheryl Bryce is now considered by some to be a local Indigenous champion for restoring camas culture (Penn 2006). She is very outspoken about the need to protect and restore camas habitat, as well as restore her peoples' relationship with this plant. Bryce is the only participant in my study who currently harvests camas on a regular basis. She grew up harvesting native plant foods and medicines with her grandmother, though did not harvest camas until later in life. To Bryce's knowledge, there are no others as engaged with the restoration of camas culture on Vancouver Island. In her own words (Cheryl Bryce pers. comm. 2011):

There's no one actively managing [the camas ecosystems] like I do, to the point of going out to the homelands and trying to reinstate protection and continue to harvest. There are some folks who are starting to learn the pit-cooking methods, but not necessarily the whole food system. It's getting there. I don't think we can ever bring it back to what it was. But I'm hoping in time we will bring a lot of it forward and continue it in different ways.

Based on my interviews, and through my conversations I have had with people over the course of my research, it appears that most Straits Salish and *Hul'qumi'num* people do not have first-hand experience with harvesting or eating camas. As JB Williams, Ecological and Cultural Restoration Practitioner and Teacher of the *Tsawout* First Nation, explained (pers. comm. 2011):

It's not very common at all [to have eaten camas] within my family or within the community because...there's just a loss of traditional knowledge. And with that loss of the traditional knowledge, is the loss of connection with these food plants...the camas. And with the camas being so rare right now, there's just not really any opportunity for my family, or even the community to...eat [camas].

I did, however, talk with people over the past few years at Indigenous foods events who knew, to varying degrees, about the traditional use and cultivation of camas. Some had sampled camas at recent community pit-cooking events. Several elders shared memories of eating camas earlier in life, or told me about their family members who harvested camas bulbs in the past. During an interview *Luschiim* (Dr. Arvid Charlie), a cultural knowledge-holder of the Cowichan First Nation, expressed some enthusiasm with the idea of camas being eaten again more regularly (pers. comm. to Nancy Turner 2011) : “I know some people are trying to bring it back. And I wouldn't mind”.

When attending Central Coast Salish traditional food gatherings hosted by various Nations over the course of my research, I have noticed that camas bulbs were typically present in small quantities or completely absent. While this might suggest a lack of interest in camas, it may also be due to other factors such as lack of availability or timing of feasting events (e.g., since the camas harvesting window is short people would have to dry and store bulbs to use during the rest of the year). Gauging the level of

interest in restoring elements of camas culture is difficult since reconnecting with traditional foods often takes the back seat to other more pressing issues. As VIHA Aboriginal Communities Nutritionist Fiona Devereaux explained (pers. comm. 2011) :

I guess if you look at everything, what priority is health [and traditional foods renewal] in the [Indigenous] communities? I would say it's low—very low on the priority level when you are dealing with things like housing, poverty, addictions, mental health issues, and trauma.

What might appear as a lack of interest also might be an expression of socio-economic barriers (Fediuk and Thoms 2003). Almost all of my participants mentioned that if funding were readily available for this kind of work it is likely that many more indigenous people would pursue work doing ecological and cultural restoration. While it would be a stretch to say that there is overwhelming interest in camas harvesting and use in Straits Salish and *Hul'qumi'num* communities at this time there a number of people, both in British Columbia and abroad, who are interested in teaching others about this plant and would like to see elements of camas culture restored (Elise Krohn pers. comm. 2012).

Camas as a Modern Food

When asked why reclaiming traditional plant foods like camas was important to them, Indigenous participants often discussed how returning from a diet high in refined carbohydrates and sugars, to a diet that was more similar to that of their ancestors could help improve the health of their communities. As Ken Elliott, a Native Plant Nursery Manager of the Cowichan First Nations, explained (pers. comm. 2011): “Our great-grandfolks—a lot of them—would live close to 90 or 100 years of age, maybe even older than 100...So eating their natural foods kept their bodies healthy”. By cultivating and eating traditional foods Indigenous people may be able to reduce the high incidence of diabetes, obesity, heart disease, and other diet-related diseases in their communities

(Damman *et al.* 2008; Kuhnlein *et al.* 2009).

Participants talked about how native plants foods offer a practical and affordable way of feeding one's family since are adapted to the local ecology. Several people suggested that camas would be a great crop to grow in home and community gardens. As Brenda Beckwith (pers. comm. 2011 emphasized: “[Camas is] easy to grow, easy to cultivate...does well with, I think, various ranges of disturbance, except no disturbance at all”.

When asked, though, if they thought camas would be used again as a modern staple food, most people I interviewed replied that they didn't think it was realistic at this time given the lack of abundance of camas on the landscape, and the limited size of home gardens. However, several people suggested that, by creating new sites for harvesting or promoting camas as a garden or landscaping plant, it could become a more common food in the near future.

Other Indigenous people I spoke with at traditional foods events were less than enthusiastic about the idea of eating camas on a regular or even yearly basis. Some told me that they had tried it, but didn't like the taste or texture of camas, or thought that it was tasteless (e.g., Earl Claxton Jr., a Cultural and Ecological Teacher of the *Tsawout* First Nation, pers. comm. 2012). This is interesting and unfortunate for those trying to promote camas as a nutritious food, given that camas was once considered to be a sweet and delicious treat (Beckwith 2004; Turner and Kuhnlein 1983). This apparent change in opinion likely has something to do with how long camas bulbs are cooked today.

The traditional pit-cooking method (see section 1.3.1) is finding its way back into

traditional feasting events. Yet, due to factors such as lack of access to adequate quantities of camas, and other traditional root vegetables, the contents in pit-cooks and the duration of the cooking are much different today. Cheryl Bryce (pers. comm. 2011) explained how the scarcity of camas is affecting the method of pit-cooking: “Back then they cooked [camas bulbs] 24-48 hours and the pits were huge. They were much bigger than the pits that I am cooking in. We just don’t have as much camas to do that now”.

Today, small quantities of camas bulbs are sometimes included in pit-cooks while introduced vegetables such as potatoes, carrots, beets, and onions generally make up the majority of the pit (pers. observation 2009-2012). Since the vegetables used in contemporary pit-cooks require only 3-4 hours of cooking, the camas bulbs may not be fully cooked when the pit is opened. Camas bulbs, pit-cooked in this manner, are still light in colour, and taste bland (pers. observation 2009-2012). Historical documents indicate that camas cooked over-night is dark in colour and quite sweet. Shortened pit-cooking times appears to be inhibiting the full flavour and the nutritional value²⁰ of camas to be realized.

Experimenting with overnight pit-cooking is of interest to the people I interviewed. Yet with limited access to camas bulbs lengthy cooking times makes this method seem somewhat impractical at this time. One alternative would be to experiment with cooking camas in a kitchen setting (Turner and Kuhnlein 1982). This likely would be essential to making camas more of a regular food for modern times. Some examples of this faster or easier cooking could include steaming the bulbs in a slow cooker, kettle, or

²⁰ A longer steaming time is necessary to ensure the complete hydrolysis of camas’s long-chain carbohydrates, inulin, to digestible fructans and fructose (Crawford 2007; Konlande and Robson 1971; Turner and Kuhnlein 1983).

oven (See Appendix 5 for recipes).

Re-instating Camas Traditions and Teaching a New Generation

When the use of a traditional food like camas is almost lost, it is not just the presence of a nutritious food that has all but vanished from a diet but also the decline of the associated knowledge, culture, and practices (Turner and Turner 2008). As Cheryl Bryce (pers. comm. 2011) explained about traditional plant harvesting: “It’s not just like going into a grocery store and buying something. There’s much more of a connection to it”. Traditional foods are inextricably linked with ecological knowledge about the habitats where they grow and an understanding of the technology needed for harvesting, cultivating, and preparing the foods. Additionally, the language, belief systems, songs, stories, and social structure that accompany these foods are integral to their cultural significance (Turner *et al.* 2000; Turner and Turner 2008). With the decline of camas bulbs in the Indigenous diet came a decline in this cultural knowledge and the associated practices (Turner and Turner 2008).

The Central Coast Salish people I interviewed expressed a great deal of enthusiasm for bringing forward many elements of a traditional camas culture²¹ (Section 1.3 for background on “camas culture”). Re-instating cultural roles was emphasized, particularly the role of ecological caretaker and plant specialist. Cheryl Bryce (pers. comm. 2011) explained the importance of this role to her:

It’s more of a life role, being a traditional lands manager or a traditional harvester...And through our ancestors this was a women’s role. And it is a

²¹ Camas culture is defined as a root production system, with multi-scalar cultivation activities and an adaptive economic framework, that includes social patterns of inherited resource tenure and decision-making mechanisms, intensive horticultural practices, and regular fire use to ensure a predictable and abundant supply of camas bulbs for food (Beckwith 2004, pp. 209-210, 213).

very honourable role because [the Garry oak ecosystem] was theirs to interact with...It was theirs to manage, to help keep it here.

Reclaiming this role, along with the accompanying tradition of inherited resource sites, is complicated given the privatization of land. Participants reported that finding culturally important plants necessitates negotiating with current landowners, or staff of protected areas, to gain access to harvesting sites. Additionally, the role of ecological caretaker has expanded from one of cultivator to include ecological restorationist, taking time away from reviving other aspects of camas culture. Despite these challenges, the Indigenous people I spoke with felt committed to taking on this role.

JB Williams of the *Tsawout* First Nation has been working for five years to restore native plants to a protected area within his traditional territory through the SeaChange Marine Conservation Society. Part of this work involves the restoration of a savannah where Williams hopes to teach others how to harvest camas bulbs. Furthermore, Williams is active within the local traditional foods restoration community where he leads native plant walks, organizes pit-cooking events, and shares traditional stories (JB Williams pers. comm. 2011). He often works alongside one of his teachers, Earl Claxton Jr., to mentor the next generation. As Williams (pers. comm. 2011) explained:

My role is mainly being a teacher, to not only the First Nation students, but also to non-First Nations. Just because we need more people to know about these wonderful plants and what they can do for us, in terms of medicine and food and tools.

Ken Elliott, of the Cowichan tribes, is actively engaged with ecological restoration through his native plant nursery. He grows camas, along with many other native plants, and hopes to start propagating camas *in situ* using traditional methods. His vision is to grow enough camas for local restoration projects, as well as provide bulbs for local people

to eat (K. Elliott pers. comm. 2011). Moreover, Elliott is working to pass on his knowledge of native plants and enthusiasm for ecological restoration by giving talks at schools and tours of the ecosystems he has worked to restore.

Cheryl Bryce of the Songhees First Nation is especially passionate about sharing the cultural knowledge and the roles with the younger generation. Bryce (pers comm. 2011) described the different cultural roles her nephews are learning:

Josh can identify so many of the different plants. And he has helped with some of the harvesting and [invasive plant] pulls...One of my other nephews...loves the singing part...Singing is...part of the other cultural things you do for the environment, for the food we will take, and the food that we celebrate. So everyone has a different part in it all, or a different role, a different way of getting it back and of giving back...one loves to do the cooking part of it. So he'll be there for the whole pit cook...I know that at least some of it will continue on if it's not necessarily one person that will hold on to all of that [knowledge].

Bryce is actively teaching outside of her family. She organizes volunteer habitat restoration days once a month and is a well-known advocate for camas in the community and in the schools.

Perhaps the most visible elements of camas culture that people are working to restore are the cooking and sharing of camas at community pit-cook events. Both Williams and Bryce have conducted numerous community pit-cooks with camas and introduced veggies on the Camosun College campus, and other locations, such as *SNIDCEL* (Gowland Tod Provincial Park), the University of Victoria campus, and Chatham and Discovery island (Gomes 2012; Higgs 2005; Tudge 1996). These events offer great opportunities to practice and share other elements of traditional camas culture, such as language, songs, stories, and ceremonies. They bring the mission to restore camas-harvesting traditions, and camas habitat, to a wider audience. Bryce (pers. comm. 2011)

described a pit-cook event she helped organize on the University of Victoria campus:

We invited the neighbours that were next to UVic...and different Nations...It just became a huge event. And it was a way to educate people. We talked about indigenous food systems, indigenous food sovereignty, and all kinds of concerns, barriers, and issues...we celebrated the food and we celebrated the land. And for me it was amazing just to see the kids coming to help...they were getting their hands in and connecting with the earth...and it was just great. All the sharing of the food, the trading of food...because that was one of the places where that [traditionally] happened.

Restoring the entire socio-cultural system associated with camas cultivation is a challenging and, perhaps, even impossible goal (Beckwith 2004; Turner and Turner 2008). It is evident, however, that the desire to revive the Indigenous relationship with camas involves much more than cultivating a nutritious food.

2.3.2 Protected Areas as Sites for Cultural Renewal

With the extent and ecological quality of Garry oak ecosystems seriously diminished in British Columbia, gaining access to camas populations large enough for cultivation and consumption is challenging. As noted previously, some of the best remaining sites are protected in parks and preserves by government agencies, and environmental NGO's, such as the Nature Conservancy of Canada. As Williams (pers. comm. 2011) explained: "Besides the few small patches on private land, [protected areas] are essentially the last refugia for the camas". The Indigenous people I interviewed see efforts to protect Garry oak ecosystems from development pressures as essential to guarding camas and other important cultural resources. However, they also expressed that protected areas are valuable sites for renewing cultural roles and practices. As Elise Krohn, a teacher at the Northwest Indian College in Washington, explained (pers. comm. 2012): "Ironically, the [Washington State Fort Lewis Military] Base is one of the best

camas prairie sites because they burn regularly to prevent fires from firearm practice”.

Interest in Protected Areas

Participants described protected areas as important places for bulb and seed harvesting, ecological and cultural mentoring, and re-establishing an Indigenous role as ecological caretaker. As Williams (pers. comm. 2011) explained:

I think it's essential not only to have [protected areas] as a place as a refugia for these plants, but it's also a good place to do two things: to teach my community members how to identify [and] how to harvest these plants in a sustainable manner, as well as show the general public that there are still First Nations out there that retain this knowledge [and] that are practicing their rights...to show them that we're not just a chapter in some history book.

Having access to camas bulbs in protected areas for personal consumption and community feasting events is one interest participants expressed. Yet the collection of camas bulbs and seed for restoration efforts, or for transplanting into community gardens, seemed to be of greater importance. As Williams (pers. comm. 2011) explained: “[I want to] keep those places protected, but selectively harvest from there, but not harvest for myself, but harvest to transplant to other spots where we can have another site of camas, and slowly increase [the quantity of camas] that way”.

As mentioned earlier, this interest in protected areas as ‘bulb and seed banks’ makes sense because most commercial plant nurseries focus on growing non-native plants (GOERT 2011; Ken Elliott pers. comm. 2011). Finding camas bulbs to transplant into a personal or community garden is, therefore, quite difficult. Several of the volunteers who came out to help harvest camas during my research expressed an interest in taking bulbs with them to plant. Locating a source of camas bulbs and seed, it seems, is a key component for accelerating the restoration of camas habitat and culture outside of

protected areas at this time.

While Indigenous people are working on restoring the habitat outside protected areas for the continuation of their cultural practices in the future, in the interim they see protected areas as important outdoor classrooms. I observed this use of protected areas for teaching while carrying out my experimental camas harvest at the Cowichan Garry Oak Preserve. The Indigenous volunteers came out in multi-generational groups to help harvest. The parents or adults in these groups used the setting to share ecological and cultural information with the youth. Beyond learning about camas as a traditional food, the volunteers were able to gain knowledge of camas ecology (e.g., soil type, associated plant species, and pollinators), as well as learn techniques for harvesting.

In addition to providing a context for educating the next generation, protected areas were portrayed as important places to reinstate the Indigenous role of ecological caretaker. As Williams (pers. comm. 2011) explained, it is important that the general public sees that First Nations still retain traditional plant knowledge and are actively practicing their role as ecological managers. Bryce (pers. comm. 2011) expressed a similar sentiment: “Part of the reinstating is just standing up and taking it back and saying, ‘it’s my role and I’m going to continue to do it’”.

Current Use of Protected Areas

When asked if protected areas are currently important harvesting sites, both Bryce and Williams told me they use protected areas for harvesting. They explained that their decisions about where to harvest are guided by traditional territories and protocols, as well as the perceived stability of the plant populations and safety of the harvesting site. Current designation of sites as protected areas is considered by them to be irrelevant.

Furthermore, they expressed their belief that asking permission to harvest in most protected areas is unwarranted. As Williams (pers. comm. 2011) explained:

I just presume that I am allowed [to harvest in protected areas] because I know that I stand on firmer legal ground...Cause all [they're] really standing on is a policy. It's not a law. And just because of that fact I know that I can go and harvest there and not have to ask anybody...Especially if it's within parklands or Crown lands.

Bryce (pers. comm. 2011) expressed a similar sentiment: "I go all over, federal, provincial, or what is considered federal, provincial or municipal lands to harvest. And it's all within part of our ancestral homelands and it's a practice I've done with my Grandma and continue to do today". In this way, the act of harvesting and managing traditional foods can be seen as a demonstration of Indigenous land rights. Whether or not these assertions would hold up in court is uncertain.

The Fort Victoria Treaties have been used to protect access to traditional fishing sites (Claxton vs. Saanichton 1989). To my knowledge, though, these treaties have not been used to defend Indigenous plant harvesting rights. The treaties promised First Nations people that "*village sites and enclosed fields*" were to be kept for their own use, and for the use of their children. These treaties could be used to argue Indigenous rights to former camas-harvesting grounds, since these areas could be seen as part of a village site (B. Beckwith pers. comm. 2011; N. Turner pers. comm. 2011). However, none of the people I spoke with were currently taking these issues to court.

Alternatively, some Indigenous People are choosing to assert their treaty rights through direct action by continuing to harvest and bringing the next generation with them to learn. This approach to harvesting seems completely just given the history of land appropriation and cultural marginalization. Yet, it potentially limits the extent of resource

tending and teaching that can be carried out due to conflict with other park users or managers who might see plant harvesting as illegal or ecologically damaging. As Bryce (pers. comm. 2011) explained:

I have been run out of the parks, like Goldstream or other places where I have gone to do harvesting, where people just don't understand. Even when I have been at different locations throughout Victoria, some people kind of know what your doing and they leave you alone, others will come up and say 'oh you're harvesting this, you're harvesting that,' some people I would have a conversation with, others would just come running at us yelling that we have no right...I was even run out of parks at times, being chased.

One can imagine the stress involved with trying to tend a plant population, or demonstrate proper harvesting techniques, under the threat of being chased out of a protected area. For this reason direct action harvesting alone might not yield the desired result of passing on camas culture to the next generation. Another approach, which might lead to more stable connections with camas sites, could involve collaboration with the current managers on the management of camas populations.

Willingness to Collaborate with Current Managers

When asked if they were interested and willing to collaborate with current staff of protected areas on the management of camas populations, Indigenous participants gave a mixed response. Participants all agreed that discussions needed to happen with the current managers of protected areas to ensure the native plants and ecosystems were protected, and sites were safe for harvesting. However, they also expressed a certain level of scepticism or hesitation about the collaborative process.

Cheryl Bryce (pers. comm. 2011) talked about feeling discouraged by some negative encounters with scientists and land managers in the past. For example, she

expressed the feeling that there is a lack of respect for the opinions and knowledge of Indigenous people. A history of cultural appropriation, misrepresentation, and the ‘tokenization’ of Indigenous knowledge were all discussed as reasons why some Indigenous people might feel hesitant about working with scientists or land managers. Bryce (pers. comm. 2011) described how some people she spoke with seemed interested in using the Indigenous knowledge but not open to including Indigenous people in ecological management:

[They’ll say,] ‘Okay we agree that [harvesting and burning] is an important part,’ but they really don’t want you involved. They just want to go off and do their thing. They’re not truly trying to build that relationship and create the trust, or do what is necessary to work towards co-management.

Another hesitation that came up during interviews was the lack of continuous paid work for Indigenous people. While some Indigenous people are paid to do management or collaborative ecological work, many volunteer their time to work on projects where non-Indigenous people are being paid or are otherwise benefitting. This power imbalance can erode the desire to collaborate. Lastly, interviewees expressed some scepticism that staff of protected areas are currently authorized to collaborate with Indigenous people given the tensions around treaty negotiations and current policies that restrict harvesting.

2.3.3 Support for Renewal of Camas Culture in Protected Areas

In the past couple of decades, local interest in understanding and incorporating traditional Indigenous management strategies, such as burning and harvesting, in Garry oak ecosystem protected areas has grown (B. Beckwith pers. comm. 2011; T. Ennis pers. comm. 2010; R. Walker pers. comm. 2011). Given this growing interest, I was curious to know how local land managers could see Indigenous camas harvesting and management

fitting into their protected areas. Despite differences in land designations (private vs. public) and policies, the managers I interviewed were receptive and had surprisingly similar suggestions of how to incorporate Indigenous camas harvesting into their protected areas.

Receptivity to Indigenous Camas Harvesting in Protected Areas

The land managers I spoke with were all receptive to the idea of people in First Nations communities harvesting camas in the protected areas where they work. In the case of the Gulf Islands National Park Reserve (GINPR), First Peoples who want to come and harvest traditional resources are welcome to harvest now without seeking a permit. As Rob Walker, Manager of Resource Conservation at the GINPR, explained (pers. comm. 2011):

[Indigenous harvesting rights are] implicit in the National Parks Act, let alone whatever Treaty and Aboriginal rights are put on the table. So Canada National Parks Act—the thing that defines a National Park Reserve as being different from a National Park—is that Aboriginal People have rights to exercise their traditional resource harvesting activities. So we don't even have to start talking Douglas Treaty...or [even] talk about their historic rights. It's explicit in law that they can go out and do traditional resource harvesting in the National Park Reserve.

Walker also stated that, in the future, incorporating camas harvesting into a larger management project, with funding, might be possible. This would be most likely to happen in an experimental context where the interaction between camas harvesting and prescribed burning could be monitored.

The Nature Conservancy of Canada's (NCC) Cowichan Garry Oak Preserve (CGOP) staff indicated that they would support camas harvesting on their property (T. Ennis pers. comm. 2010). They see camas harvesting as compatible with their ecological

restoration and conservation objectives, and already have helped to facilitate multiple camas harvests, including two harvests with Cowichan Tribes, on the CGOP property.

Tim Ennis, the NCC Director of the Land Stewardship Program for the BC Region, described how the first camas-harvesting event came about (pers. comm. 2010):

A woman [from the Cowichan Tribes Land Management Department] contacted me and asked about the possibilities of this camas harvesting idea that they had come up with. And so we were of course just thrilled. We've always intended from early days to have an objective of restoring some semblance of camas harvesting at the CGOP.

Similar to Rob Walker, Ennis is interested in having a camas harvesting program that incorporates ecological monitoring and ongoing management. Calling ahead of time to ask permission before coming onto the NCC property is necessary. As Ennis (pers. comm. 2010) emphasized: "Not just anyone can show up, any old time they want to and do whatever. That would defeat some of the purposes around species at risk protection". What NCC is looking for is a long-term collaboration with local First Nations to manage the resources and do experimental harvesting.

In terms of the Victoria City Parks, the employees I spoke with were open to the idea of camas harvesting and they even believe that it might be beneficial to the ecosystems. Presently though, there is an \$85 fine for anyone who removes plant material from Victoria City Parks without first asking permission (F. Hook pers. comm. 2011).

However, there is a permit process set-up for lawful plant removal. Fred Hook, Environmental Technician of the Victoria City Parks, explained (pers. comm. 2011):

We do have a permitting process in place now for scientific research here...So when someone is in here doing some legitimate collecting of plant material or insects, or anything like that that, we know what's going on [and] when someone calls in to say, 'there's someone out there collecting,' we can say 'yes we know, and this is what it's for'. And I see a

process similar to that [for harvesting culturally important plants]. [A process] that simply makes sure that it is legitimized...so that we don't get random people in here digging that have no intention of doing a traditional practice or that don't know how to do it and damage what they are working with.

While there might be potential to amend the current rules to allow for unconditional traditional harvesting in city parks, Hook felt that these decisions would need to be worked out at a higher level—BC government to First Nation government, likely due to the ongoing First Nation treaty process in BC. As he explained (pers. comm. 2011):

So if I get a native family who comes to me and says 'Can I harvest in the park?' I am in no position to tell them 'yes' or 'no'. This needs to be worked out at a government level...I can make recommendations and they may work their way up to council and they may pass a by-law, but it would be a whole lot better if that were a top-down decision.

Collaboration

Two of the managers I spoke with were enthusiastic about the idea of working with local Indigenous Peoples to manage the resources in the protected areas. As Tim Ennis (pers. comm. 2010) of the Nature Conservancy emphasized: "Co-management has been on our minds around this [CGOP] property from day one". Ennis is hoping to work towards co-managing a section of the preserve with Indigenous people interested in doing traditional harvesting, and he suggested that entering into a long-term collaborative agreement would work best. In Ennis's words (pers. comm. 2010):

If people are going to come to this site and harvest, what we really would want is commitment. I don't think I'd be interested in someone coming out one day and digging up a bunch of bulbs and then not ever seeing them again. I think we'd like the idea of seeing things done with a longer-term perspective and with maybe more management in there, besides just harvesting. So let's talk about weeding other non-target species, let's talk about burning them, maybe not necessarily every year, but on some kind of regular cycle, burning the plots. Let's talk about spacing the bulbs and how we're going to harvest them, or how they would harvest...which

bulbs, under what circumstances, and how they would determine which ones to leave and under what circumstances.

Rob Walker also saw the benefit of working together with the First Nations to create a pilot project, and eventually a program, around camas harvesting and management. As he explained though, the term ‘co-management’ is somewhat taboo (R. Walker pers. comm. 2011):

It’s a loaded term for us. However you are using it, co-management is illegal for the Federal government because it fetters the authority of the minister. So what we do is somewhere on that spectrum of consultation, accommodation, co-operative management. That is what we are allowed by law to do. So we have to be really careful about that language.

Walker explained that the staff at the GINPR could support, and even help to facilitate traditional camas harvesting if it were framed, at least initially, as a pilot project with a research component. He proposed that interested First Nations and the staff at the GINPR could define the objectives of a pilot project, seek funding, and choose an area to implement activities such as ecological restoration, prescribed burning, camas harvesting, and monitoring. Once enough has been learned in the experimental pilot project stage, a more formal program could be established to support ethnoecological restoration of a camas culture. As Walker (pers. comm. 2011) explained, this pilot stage would be crucial to understanding whether camas harvesting could be considered an important management tool, how it could be built into a program with funding, and what roles various people involved would play. However, as I mentioned earlier camas harvesting is already permitted at the GINPR, it just is not *actively* supported.

Integrating Camas Harvesting into Existing Management

The land managers I spoke with are already making attempts to integrate traditional ecological management knowledge and strategies at their protected sites. The

information they are using is gleaned from a variety of sources, including university courses, other protected area managers, and people in the local Indigenous communities.

Tim Ennis (pers. comm. 2010) described how a conversation he had with *Luschiim*, a *Hul'qumi'num* elder, has helped guide the management at the Cowichan Garry Oak Preserve:

I asked [*Luschiim*] about eliminating some of the Douglas-fir saplings that were coming up in the understorey throughout the oak areas on the property. And he agreed with that as being a good idea. But then...he told me this story about how one day this eagle had been chasing a great blue heron and this heron had nowhere to go and it dove into this thicket of young Douglas-fir saplings and concealed itself in there, in a place where the eagle couldn't get at it...and survived, got away from the eagle... And what I took from that message is that we probably shouldn't do a uniform treatment over the whole area and that kind of complexity and diversity of habitat structures is important. As a consequence of that we made sure to leave the odd one and clumps of [Douglas-fir for] regeneration...to heed those pieces of advice.

The land managers I spoke with agreed that establishing management strategies more in-line with the traditional Indigenous model likely would improve the ecological integrity of the areas they managed. More specifically, they all were interested in reintroducing fire as a management tool. However, since gaining permission from the fire departments to conduct prescribed burns in protected areas is often challenging, mowing is often used as an alternative (I. Banman pers. comm. 2010). Fred Hook explained how the use of this method has evolved over time in Beacon Hill Park to maintain the camas populations (pers. comm. 2011):

When I came here 25 years ago the camas fields were mown for hay. And they were mowed for hay right up until probably the early 1980's. So they were cut just at the time the grasses were ripe. Camas had finished flowering, but really hadn't even started to set seed at that point, or at least hadn't distributed its seed. Probably a decade ago [approx. 2000] that changed and they actually did wait until the camas set seed, but just kind

of immediately after that...It's not by any means a perfect replication of the [traditional] system but it at least keeps the aggressive native plants at bay...What I have done in the last five years is adapted the mowing regimes to mimic as best as possible the effects of [Indigenous] burning.

Hook explained that, although, some management practices in Beacon Hill Park, such as correctly timed mowing, might ensure the presence of traditionally important plants, at this time the park staff doesn't actively attempt to increase the number or range of these plants. He suggested that intentional camas enhancement, with the participation of local First Nations, could be the next component of the mowing program at Beacon Hill Park. However, with a comprehensive parks management plan still in the works for the City of Victoria, finding funding and support for a camas management program could be challenging (F. Hook pers. comm. 2011). Alternatively, this could be a great time for local First Nations to submit their own proposal for traditional camas management in the park.

Of all the traditional management strategies for deep soil Garry oak ecosystems, fire has peaked the interest of managers the most. As Rob Walker explained (pers. comm. 2011): "There's finally sort of a groundswell [in Canada]...NCC is doing it. Everyone is talking about it. BC wildfire management branch is talking about doing this kind of stuff. So it has been a long time coming, but I think we are on the verge". The Indigenous people I spoke with also are interested in seeing fire restored to the Garry oak ecosystems. This mutual interest provides an opportunity for beginning to work across cultures. In fact, this interaction is starting to happen at the CGOP where people from both First Nations and non-First Nations are being invited to participate in a yearly prescribed burning program (I. Banman pers. comm. 2012). Ennis (pers. comm. 2010) suggested that the next step might be to organize a camas-harvesting program in conjunction with the yearly burn program.

Rob Walker (pers. comm. 2011) already can envision how the ecological restoration, and prescribed burning program, he is developing could be expanded to incorporate experimental camas harvesting:

I see [camas harvesting] as an opportunity that we will present if we get down that road of restoration to providing some places with some camas and some appropriate management techniques. Then I would offer that up as something that we could facilitate to get a culture camp, something with elders and youth doing some harvesting. We could build that into our monitoring or our research or whatever phase we are at, and learn a lot from them. And they could use [the space] to meet their own cultural requirements.

Experimental camas harvesting could be integrated into an existing experimental program like prescribed burning. As Walker (pers. comm. 2011) explained:

So the plan for this burning [in the Gulf Islands National Park Reserve] is that it's experimental and we want to investigate how fire can work in conjunction with other tools. For instance, harvesting disturbance, disturbance that emulates camas harvest or direct camas harvest.

If camas harvesting were integrated into existing managements plans, what form or purpose would camas-harvesting have? The non-Indigenous land managers and ethnobiologists I spoke with all agreed that taking an experimental approach to camas harvesting in protected areas, at least initially, would be the best approach. Although the Indigenous land managers I interviewed did not propose taking an experimental approach to harvesting in protected areas, my conversations with them did not lead me to believe that they would oppose this idea.

One approach could involve establishing a relatively small space within a protected area for camas harvesting and monitoring to better understand the effects before larger spaces would be opened up for harvesting. Another option, suggested by several participants, would be to increase the quantity of camas individuals in protected

areas using traditional management techniques for the primary purpose of transplanting a portion of the camas bulbs produced to new locations. Since some, or maybe most, protected areas might be too fragile, or contain inadequate quantities of camas for food cultivation at this time Brenda Beckwith (pers. comm. 2011) also suggested this model as an alternative:

Let's get together and figure out how we can manage the *in situ* camas. But let's set aside some [other] land to grow [camas for] food. I think there are parts of a traditional management system that can be incorporated into management [of protected areas] and we can call that co-management, like the tilling of the soil and the selective weeding and all these things that can happen to promote the sustainable health of a savannah. But, in terms of a food resource, I think it needs to be done elsewhere.

This model would offer the opportunity for Indigenous people to participate in management and to teach management to the next generation in the most intact camas populations. It also would offer a source of bulbs and seed for Indigenous restoration projects to happen outside of the protected areas, without putting too much pressure on the existing camas populations in these protected areas.

Another strategy, suggested by Fred Hook, could involve providing a certain number of permits each year for Indigenous camas harvesting. The model would allow some people to harvest, and help protected areas staff to monitor the extent of harvesting currently occurring in the parks. Some land protection and management agencies in nearby areas already are offering plant-harvesting permits. Elise Krohn (pers. comm. 2012) told me, "I have harvested camas at the Mima Mounds through Department of Natural Resources. Their tribal liaison has worked with us to let native folks harvest camas and St. John's wort there [for medicine making]". Additionally, the Nisqually tribe has a partnership with Fort Lewis Military Base in Washington State, which allows them

to harvest native plants (E. Krohn pers. comm. 2011). As Hook proposed, the Victoria City Parks could enter into a similar permitting agreement with First Nations to harvest a limited quantity of bulbs from specified areas each year.

2.3.4 Existing and Anticipated Challenges

The proposition of introducing harvesting and management of camas into protected areas brings up a host of ecological and social concerns for those who are trying to protect and restore Garry oak ecosystems. In this section, I present and discuss the concerns raised by my participants.

Ecological concerns

One of the largest concerns expressed by the wider ecological community is that introducing disturbance such as camas harvesting and prescribed burning might cause more harm than good. Soil disturbance might provide enhanced conditions for invasive exotic plant seeds to establish, germinate, and grow (MacDougall and Turkington 2005). Additionally, harvesting could damage rare plant populations or cause harmful soil compaction, constraining native biota. However, the managers I spoke with didn't seem overly concerned with these potentially negative effects. Rob Walker (pers. comm. 2011) provided some reassurance in relation to prescribed burning:

In the kind of burning we're talking about, if you have a little site with a rare plant or a hundred [rare plants], it's no challenge at all to protect them...This is low intensity surface burning [we're proposing] and you could protect any little thing you need to. I think while we have a responsibility to be conservative around species at risk, my expectation is that many of the Garry oak ecosystem associated species at risk would benefit from fire.

Through adaptive management, the managers suggested that many of these risks could be

eliminated or mitigated by planning where, when, and how frequently these activities would take place.

Another concern discussed in interviews is the potential for over-harvesting. As Fred Hook (pers. comm. 2011) explained:

I was listening to the radio yesterday and there was someone on the CBC recommending that you walk through the park with a shopping bag and collect greens for your salads. Which is sort of fine. But it's kind of like everybody throwing a stone in the Grand Canyon and filling it up. One person coming through here taking salad greens is no big deal, but this park gets over one million visitors a year. So we can't let them all do that.

This concern can be addressed through a permitting system where a limit can be placed on the quantity taken at any given time and place. People won't necessarily want to harvest large quantities either. As Ennis (pers. comm. 2010) explained, the camas-harvesting event at the CGOP property was much more about getting people out to the site to learn about camas harvesting, rather than extracting a large amount of bulbs:

I think there were probably about 40 people in attendance...Everyone who wanted to had a turn doing some digging and got their hands dirty and had some camas bulbs in their hands, and I think probably at the end of the day maybe a dozen to twenty or something [bulbs] actually got taken out of the ground.

The general consensus among participants is that the collaborative, experimental, pilot project approach, as described in the previous section, would provide sufficient safeguards against ecological damage. The land managers I spoke with anticipated that camas harvesting would be compatible with their current conservation and restoration goals. The main hope, as I understand it, is that people interested in camas harvesting will work with the staff of protected areas to develop a plan, or at least seek permission, so that the extent of harvesting can be regulated and the harvested areas monitored.

Safety of Harvesters

Beyond concerns about damaging the plant and animal populations, there are also precautions that need to be taken to ensure the safety of harvesters. One concern expressed by several participants was soil contamination. Because complete site histories are not available for all protected areas there is a risk that people could harvest in areas with high levels of toxins including pesticides or herbicides. As Cheryl Bryce (pers. comm. 2011) expressed: “I don’t want to be going into a place harvesting where they have put pesticides or chemicals”. While this concern could be reduced through soil testing, the questions remain, ‘who will pay for these tests?’ And, ‘whose responsibility is it to ensure that the area is safe?’ In some cases the people managing the site may already have preformed soil testing to identify contaminated sites (T. Ennis pers. comm. 2010). So it is largely a matter of communication between harvesters and the staff of protected areas.

Perhaps a greater concern, though, is the presence of poisonous plants such as death camas, which could make harvesting of edible camas bulbs dangerous and legally daunting. As Fred Hook (pers. comm. 2011) expressed:

If they did [want to harvest camas], there would be the problem with the death camas, which is not by any means a short-term issue...You would have to wait for a long time to make sure you have a patch absolutely clear [of death camas bulbs]. Even in the patches where...you can go out at this time of year and not see any death camas now, you don’t know that there isn’t one that’s just short of blooming age in the ground.

As Hook stressed, weeding out death camas would require persistence and time. Perhaps harvesting permits would need to be accompanied by legal disclaimers as well.

Challenging Social Norms

Some of the most complicated challenges discussed by park managers involve

balancing the values and needs of various interest groups, and stretching the current social norms around the purpose of protected areas. For starters, some park users might believe that the primary reason for establishing ecological preserves is to exclude or greatly limit human interaction to observation or restoration activities. Introducing camas harvesting and management may be perceived as unacceptable or incompatible with the protected area goals. Unlike harvesting other plants, like berries or herbs, where only part of the plant is harvested and the harvester can maintain a low profile while harvesting, unearthing camas bulbs involves the breaking up of soil and removal of the entire plant. Other park-goers might find this activity disruptive or ‘out of place’ and confront the harvester. When some park users are ignorant of native plants and their uses, it is challenging to have a discussion with them about other worldviews and approaches to management. As Tim Ennis (pers. comm. 2010) explained:

The public, generally speaking, doesn’t even know what an oak tree is. So you have to take them from what’s an oak tree, why are there so many of them, how come they’re important...Getting as far deep into the subject matter as ‘Aboriginal people traditionally harvested camas and we need to restore a fire management program’...Oh, there’s distance to travel there.

Over the past few years some people have asked me, ‘If First Peoples want to eat camas, why don’t they just grow it in their back yards?’ While this isn’t necessarily a bad suggestion—in fact some Indigenous communities are doing just this—limiting camas cultivation to backyards at this time would restrict the revival of this cultural practice due to the time required to re-establish a useable camas population. Such a statement could also be perceived as offensive, given the history of colonization in this area. As Nancy Turner (pers. comm. 2011) explained:

There used to be camas all over the place and the settlers brought their pigs and cattle in and pretty much decimated most of the camas and made it inaccessible by privatizing the land base and so-forth. So, you're sort of forcing the victim to make their own reparations for injustices that were done in the past...Furthermore the system of camas production that people had here requires pretty large areas to actually produce enough camas to be a viable nutritional option for people. So having a small plot of camas in your yard, like I do, isn't going to really do it. You need a large area where you can do the repetitive selective harvesting and serial harvesting across the landscape.

At this time, participants expressed that getting the wider public to understand why protected areas might be logical and fair places for some form of traditional camas harvesting and management to happen is challenging. Tim Ennis (pers. comm. 2010) emphasized, though, that what the public views as normal on Vancouver Island, BC is slowly changing:

In the last few years, for example, I've seen more than ever before people from the local First Nations harvesting fish at Goldstream...So if the public can handle seeing people fishing salmon out of Goldstream, which is the major 'come and see the salmon spawning, interpretation destination of the whole south Island'...If the public can handle seeing Aboriginal harvesting taking place through largely traditional means in Goldstream Provincial Park, then I think...that's a token or a symbol that observing camas harvesting activities in time, with the right kind of education/interpretation in other regional parks, or provincial parks, or federal parks, or whatever, is going to be palatable too.

There is already a growing group of people who would find the cultivation of camas commendable, given the movement for using local foods. As Brenda Beckwith (pers. comm. 2011) explained: "There's a big push [regionally] for sustainable foods, for local foods, and growing a food that has been grown here for thousands of years. And cultivating camas makes a lot of sense in terms of sustainability". Building acceptance of camas cultivation in parks through such movements could be a very powerful strategy.

Finding Funding

When discussing the potential for cross-cultural ecological management collaborations, several participants raised the topic of sparse employment opportunities for First Nations communities. As Rob Walker (pers. comm. 2011) explained, when approached to collaborate on a project, Indigenous Peoples might ask: ‘Well you’re getting paid to work on it, what about us?’ Walker agreed that it is a completely reasonable question, but explained that it is not as simple as designating excess funding to these collaborations. Participants explained that budgets for ecological work are declining so proposing new projects or expanding funding to include new components in existing projects is challenging.

One approach is for the staff of protected areas to actively seek out Indigenous Peoples to participate in the programs that already have funding. Both Tim Ennis and Rob Walker said they are actively seeking to include Indigenous people in their organizations. For example, the GINPR holds fire suppression training courses, which they invite members of First Nations communities. Walker (pers. comm. 2011) explained:

I want to see those people—because you have to be certified to be on a fire operation or organization—out on those operations, helping us put that cultural fire back on the landscape...I see it as an inherent responsibility—part of our overall federal government fiduciary relationship with First Nations—to try to facilitate opportunities.

Funding for collaborative management of camas populations, or innovative projects that include experimental camas harvesting, could greatly advance the restoration of camas traditions. The challenge to gaining funding for ethnoecological restoration projects is figuring out how to raise the importance of camas harvesting in the eyes of supervisors higher up in the organizations, as well as for funders.

Respecting Indigenous Protocol and Privacy

A challenge for current park managers involves the desire by some Indigenous harvesters to maintain a level of privacy around harvesting and management practices, and cultural events. Because traditional harvesting and management knowledge cannot be shared with everyone, it can make it difficult for non-First Nations managers to work with First Nations peoples, or to ensure a private space for practices like camas harvesting to occur. Cheryl Bryce (pers. comm. 2011) explained an experience with Victoria City Parks:

Twelve years ago or longer, I went to them to talk about their management plans and just say ‘Okay, so you know I do harvest in here. Are you putting any chemicals in this area?’ The problem is they want to know too much. They want to know what you’re harvesting. They want to know the whole practice, which I feel is too [personal]. Like I mentioned, it’s something you pass down through your family.

While requests for privacy are reasonable given the cultural and historical context, it is challenging logistically to keep harvesting activities private, or prevent non-First Nations people from witnessing cultural practices in protected areas, due to the public nature of these spaces. As Fred Hook (pers. comm. 2011) explained:

[Four local chiefs] wanted to do a purification ceremony [in Beacon Hill Park], and we tried very hard to accommodate that. And in the end we were unable to because they required it to be a private ceremony and there was no place in this park where we could satisfactorily ensure them that there would be no non-native observers, that we could keep people away.

Another concern that managers are figuring out is which Nation to collaborate with on management of an area. Some managers fear that by allowing one people from one Nation to harvest or collaborate on management might spark conflict with people in another Nation who feel they have more rights to that piece of land. Tim Ennis (pers.

comm. 2010) expressed this concern:

We don't have any sense of who the rightful owners of our particular camas beds [at the CGOP] would have been...which families, or anything like that...So that adds an interesting dynamic to the subject, to the conversation, because we want to partner with people who are interested in helping us with [management] and doing some harvesting on this site. But we really don't want to offend anybody, or do anything that is out of step with traditional values.

After talking with JB Williams, I understood that this would be dealt with among Nations.

As he explained to me, if someone from one First Nation wanted to harvest or help manage a resource in another First Nations' traditional territory, they would simply ask them permission first (JB Williams pers. comm. 2011). In his words:

You go in there with a good heart and then explain to them...who you are, where you're from, what you're going to harvest and what you're going to use what you're harvesting for. And then just ask their permission...that it's okay to be in their territory harvesting their materials. And you either get a kind-hearted 'yes', or a kind-hearted 'no'.

Williams didn't see this as a concern at all. It is simply part of the traditional protocol. In Utah, Zion National Park has a dual-permitting system with the Southern Paiute to allow for collection of native plants, which deals with this exact issue (Ruppert 2003). A similar system could be worked out with the local First Nations for permitting camas harvesting.

Gaining Trust

A history of negative interactions shadows the process of negotiating respectful cross-cultural collaborations between land managers today. This challenge can be enough to make both First Nations and non-First Nations managers step back from the negotiating table. Some indigenous people are concerned that non-indigenous managers will completely direct collaborative management projects (C. Bryce pers. comm. 2011).

This concern can make some First Nations decide that it is easier to continue working on

their own. In many cases non-First Nations may feel that they are in the position of defending themselves for the actions of their ancestors. As Brenda Beckwith (pers. comm. 2011) explained:

You're not just getting people coming to the table...saying, 'we're going to harvest camas. How are we going to go about doing this?' No, we get people and we get history and we get their ancestry and we get the whole story. And because we are not them, we are—whether we like it or not—seen as the “enemy,” the person who needs to prove themselves. To prove that we are not going to appropriate their knowledge, their land, their resources... And you know, rightly so. But sometimes I wish I could come to a table and we could put all that aside and we could move forward, and just know that we're coming to the table and give each other the benefit of the doubt and with our best foot forward.

Moreover, as First Nations treaties are being negotiated in British Columbia, some managers expressed fear that inviting Indigenous people in to harvest camas, or other plants, could be used as an acknowledgement of traditional territory rights in court cases, and eventually end in a complete take-over of a protected area, or the firing of non-native employees.

Despite concerns, some people are making strides towards working together. It takes courage, forgiveness, patience, an open mind, and, most of all, it takes time. It is clear from both sides of the table, that a certain level of commitment will be required to gain the trust needed to move forward. As Cheryl Bryce (pers. comm. 2011) explained:

It takes time to build those relationships, to trust people as well. So making sure that it's people who are going to be there for the long-term and be able to maintain those relationships. Because that's a lot to share and to work towards, and it would be horrible to put all of that effort into it and then see it just not go anywhere. So I think there definitely is room for [collaboration]. It's just going to take time.

2.4 Summary

In this chapter I have described the social and cultural context of proposed camas harvesting in protected areas on Vancouver Island, British Columbia, that emerged from the interview process. This included:

- (1) The elements involved with restoring camas culture;
- (2) A rationale for including camas harvesting in protected areas;
- (3) Interest and potential strategies for cross-cultural collaboration in the restoration of camas culture in protected areas; and
- (4) Anticipated challenges to carrying out these strategies.

Given the limited extent of camas habitat, protected areas are seen by First Peoples as important places to continue and restore a camas culture. First Peoples appear to believe that harvesting culturally important plants in these areas is their right. Within their culture the roles of manager and harvester are not separate. Therefore, Indigenous peoples who are interested in camas harvesting in protected areas also are interested in having a voice and a role in managing these resources.

Overall, non-Indigenous land managers are supportive of the inclusion of some level of camas harvesting in protected areas. They are interested in developing long-term relationships with people who want to harvest and collaboratively manage culturally important resources. The most likely way they see this happening is through pilot projects, which involve small-scale experimental harvesting and ecological monitoring. In Victoria City Parks it might be more realistic to first work on developing a permit for traditional plant harvesting before trying to establish a collaborative management and monitoring project.

Both Indigenous and non-Indigenous managers discussed a range of anticipated

challenges. Though it seemed for every challenge someone offered a potential solution. Taking small steps to ensure safety of harvested camas and ecological protection was emphasized. Educating the general public about the potential social and ecological benefits of including traditional management in protected areas was also suggested as a necessary step. Lastly, the need for improved cross-cultural communication between Indigenous and non-Indigenous managers was discussed. This last suggestion involves sitting down at a table and having, at times, lengthy and perhaps uncomfortable conversations. But both groups emphasized the importance of gaining trust and a commitment, and that won't happen overnight.

The perspectives gained in these interviews provide a starting point for a cross-cultural conversation around the potential for camas harvesting and collaborative management in protected areas. Although there are many details to work out, as Tim Ennis (pers. comm. 2010) exclaimed: “The future looks bright!” In the next chapter, I present my findings of how one season of experimental camas harvesting affected the existing camas population and wider plant community in a protected area.

Chapter 3: Plant Population and Community Level Responses to Camas (*Camassia leichtlinii*, *C. quamash*) Bulb Harvesting

3.1 Introduction

As discussed in the previous chapter, though camas bulbs are no longer central to the diet or culture of Central Coast Salish Peoples, there is some interest in renewing on the ground harvesting and cultivation traditions. First Peoples wishing to harvest camas bulbs, for food or transplanting, generally visit the most intact plant populations that they can find and access. Since most of the extensive patches of camas on southern Vancouver Island are now found in local parks and protected areas (Senos *et al.* 2006), these sites could play an important role in the renewal of camas harvesting and cultivation traditions.

Over the past 150 years, Garry oak ecosystems have been impacted significantly by fire suppression, conversion of both open and forest ecosystems to agricultural fields, the introduction of domesticated livestock and agricultural crops, and an influx of exotic species (Beckwith 2004; Boyd 1999; Lutz 1995). These shifts in land management systems have substantially changed the soil structure, patterns of hydrology, vegetation composition, and the extent of camas populations across the landscape (Beckwith 2004). These ecological changes, combined with the fragmentation of camas habitat, make the precise effect that camas harvesting would have in today's Garry oak ecosystems uncertain. Understanding how camas harvesting might affect both the camas population and associated ecosystems is important to determining if protected areas can support the renewal of camas traditions. In other words, this chapter outlines whether harvesting of camas bulbs is consistent with the restoration and conservation of ecological integrity.

There are only a few studies that explore the effects of harvesting geophytes on the geophyte population and/or plant community structure (Anderson 1993; Beckwith 2004; Castle 2006; Lloyd 2011). Only one study has examined the effects of camas cultivation on the camas population (Beckwith 2004). Given the current or desired use of protected areas as camas-harvesting sites by some First Peoples, and the growing interest in experimentation with traditional management activities as an ecological restoration strategy, it is evident that we need more information about how camas harvesting might affect the ecology of Garry oak ecosystems today. My field study seeks to clarify how camas harvesting affects the camas populations, plant communities, and soil structure in a deep soil Garry oak savannah ecosystem.

3.1.1 Research Questions

My research explored the ecological sustainability of harvesting camas in a protected area and was based on the following questions:

- 1) How does the simulated traditional harvesting of existing tall camas and common camas populations at varied intensities (no-harvest, low, and medium) affect the weight and abundance of camas bulbs, and the frequency, growth and reproductive capacity of tall camas and common camas individuals?
- 2) What effect does simulated traditional camas harvesting at varied intensity (no-harvest, low, and medium) have on plant community composition within an herbaceous community currently supporting both tall camas and common camas?
- 3) How does the simulated traditional harvesting of existing blue camas populations at varied intensities (no-harvest, low, and medium) affect the level of soil compaction?

To address my research questions, I collected baseline data at the Nature Conservancy of Canada's Cowichan Garry Oak Preserve on both the camas population and the wider plant community, carried out an experimental camas harvesting treatment,

and collected post-harvest data for both the camas population and the associated plant community. Additionally, I sampled the level of soil porosity in my experimental plots on two occasions after the harvesting treatments were applied. By comparing pre- and post-harvest data my research provides a clearer picture of how one season of camas harvesting affects (A) the productivity of the camas population, (B) the plant community composition in a deep soil Garry oak savannah ecosystem, and (C) soil compaction (a measure of soil porosity).

3.2 Research Methods

3.2.1 Study site

Experimental work was conducted at the Nature Conservancy of Canada's (NCC) Cowichan Garry Oak Preserve (CGOP) on southeastern Vancouver Island between Duncan and Maple Bay (Figure 3.1). This 18-hectare preserve contains some of the most extensive and intact Garry oak savannah and woodland habitat in Canada (NCC 2012).

As Tim Ennis, NCC's West Coast Program Manager, explained (pers. comm. 2010):

It is in fact the most intact remnant of a deep soil Garry oak ecosystem left in Canada. And as I understand it contains about half of one percent of that valley bottom Garry oak habitat remains extant in Canada. So it's about as close to extirpated as you can possibly get. And what makes this property the most intact, by definition, would be that in the core areas, where the habitat is at its best quality, it has more numerous native species than it has invasive species. And it has a higher cover of native species, than of invasive species...So that, with all the species at risk populations...some of which we know to be the number one Canadian populations, specifically [Howell's triteleia] (*Triteleia howellii*) for example, those are the kinds of ecological significant pieces that we focus on through our management.

The CGOP is located within the traditional territory of the *Hul'qumi'num* First Nation.

The Elkington family (British settlers) previously owned the land that the CGOP now

manages. They used part of the property for their homestead where they pastured some sheep, had a small dairy, and grew a garden from the 1860s through the mid 1900's. During this time they occasionally held equestrian events (e.g., polo matches) in the lower field on the property (I. Banman pers. comm. 2009).



Figure 3.1 Area map depicting the location of Nature Conservancy of Canada's Cowichan Garry Oak Preserve. This protected area is located just a short distance from Duncan, British Columbia, and contains some of the most intact Garry oak savannah, meadow, and woodland ecosystems in Canada (Google Maps).

The CGOP has been the focus of intensive ecological restoration since its purchase by the Nature Conservancy of Canada (NCC) in 1999. The preserve's ecological restoration and land management program focuses on invasive species control (mainly removal of exotic grasses and shrubs), native species propagation and out-

planting, ecological research and community outreach (I. Banman pers. comm. 2009). As mentioned in Chapter 2, the preserve staff have an interest in expanding their restoration projects to include collaboration with the local First Nation community in the restoration and management of plants with cultural significance, especially camas (I. Banman and T. Ennis pers. comm. 2009). They are particularly interested in understanding how harvesting of camas and post-harvest burning would affect the abundance of exotic plants and the camas population itself. These interests influenced the design of this study.

3.2.2 Field Study Design

In May 2009, 60 experimental plots were established within an area of approximately 150 square metres in a deep-soil site on the CGOP property. This savannah was previously covered by the invasive exotic plants Scotch broom and English hawthorn (*Crataegus monogyna*). These species have been largely extirpated from the site by use of brush saw, chainsaw, and regular hand pulling of germinants (I. Banman pers. comm. 2009). Encroachment by the native shrub, common snowberry, is an ongoing challenge at this site. A regular mowing regime (e.g., every year or two) has been used to control the spread of this invasive (or mid-successional) native into the open savannah. With invasive exotic and native shrubs under control, blue camas and other native forbs²², native grasses, and exotic grasses have all increased in cover (I. Banman pers. comm. 2009).

The official designation for the dominant plant community at this site is “Garry oak (*Quercus garryana*)–tall camas (*Camassia leichtlinii*)-(C36)” (Erickson 1996). The other

²² Forbs are herbaceous flowering plants that are not graminoids (e.g. grasses, sedges and rushes).

most common species present are Kentucky bluegrass (*Poa pratensis*)*²³, orchard grass*, California brome, sweet vernal grass*, common snowberry, common vetch (*Vicia sativa*)*, fool's onion (*Triteleia hyacinthina*) and nipplewort (*Lapsana communis*)*. Upon first seeing this site in February 2009, the field appeared as almost a monoculture of camas leaves (which, at this stage, resembled dense blades of grass). There was evidence of last year's grass still standing dry above the green camas plants.

The experiment was initially set up as a two-way design applying three different harvesting treatments of varying intensities (no-harvest, low, and medium) and two different burn treatments (burn and no burn). However, all 60 plots were burned accidentally in September 2009 thereby turning this study into a single factor (one way) design, where three different camas harvesting treatments of varying intensities were applied to the savannah community (Figure 3.2). It is important to recognize that the prescribed burns likely had an effect on this experiment. Therefore, it is perhaps more accurate to view any changes that occurred pre- to post-harvest as a result of the interaction between harvest and burning.

Original Design			Final Design
Burn (30 plots total)	No Burn (30 plots total)	→	Burn (60 plots total)
No Harvest (x 10)	No Harvest (x 10)		No Harvest (x 20)
Low Harvest (x 10)	Low Harvest (x 10)		Low Harvest (x 20)
Medium Harvest (x 10)	Medium Harvest (x 10)		Medium Harvest (x 20)

Figure 3.2 Two-way study involving both camas harvesting and burning treatments turned into a one-way study where burning is a constant and camas harvesting at three levels (no-harvest, low, and medium) is the single variable.

²³ * Indicates exotic species.

The layout of my field study is shown in Figure 3.3. There were 20 replicates of each harvest-intensity. Each plot covered 1.0 square metre (1-m²) and individual plots were spaced at a minimum of 0.5 metres apart. Plots were marked with rebar and coloured flagging in the NE and SW corners to designate the boundaries of each plot.

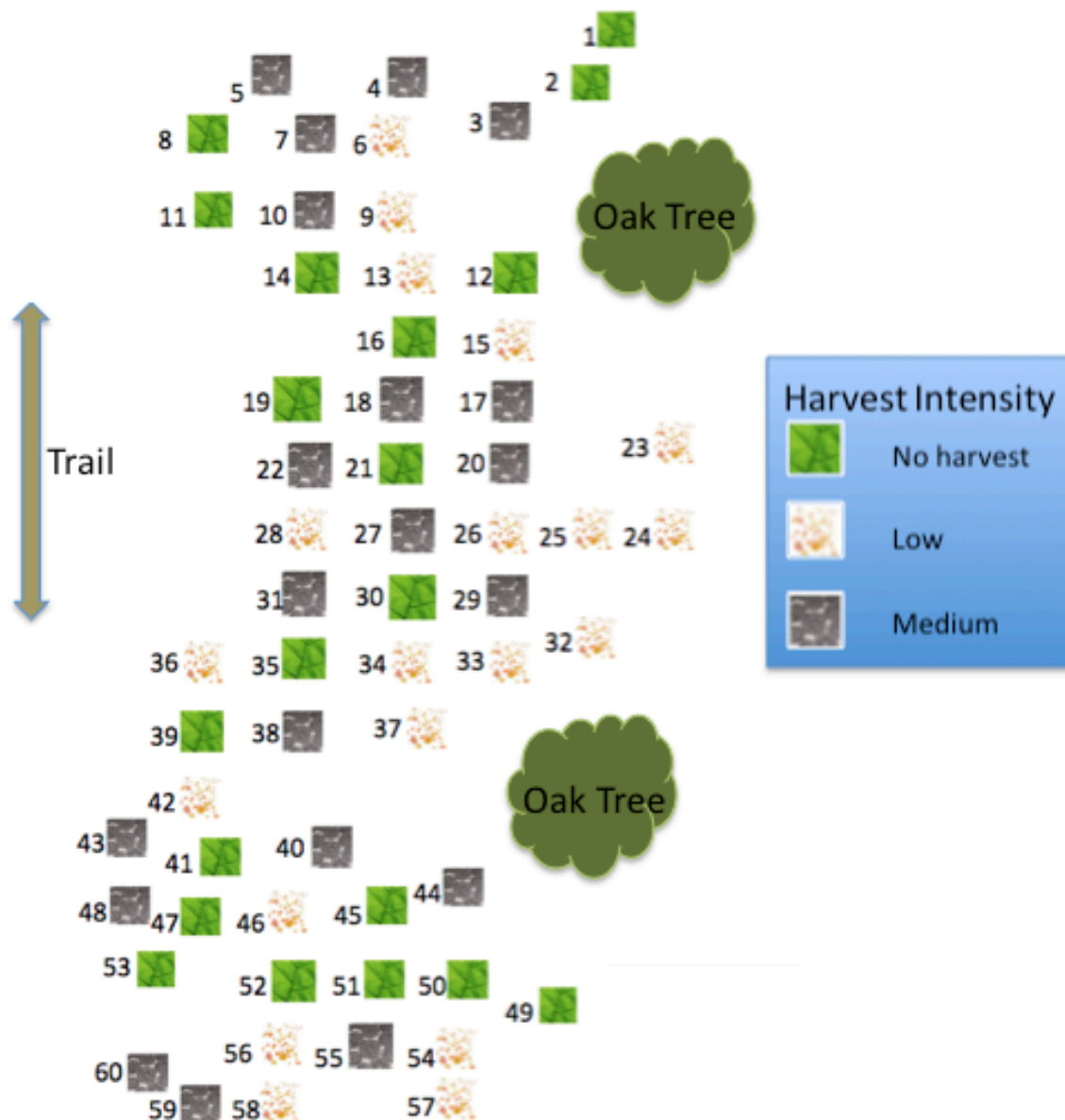


Figure 3.3 Map showing layout of experimental camas harvesting plots at the Nature Conservancy of Canada's Cowichan Garry Oak Preserve between Duncan and Maple Bay British Columbia. Harvesting intensity is depicted with coloured symbols referenced in the key. Each plot is 1.0 square metre.

Since there are two very large Garry oak trees bordering the savannah, an attempt was made to set up the experimental plots outside of the shade and roots of these trees so as to avoid the potential influence of ecological micro-site factors, such as competition with tree roots for water or differences in access to sun light.

Table 3.1 summarizes the timing and types of data collected in my experimental camas harvesting study.

Table 3.1 Experimental camas harvesting study timeline and types of data collected.

Study year	Data Collected/Experimental Treatment	Dates
2009	Plant community data collected	May 17-22
	Blue camas population data collected: - Number of flowering blue camas plants - Stem height of flowering blue camas - Number of blue camas fruits and flowers per stem	June 9-18
	Camas bulb harvesting treatment carried out (No-harvest, Low intensity, and Medium intensity)	July 7-23
	All experimental plots accidentally burned	September 15
	Soil porosity data collected	December 3
2010	Plant community data collected	May 10-16
	Blue camas population data collected: - Number of flowering blue camas plants - Stem height of flowering blue camas - Number of blue camas fruits and flowers per stem Soil porosity data collected	June 1-7 July
	All blue camas bulbs from 9 plots harvested, weighed, and categorized by size and shape	November 20- December 31

3.2.3 Collecting Baseline Plant Community Data

From May 17 to 22, 2009, using a point intercept grid method, I collected abundance and diversity data on plant species. I placed a 1-m² wooden frame with 100 intersecting points over each plot, using the rebar in the NE and SW corners to centre the

frame (Figure 3.4). With the help of a field assistant I identified and recorded the plant species under each of the 100 points. Because the frame was slightly elevated above the ground, I placed a metal rod of approximately one cm in diameter at the intersections, lowered it to the ground and recorded the plants rooted directly under the rod. Often, more than one plant was recorded for each point. After all 100 points were sampled, I recorded additional species that were observed in the plot but did not fall under any of the intersecting points and gave them an abundance of “one” to record that they were present, but not abundant enough to be detected by random sampling.



Figure 3.4 a) Measuring abundance and plant diversity July 2009 at the CGOP. Lowering a metal rod at the intersect point to the ground and recording the plants rooted directly beneath the rod; b) Field site demonstrating plant diversity with chocolate lily in bloom and tall camas just prior to blooming (Photos taken by Kate Proctor).

3.2.4 Collecting Data on Mature Camas Plants and Assigning Harvesting Treatments

From June 9 to 18, 2009 I collected demographic data on the mature camas (e.g., common and tall camas) population in my plots. Even though I noted the species during data collection there were so few common camas relative to tall camas that I ended up

lumping both species together for analysis. I considered camas plants to be mature if they had a visible flowering stalk. I began by tying a plastic tag with a unique code designating the plot number and plant number (e.g., plot 43-plant 6) around the base of all flowering camas individuals. Using these codes as a numbering system, I measured and recorded the stalk height, and counted the total number of fruit capsules, aborted fruit capsules, and aborted flowers for each mature camas plant once during the growing season (Figure 3.5).

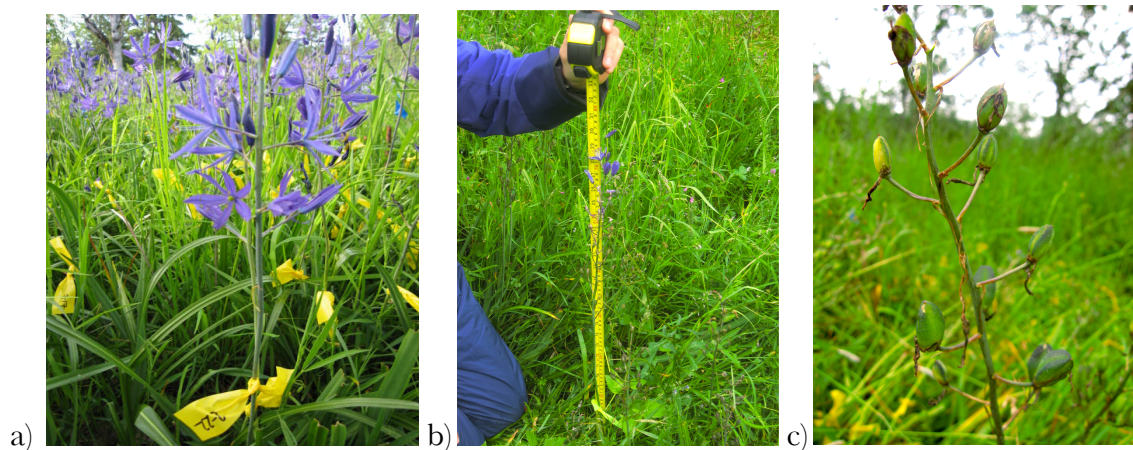


Figure 3.5 a) Mature (flowering) camas plants tagged with plot number and plant number code; b) Measuring the camas stalk height; c) Camas fruit capsules (number of capsules, number of aborted fruit, and number of aborted flowers were counted for each stalk) (Photos taken by Kate Proctor).

Following this data collection for all 60 plots I randomly assigned each plot a harvesting treatment (e.g., no harvest, low intensity, or medium intensity harvest) by pulling numbers randomly out of a hat. Based on the number of mature camas plants in a plot and the plot's assigned harvesting intensity, I determined how many camas plants would be harvested. In plots assigned *medium-intensity harvest*, all of the tagged mature/flowering camas plants were harvested. In the plots assigned *low-intensity harvest* 50% of the flowering stems were harvested. I determined the individual camas plants to

be harvested by pulling numbers randomly out of a hat. If there was an even number of mature camas plants in a plot assigned low-intensity harvest, I harvested exactly half of the mature plants. If there was an odd number of mature camas plants in a plot designated for low-intensity harvest I divided the total in half then rounded upwards. The tags marking mature blue camas plants that were *not* to be harvested were removed prior to the harvest.

3.2.5. Counting Seed and Harvesting Camas Bulbs

From July 7 to 23, 2009 I took a sample of camas seeds and applied the camas harvesting treatment. Directly before bulb harvesting commenced a field assistant and I took a sample of seed capsules from mature camas plants (approximately 10 per plot) from each plot (Figure 3.6a). The number of seeds in these capsules was recorded, along with the species name (tall or common camas). After the camas seeds were counted we scattered the seeds²⁴ over the plots they were taken from.

A crew of 21 volunteers harvested the camas bulbs over the course of two weeks. There were typically three volunteers with me on any given day and most people only came for one day. We removed bulbs of mature blue camas plants using a variety of tools, including metal shovels, trowels, wooden digging sticks (modeled after Coast Salish digging sticks) and our hands (Figure 3.6b and 3.6c). We used a metal shovel to create an edge along one side of the plot and soil was removed in increments (approximately 10 cm thick) until the base of a marked blue camas plant was reached. A metal trowel or wooden digging stick was used to dig carefully around the plant, following the stem down to the

²⁴ Scattering seeds post-harvest has been documented as a traditional management practice on southern Vancouver Island and other areas where root vegetables were harvested (Turner and Kuhnlein 1983).

bulb (Figure 3.6d and 3.6e). Sometimes the connection between the bulb and the stem was lost during the harvesting process. We made an effort to find the bulb that was attached to the stem, but on some occasions, the target bulb was not definitively found. Harvested bulbs were set aside for cooking or donation to restoration projects. After a plot was harvested the disturbed soil and unmarked bulbs were replaced (Figure 3.6f). Once a bulb was removed from the soil, it was detached from its stem and weighed.

Estimating Harvest Intensity

The harvesting treatment involved the removal of camas bulbs at three different intensities—none, low, and medium. While I determined the quantity of bulbs to be harvested in each plot based on the number of *flowering camas stalks*, it would be misleading to describe the percentage of camas bulbs harvested in relation to these numbers since there were many dormant and non-flowering camas bulbs of harvestable size. To provide a more accurate description of the percentage of bulbs harvested in relation to the total potential for harvestable size bulbs, I made a calculation based on the mean number of flowering camas individuals, in both 2009 and 2010, per plot (approximately 50 flowering bulbs), divided by the mean number of size class *five* bulbs per plot (approximately 170 bulbs) harvested in the total plot excavations in 2010. This calculation yielded the approximate percentage of class size *five* bulbs (e.g., the largest bulbs of harvestable size) harvested at the low intensity ($\sim 15\%$) and medium intensity ($\sim 30\%$).

To provide a description of the bulbs harvested in relation to the total bulb population, I made another calculation based on the mean number of flowering camas individuals, in both 2009 and 2010, per plot (approximately 50 flowering bulbs), divided by the mean number of bulbs (in all size classes) per plot (approximately 1600 bulbs). This



Figure 3.6 a) Harvested camas pods and seeds; b) Volunteers harvesting with yew and oceanspray wooden digging sticks; c) Volunteers loosening the soil around the edges of the experimental plot with metal shovels; d) Volunteer with camas bulb and stalk intact; e) Marked camas bulb with stalk intact; f) Harvested plots with soil, camas bulbs, and sod replaced (Photos taken by Kate Proctor).

calculation yielded the approximate percentage of bulbs harvested, relative to the total bulb population, at the low intensity ($\sim 0.0156\%$) and medium intensity ($\sim 0.0313\%$).

3.2.6 Accidental Prescribed Burn

Despite my intention to burn only half, or 30 of the 60 plots, the staff at the CGOP accidentally burned all 60 of the experimental plots on September 15, 2009 as part of their experimental burning program. Although I was not present during the prescribed burn, I was able to interview Irvin Banman on September 24 about the procedures used in the burns. The following description is a summary of this interview:

On the day of the burns, the weather was overcast and breezy, with some occasional large gusts of westerly winds coming up from the lake. People present at the burn included Irvin Banman, Tim Ennis, Leigh (NCC intern), and Don Granthum (fire dispatcher). Before burning commenced, around 1:30 pm, a buffer of approximately 1.5 metres was mowed around the outside edge of the plots. The mowed area was then saturated for approximately 20 minutes. Water from this saturation likely blew into the plots, though no water was intentionally sprayed into the plots at this point.

Banman started the fire in the southwest corner of the savannah using a drip torch (Figure 3.7a), and continued igniting the grass around the perimeter until the fire from all sides met in the middle. Not all of the areas readily burned, so Banman followed up by igniting individual plots (Figure 3.7b). Banman noted that the fire moved much more slowly in the plots where harvesting had taken place than outside the plots. The fire height varied from approximately 0.15 m to 0.3 m tall inside the plots (Figure 3.7c). The burn took approximately one half hour to complete. After the burn was completed, the entire area was sprayed using fire hoses (I. Banman, pers. comm. 2009).

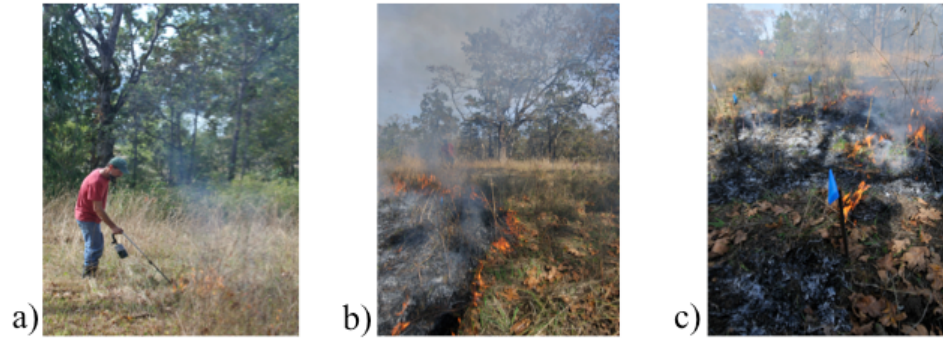


Figure 3.7 Burn procedure and fire intensity of accidental prescribed burn at the Cowichan Garry Oak Preserve on September 15, 2009 (Photos courtesy of Tim Ennis).

3.2.7 Measuring Soil Compaction

On December 3, 2009, using a Lang PenetrometerTM, I measured soil compaction (a measure of soil porosity) in all sixty plots. To measure soil compaction I pressed the probe's pin completely into the soil and read resistance to penetration. The penetrometer records resistance from 1 to 20 pounds per square inch (2.54 cm²). I repeated this measurement five times for each plot, submerging the penetrometer once into the approximate centre of each quadrant, and once into the approximate middle of the plot.

3.2.8 Re-Sampling Experimental Plots

From May 10 to 16, 2010 I re-sampled plant species abundance and diversity in all sixty plots using the same grid method described above (Section 3.2.3 and Section 3.2.4). From June 1 to 7, 2010 mature camas plants in all 60 plots were marked and numbered, and data were collected for all marked plants on height, number of fruits, aborted fruits, and aborted flowers as described above. Soil compaction (e.g., soil porosity) was re-measured in July 2010 using the same technique as described above. A sample of camas capsules was collected from all plots at this time and the seeds in these capsules were counted. Approximately 10 capsules were sampled from each plot, though this number of capsules sampled was sometimes greater if there were a large number of

mature camas plants in the plot.

3.2.9 Complete Camas Bulb Harvest in November/December 2010

Between November 20 and December 31, 2010 I returned to the field to collect *all* of the camas bulbs in nine plots (three replicates of each harvesting treatment). The purpose of this bulb harvest was to make observations about the total quantity of camas bulbs present in the 1-m² plots, to describe the size/age distribution of the camas bulb population, and to determine how harvesting camas bulbs in one year might affect bulb quantity. Another goal was to document the morphological variation in bulb size and shape.

Digging the soil and bulbs involved placing the 1 x 1 metre grid around the plot and marking a visible edge with the shovel around the sides of the grid. After the edge was made, the shovel was used to cut the plot into smaller squares. These squares, including sod, soil and soil components, were lifted into large plastic bins. The ground was quite soft from weeks of rain, so digging at this time was much easier than it was in July. The initial approach was to collect all of the soil and bulbs in the nine plots and bring this material back to the University of Victoria where a team of volunteers would sift through the soil, count, weigh, and measure the bulbs. This method proved to be quite challenging due to the large volume and weight of the soil and, therefore, this method was used for only the first three plots of soil and bulb collection.

For the remaining six plots we carried out a partial sorting in the field and completed the sorting of the sod layer in the lab. A field assistant and I harvested the sod layer for each plot, making an effort to keep approximately a 10 cm layer of topsoil intact

with the grassy clump. Keeping the sod with the soil was essential as there were many small bulbs intermixed with this top layer that could have easily been missed in a rough digging. After placing this layer of sod in a bin, we did a thorough dig and sorting of the remaining soil and bulbs, stopping when we hit either a clay or rock layer. The depth of this layer varied, but was typically 25 cm beneath the soil. We then used a 1-metre square screen, with 0.5 cm grid holes, to sift through this remaining soil in the plot. We likely collected all of the medium to largest sized bulbs, including the elongating bulbs.

Sifting through the Sod Layer for Camas Bulbs

The sod and the harvested bulbs were taken to the University of Victoria where the sod layer was picked apart and sifted through a screen. Bulbs of all sizes were removed and placed onto a tray for sorting into size classes. To prevent bulbs from drying out, the trays were lined, and the bulbs were covered, with moist paper towels until they were ready to be sorted, weighed and measured. Bulbs remained on these trays for anywhere between 15 minutes to several hours, depending upon the number volunteers present to process them.

I am certain that not all bulbs were found during the sorting process, as some were small enough to slip through the screen. However, I am confident that almost all of the largest bulbs were found. Some of the bulbs had pieces missing due to the process of harvesting with a metal shovel. If the majority of the bulb was still intact (e.g., three quarters or more) the bulb was included in the measuring process. If the bulb was cut in half, an effort was made to match the bulb up with its severed half. If this half could not be found, the partial bulb was not included in the measurements.

Sorting, Weighing and Measuring the Bulbs

The camas bulbs were first roughly measured on grid paper with 1 cm squares and placed into five shape and size classes (Table 3.2).

Table 3.2 Camas bulb size class data collected in total excavation of 9 experimental plots at the Cowichan Garry Oak Preserve, from November 20 to December 31, 2010.

Bulb size and shape class	Size class description	Bulb weight data collected	Bulb width data collected	Bulb length data collected
1	Tiny bulbs length: 0-1 cm	Every <i>tenth</i> bulb was measured	Every <i>tenth</i> bulb was measured	Every <i>tenth</i> bulb was measured
2	Small bulbs length: 1-2 cm	Every <i>fifth</i> bulb was measured	Every <i>fifth</i> bulb was measured	Every <i>fifth</i> bulb was measured
3	Medium bulbs length: 2-3 cm	Every <i>fifth</i> bulb was measured	Every <i>fifth</i> bulb was measured	Every <i>fifth</i> bulb was measured
4	Elongated bulbs length: > 1 cm	<i>All</i> bulbs weighed individually	<i>All</i> bulbs were measured	Every <i>fifth</i> bulb was measured
5	Largest bulbs (not elongated) length: > 3 cm	<i>All</i> bulbs weighed individually	<i>All</i> bulbs were measured	Every <i>fifth</i> bulb was measured

Width and length measurements were taken in order to assign bulbs to size and shape class. The width was measured at the widest part of the bulb. Length was measured from the base of the bulb to the top of the bulb sheath (Figure 3.8).



Figure 3.8 Width of the camas bulb was measured at widest part. Length was measured from the base of the bulb to the top of the bulb sheath.

Only whole bulbs were used for this measurement, but otherwise bulbs were chosen randomly (e.g., a bulb was grabbed from the pile without looking at the bulbs). A digital scale was used to weigh the bulbs to the nearest hundredth gram.

Camas bulbs in size classes Four and Five (the largest size classes) were measured with the greatest detail because they demonstrated a higher variability in shape and weight. Weight and width measurements were taken for *all* bulbs in size classes four and five. Length was measured for every fifth bulb. The bulbs in size classes One, Two, and Three (the smaller size classes) demonstrated a lower variability in mass therefore subsets of these bulb classes were measured and weighed. A sub-sample of these size classes was sampled taking a random sample from each class. Bulbs in class Two and Three were randomly placed into groups of five. Bulbs in class One were placed randomly into groups of ten.

Returning the Soil and Bulbs to the Field

After the sorting, weighing, and measuring of the camas bulbs was completed, the soil, with most of the camas bulbs, was taken back to the CGOP and redistributed back into the plots. We made an effort to put the largest bulbs (including the elongating bulbs) at the bottom and the smallest bulbs towards the top with a layer of soil on top (to protect the bulbs from predation, desiccation, and to promote re-establishment). A portion of the larger bulbs went to local restoration projects.

3.2.10 Statistical Analysis

Univariate and multivariate approaches were used to examine changes in the camas population, plant community composition, and soil porosity. These approaches are

described in the following sections.

Camas Population Responses to Camas Harvesting Treatments

To examine the responses of the camas population to experimental harvesting treatments, I performed univariate statistical analyses using SPSS (V17). The following null hypothesis was tested using a one-way Analysis of Variance (ANOVA):

H01: Harvesting treatment has no effect on existing camas populations.

The first set of camas response variables tested for H01 were pre- to post-harvest changes in:

- (1) Number of flowering camas per plot;
- (2) Mean height of flowering camas stalks per plot; and
- (3) Mean number of fruits, aborted fruits, aborted flowers and potential fruits²⁵ per camas stem.

A second set of camas population response variables was also tested for H01. These comparisons utilized post-harvest (e.g., year two) data only, and made comparisons between plots with different harvest treatment intensities. They included the following response variables:

- (1) Mean number of camas seeds per pod;
- (2) Total bulb weight per plot;
- (3) Total number of bulbs per plot,
- (4) Mean bulb weight per plot;
- (5) Total bulb weight in each size class (1-5);
- (6) Total number of bulbs in each size class (1-5); and
- (7) Mean bulb weight in each size classes (1-5).

Assumptions for normality and equal variances were checked using the Shapiro-Wilk test and Levene's test, and by examining normal Q-Q plots and histograms of the

²⁵ Potential number of fruit was calculated by adding the number of fruit, number of aborted fruit and number of aborted flowers.

frequency distribution of the variables. Data have normal distribution and equal variances ($p \geq 0.05$) unless stated otherwise in the results.

Plant Community Response to Camas Harvesting Treatments

I performed both univariate and multivariate analyses to examine changes in the plant community composition and frequency of plant species. The following null hypothesis was tested:

H02: Harvesting treatment has no effect on plant community composition and frequency of plant species.

Univariate Analyses

I created categories of plant species using two factors: native vs. non-native, and species growth habit (e.g., forb, grass, tree). I ran one-way ANOVA's using SPSS (V17) comparing the number of individuals in every category for each treatment. To examine pre- to post-harvest changes in species frequency per plot, I ran one-way ANOVA's using SPSS (V17) comparing the number of each species for all three treatments. Assumptions for normality and equal variances were checked using the Shapiro-Wilk test and Levene's test, and by examining normal Q-Q plots and histograms of the frequency distribution of the variables. Data have normal distribution and equal variances ($p < 0.05$) unless stated otherwise in the results.

Multivariate Analyses

In addition to the one-way ANOVA model, the null hypothesis was tested using a multivariate approach. This approach involved calculating a Bray Curtis Distance matrix, and performing an analysis of similarity (ANOSIM) test, and a similarity of percentages (SIMPER) test in PRIMER (V6). This calculation and the two tests are described below.

Prior to conducting the multivariate analysis, I eliminated the plant species that were in less than 10 percent of my plots. This elimination was done to reduce the influence of un-common species that would make otherwise very similar plots appear to be substantially different in such an analysis. Making the cut-off at 10 percent allowed common camas to remain in the multivariate analysis, though it was in exactly 10 percent of my plots. Because there was a sampling range of 100-215 individuals per plot, I standardized my data by samples (i.e. plots), so sample totals were all equal to 100 percent. This calculation removed differences in total abundance of individuals sampled between plots, turning counts for each sample into relative percentages.

Prior to calculation of the dissimilarity matrix, I transformed the data using a square root calculation to reduce the dominant contribution of abundant species on the Bray-Curtis similarity calculation (Clarke and Gorley 2006). This transformation effectively allowed the changes of less abundant species (which were the majority of the species present) to be detected where they might otherwise be missed in a plant community that was dominated by only a few species (e.g., *Camassia leichtlinii*, *Dactylis glomerata*, *Poa pratensis*, and *Vicia sativa*).

Using standardized and square root transformed species frequency data collected in each plot both pre- and post-harvest, I calculated a Bray Curtis Distance matrix in PRIMER (V6) (Clarke and Gorley, 2006; Clarke and Warwick, 2001). This matrix provided a basis for conducting the multivariate analyses. To test for statistical differences in plant community composition between experimental plots, I used PRIMER (V6) to perform an analysis of similarity (ANOSIM) on the following groups:

- (1) 2009 No harvest plots;
- (2) 2009 Low intensity pre-harvest plots;
- (3) 2009 Medium intensity pre-harvest plots;
- (4) 2010 No harvest plots;
- (5) 2010 Low intensity post-harvest plots; and
- (6) 2010 Medium intensity post-harvest plots.

ANOSIM acts on the resemblance matrix and runs a test analogous to the standard univariate one- or two-way ANOVA (analysis of variance). ANOSIM tests the null hypothesis that there are no significant differences in species composition among groups specified by a single factor. The significance of the R_{ANOSIM} statistic was calculated by performing 9999 randomizations on my standardized and transformed plant community data. If the global R is larger than any of the 9999 permuted values then the null hypothesis is rejected at a significance level of $p < 0.0001 = p < 0.01\%$ ($< 1/9999 = < 0.0001$). ANOSIM also performs pair-wise tests to examine differences between groups. Using the following factors, Year (2009/2010) and Harvest Treatment (no harvest/low intensity/medium intensity), I carried out pair-wise tests with the groups described above.

All ANOSIM tests yield a R_{ANOSIM} statistic that can be used to evaluate the similarity/dissimilarity between samples or groups. 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 (Clarke and Warwick 2001). Clarke and Warwick (2001) suggest that the global R will never get larger than 0.15 unless there is some real difference between groups. To assess the relative contributions of plant species to the similarity/dissimilarity measures, I used the Similarity Percentages (SIMPER) test of PRIMER.

Effect of Harvesting on Soil Porosity

Univariate statistical analyses were performed using SPSS (V17) to examine the

effect of experimental harvesting treatments on the soil porosity. The following null hypothesis was tested using a one-way Analysis of Variance (ANOVA):

H03: Harvesting treatment has no effect on the level of soil porosity.

Two separate one-way ANOVAs were run on the soil porosity measurements that were taken twice *after* the harvesting and burning treatments occurred: once in December 2009 and again in July 2010.

3.3 Results

3.3.1 Camas Population Response to Camas Harvesting Treatments

Question 1: How does one season of simulated traditional harvesting of camas bulbs in an existing blue camas population at varied intensities affect the weight and abundance of camas bulbs, and the frequency, growth, and reproductive capacity of camas individuals?

Harvesting of camas bulbs in July 2009 at both low and medium intensity, followed by a prescribed burn in September 2009, did not significantly affect the weight or abundance of camas bulbs or the quantity, stem height or flowering/fruitleting potential of the 2010 camas populations (see Appendix 6.1a & 6.1b for summary tables of the above- and below-ground camas population data). *None* of the ANOVA tests I ran on the camas population variables yielded significant results (Table 3.3). I have excluded the results for changes in total weight and mean of bulb in size classes One – Four in this table. The ANOVA results for bulb size class Five, the largest size class, were included because this is the size of bulbs that were harvested in the experiment and would be harvested, theoretically, for food today by Central Coast Salish Peoples.

Table 3.3 Results of one-way ANOVA's testing the response of the camas population to camas bulb harvesting at two different intensities. No significant results were found for any variable.

Camas Population Variables	F	df	P
Total camas bulb weight per plot	3.725	2, 6	0.089
Number of camas bulbs per plot	2.568	2, 6	0.156
Total camas bulb weight in <i>size class Five</i> per plot	2.577	2, 6	0.156
Number of <i>size class Five</i> camas bulbs	2.157	2, 6	0.197
Number of flowering camas plants	0.583	2, 57	0.562
Stem height of flowering camas	0.541	2, 57	0.585
Number of viable camas fruit per stem	0.054	2, 57	0.948
Number of potential camas fruit per stem	0.066	2, 57	0.937
Number of camas seeds per pod	2.008	2, 57	0.144

3.3.2 Plant Community Response to Camas Harvesting Treatments

Question 2: *What effect does one season of simulated traditional blue camas harvesting have on overall plant community composition within an herbaceous community currently supporting camas?*

Univariate Results of Plant Community Composition

There were only three categories—native shrubs, exotic shrubs, and exotic annual forbs—that showed significant changes after a harvest treatment (and prescribed burn).

The results from this analysis are summarized in Table 3.4.

Table 3.4 Harvesting induced changes in plant categories found in ANOVA's and contrast tests. Significant results are in bold.

Growth Habit	F	df	P	Contrast: No Harvest & Low Intensity Harvest	Contrast: No Harvest & Medium Intensity Harvest
<i>Reduced</i>					
Native shrubs	4.036	2, 57	0.023	$t_{57} = 0.819$ $P = 0.416$	$t_{57} = 2.766$ $P = 0.008$
<i>Increased</i>					
Exotic shrubs	4.452	2, 57	0.016	$t_{57} = -2.774$ $P = 0.007$	$t_{57} = -2.338$ $P = 0.023$
Exotic annual forbs	9.303	2, 57	<0.001	$t_{57} = -2.923$ $P = 0.005$	$t_{57} = -4.209$ $P < 0.001$

Harvesting significantly reduced ($F_{2, 57} = 6.829$, $P = 0.002$) the abundance of

Kentucky bluegrass (*Poa pratensis*), though this harvest-induced reduction was not seen with other exotic perennial grasses. Harvesting significantly reduced ($F_{2, 57} = 3.338$, $P = 0.043$) the abundance of common snowberry (*Symphoricarpos albus*). Harvesting significantly increased the abundance of Scotch broom (*Cytisus scoparius*). Harvesting significantly increased the abundance of weedy or exotic annual forbs ($F_{2, 57} = 9.303$, $P < 0.001$), including common cleavers (*Galium aparine*)²⁶, hairy cat's ear (*Hypochaeris radicata*), and nipplewort (*Lapsana communis*). (See Appendix 6.2 for a summary table of the plant population data). The significant changes in species frequency are summarized in Table 3.5.

Table 3.5 Harvesting Induced Changes in Plant Species ANOVA's and Contrast Tests²⁷ (Starred-*-plants are exotic species).

Species	F	df	P	Contrast: No Harvest & Low Intensity Harvest	Contrast: No Harvest & Medium Intensity Harvest
<i>Reduced</i>					
*Kentucky bluegrass (<i>Poa pratensis</i>)	6.829	2, 57	0.002	$t_{57} = 1.937$ $P = 0.058$	$t_{57} = 3.694$ P < 0.001
Common snowberry (<i>Symphoricarpos albus</i>)	4.075	2, 57	0.022	$T_{37.643} = 1.170$ $P = 0.249$	$t_{28.832} = 2.466$ P = 0.020
<i>Increased</i>					
*Log10 Scotch broom (<i>Cytisus scoparius</i>) + 14	3.338	2, 57	0.043	$T_{57} = -1.963$ $P = 0.055$	$t_{57} = -2.436$ P = 0.018
* Common cleavers (<i>Galium aparine</i>)	3.897	2, 57	0.026	$T_{57} = -0.636$ $P = 0.527$	$t_{57} = -2.672$ P = 0.010
*Log10 Hairy cats ear (<i>Hypochaeris radicata</i>) + 26	9.898	2, 57	<0.001	$t_{57} = -2.698$ P = 0.009	$t_{57} = -4.413$ P < 0.001
*Log10 Nipplewort (<i>Lapsana communis</i>) +9	4.351	2, 57	0.017	$t_{57} = -2.466$ P = 0.017	$t_{57} = -2.635$ P = 0.011

²⁶ The status of common cleavers (*Galium aparine*) as native or introduced (e.g. exotic) is somewhat debated in the ecological literature (Gucker 2005). However, in this study I considered common cleavers to be introduced in line with other local ecologists (e.g., GOERT 2013; MacDougall 2005, 2007).

²⁷ A Log10 transformation of *Cytisus scoparius*, *Hypochaeris radicata*, and *Lapsana communis*, corrected for poor homogeneity of variance. After the transformation I corrected for negative values. No transformations worked to correct homogeneity of variance for *Symphoricarpos albus*, so an ANOVA was run on the untransformed data. The output for the *Symphoricarpos albus* contrast tests provided two results (one for equal variance, and one that does not assume equal variance). I used the results that did not assume equal variance, which meant that the degrees of freedom (*df*) for this contrast test differed from the others.

Multivariate Results of Plant Community Composition

The ANOSIM test yielded a global $R = 0.167$, $p < 0.0001$ suggesting that while there were statistically significant differences in plant community composition, these differences can be considered minor since $R < 0.25$. However, since $R > 0.15$, it was worth investigating whether there was a clear trend in any of the pair-wise tests. Comparisons between 2009 plots designated ‘no harvest’, ‘low-intensity harvest’, and ‘medium intensity harvest’ all yielded R_{ANOSIM} values of zero (or close to zero), or essentially no meaningful difference between groups. This shows that the plant community composition prior to harvesting was relatively homogenous. Comparisons between 2009 ‘no harvest’ plots and 2010 ‘no harvest’ plots yielded an R_{ANOSIM} value of 0.184, $p < 0.0003$. This R_{ANOSIM} value suggests a small, yet significant, difference in the plant community composition between years with no harvesting.

Comparisons between the 2009 low intensity pre-harvest plots and 2010 low intensity (~15%) harvest plots yielded an R_{ANOSIM} value of 0.155, $p < 0.001$, or significant with minor differences in plant community composition. This R_{ANOSIM} value is so close to 0.15 that it is difficult to show that there are real differences in the plant community composition between these groups. A comparison between the 2009 medium intensity pre-harvest plots and 2010 medium intensity (~30%) harvest plots yielded an R_{ANOSIM} value of 0.359, $p < 0.0001$, or significant with moderate differences in plant community composition. The R_{ANOSIM} is high enough (> 0.25) to warrant a closer investigation.

I used the Similarity Percentages (SIMPER) test of PRIMER to assess the relative contribution of different species on the significant differences (R_{ANOSIM} of 0.359, $p < 0.0001$) in species composition between the medium intensity pre- and post-harvest

plots. The results are summarized in Table 3.6. (See Appendix 6.2 for a summary of the plant community data). The species are ordered based on their relative contribution towards differences in composition in a group. In some cases species abundance increased, while in other cases it decreased.

Table 3.6 Results of SIMPER Detailing the Species Contributions to the Average Dissimilarity Between 2009 and 2010 Medium Intensity Harvest Plots.

Species	Growth Form	2009 Average Abundance Pre-Harvest Medium Intensity	2010 Average Abundance Post-Harvest Medium Intensity	Species' Contribution to Differences Between Years (%)	Species' Cumulative Contribution to Differences Between Years (%)
<i>Anthoxanthum odoratum</i>	Exotic perennial grass	2.30	1.28	8.61	8.61
<i>Symphoricarpos albus</i>	Native shrub	2.55	1.65	7.70	16.32
<i>Lapsana communis</i>	Exotic annual forb	1.05	2.24	7.43	23.75
<i>Vicia sativa</i>	Exotic perennial forb	3.44	2.11	6.15	29.90
<i>Triteleia hyacinthina</i>	Native perennial forb	0.72	1.74	5.90	35.80
<i>Poa pratensis</i>	Native perennial grass	2.58	2.48	5.43	41.23
<i>Camassia leichtlinii</i>	Native perennial forb	6.16	6.52	5.26	46.49
<i>Cytisus scoparius</i>	Exotic shrub	0.34	1.05	4.63	51.13

3.3.3 Effect of Camas Harvesting Treatment on Soil Porosity

Question 3: How does the simulated traditional harvesting of camas bulbs in an existing blue camas population at varied intensities affect the level of soil compaction (e.g., soil porosity)?

The camas harvesting treatment (e.g., the combined data for both low and medium intensity harvest), along with the post-harvest burn significantly, increased ($F_{2,57} = 5.401$, $P = 0.007$) the level of soil porosity measured in December 2009. When each

harvest intensity was analyzed separately, pair-wise comparisons showed that plots harvested at *medium* intensity had significantly higher ($t_{2, 57} = 3.287$, $P = 0.002$) soil porosity, as compared with the control (no-harvest plots), while those plots harvested at *low* intensity did not have significantly higher ($t_{2, 57} = 1.641$, $P = 0.106$) levels of soil porosity.

Measurements taken seven months after the initial post-harvest soil porosity sampling (July 2010) still showed a significant ($F_{2, 57} = 20.469$, $P < 0.001$) decrease in soil porosity due to harvesting (e.g., this test utilized combined data for both low and medium intensity harvest). Pair-wise (contrast) tests carried out on these data showed that plots harvested at both low ($t_{2, 57} = 3.484$, $P < 0.001$) and medium intensity ($t_{2, 57} = 4.465$, $P < 0.001$) had a significantly higher level of soil porosity as compared to the control (e.g., no harvest). (See Appendix 6.3 for a summary table of the soil porosity data).

3.3.4 Annual Trends Independent of Harvesting

Comparison of no-harvest plots in 2009 and no-harvest plots in 2010 demonstrated that there were significant changes in both the camas population and plant community that occurred independent of harvesting. (See Appendices 6.1 and 6.2 for a summary of camas population and plant community data). The changes seen between years in the no-harvest plots are summarized in Table 3.7.

Multivariate ANOSIM analyses on no-harvest (i.e. control) plots between years also showed significant changes ($R=0.184$, $p=0.03$) in species composition. I ran a SIMPER test on these data to determine which species were contributing to the between year changes. The results of this test are displayed in Table 3.8.

Table 3.7 Summarizing Annual Changes in 'No Harvest Plots': ANOVA's of Camas Population and Plant Community Composition Independent of Harvesting

Variable	Annual Change in No Harvest Plots	F	Df	P
<i>Camas population</i>				
Number of flowering camas	Increase	24.107	1, 38	<0.001
Number of viable camas fruits	Increase	45.491	1, 34	<0.001
Number of aborted flowers	Decrease	95.260	1, 34	<0.001
<i>Plant community</i>				
Native perennial forbs	Increase	5.856	1, 38	0.020
Log10 Exotic perennial forbs	Decrease	8.314	1, 38	0.006
Log10 Exotic annual forbs	Increase	5.384	1, 34	0.026

Table 3.8 Results of SIMPER Detailing the Species Contributing Most to the Average Dissimilarity Between 2009 and 2010 *No Harvest* Plots.

Species	Growth Form	2009 Average Abundance in No Harvest Plots	2010 Average Abundance in No Harvest Plots	Species' Contribution to Differences Between Years (%)	Species' Cumulative Contribution to Differences Between Years (%)
<i>Anthoxanthum odoratum</i>	Exotic perennial grass	2.42	0.93	10.06	10.06
<i>Triteleia hyacinthina</i>	Native perennial forb	0.94	1.88	8.42	18.48
<i>Poa pratensis</i>	Exotic perennial grass	3.03	3.87	7.09	25.58
<i>Vicia sativa</i>	Exotic perennial forb	3.42	2.29	6.98	32.56
<i>Lapsana communis</i>	Exotic annual forb	1.53	1.65	6.37	38.92
<i>Symphoricarpos albus</i>	Native shrub	2.38	2.10	5.85	44.77
<i>Perideridia gairdneri</i>	Native forb	0.59	1.05	5.59	50.36

3.4 Discussion

This study demonstrated that one season of experimental camas harvesting at varied intensity in a deep soil Garry oak savannah dominated by tall camas, followed by a broad-scale burn, where camas harvesting and post-harvest burning had been absent for more than 150 years, had no detectably significant effect on the camas populations and relatively little effect on the plant communities.

Interestingly while harvesting seemed to have no effect on the camas population, between year changes seen in the camas populations in control plots suggest that other factors did have an influence. Any changes that were observed from the control plots were potentially due, in part, to variation in rainfall or temperature, or other environmental factors such as grazing by deer. However, the results of this study were likely influenced by the accidental prescribed burn as well. In other words, the effects of harvesting treatment may be seen more accurately as the interaction of harvesting and post-harvest burning treatments.

Sample size and number of replicates was sufficient for most variables (60 samples, 20 replicates). However, in the case of the camas *bulb* population data there were only 9 samples, and 3 replicates. So harvesting effects on bulb populations might not be representative.

3.4.1 Question 1

How does harvesting of camas bulbs at varied intensities affect the weight and abundance of camas bulbs, and the frequency, growth and reproductive capacity of camas individuals?

Harvesting of camas bulbs in July 2009, at both low (~15% of largest bulbs) and medium (~30% of largest bulbs) intensity, followed by a prescribed burn, did not

significantly affect the weight or abundance of camas bulbs, or the quantity, stem height or flowering/fruitle potential of the 2010 camas populations. If harvesting had an affect on any of these factors, it was not detected through my analyses. These data suggest that harvesting camas bulbs at low and medium intensity for one season does not negatively, or positively, affect growth, abundance or reproduction of the camas population. This may mean that camas bulbs could be harvested at a site at low to moderate levels, and the population could continue to produce a supply of bulbs over the long-term. Interestingly, the no-harvest plots demonstrated several changes in the camas population between years. These results are discussed in section 3.4.4.

A relatively large bulb population (on average 1600 bulbs) contained in a one square metre plot in a deep soil Garry oak savannah, which was sustained after one year of harvesting, may indicate the resilience of camas populations (Figure 3.9). However, it is important to note that very few camas bulbs were actually removed relative to this large bulb population. Histograms of both the total number (Figure 3.10) and the total weight (Figure 3.11) of bulbs per size class in each plot demonstrate the abundance of non-flowering camas bulbs, the distribution of camas bulbs per size class, as well as the relatively small portion of camas bulbs removed during the 2009 harvesting treatment as compared with the total bulbs found in the 2010 complete bulb collection.



Figure 3.9 Photo of all camas bulbs (approximately 1600) unearthened from a one-metre square plot from my study site at the Cowichan Garry Oak Preserve. (These bulbs are primarily tall camas). Bulbs arranged in largest to smallest size classes (5 to 1) from left to right. (The grid in the background measures 1.0 cm x 1.0 cm). Despite harvesting 0%, 15% or 30% of the largest bulbs in the previous year, there were no significant differences found in the total number, or weight of bulbs in any size classes (Photo taken by Kate Proctor).

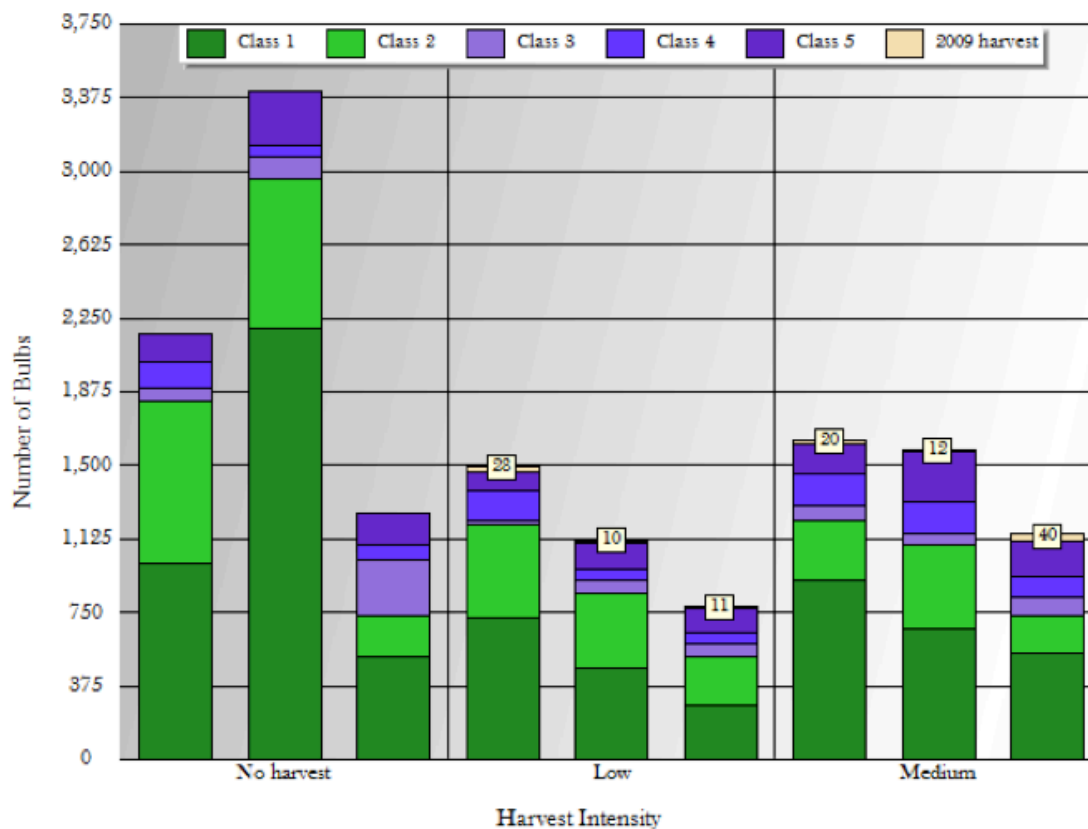


Figure 3.10 Histograms demonstrating the total number of camas bulbs per plot by harvest intensity. (Note the low variability both within and between harvest treatments). The total numbers of bulbs removed per plot in the 2009 harvest treatment is also included for comparison. (Note the low number of bulbs removed in 2009 as compared with the total number of size class 5 bulbs found in 2010).

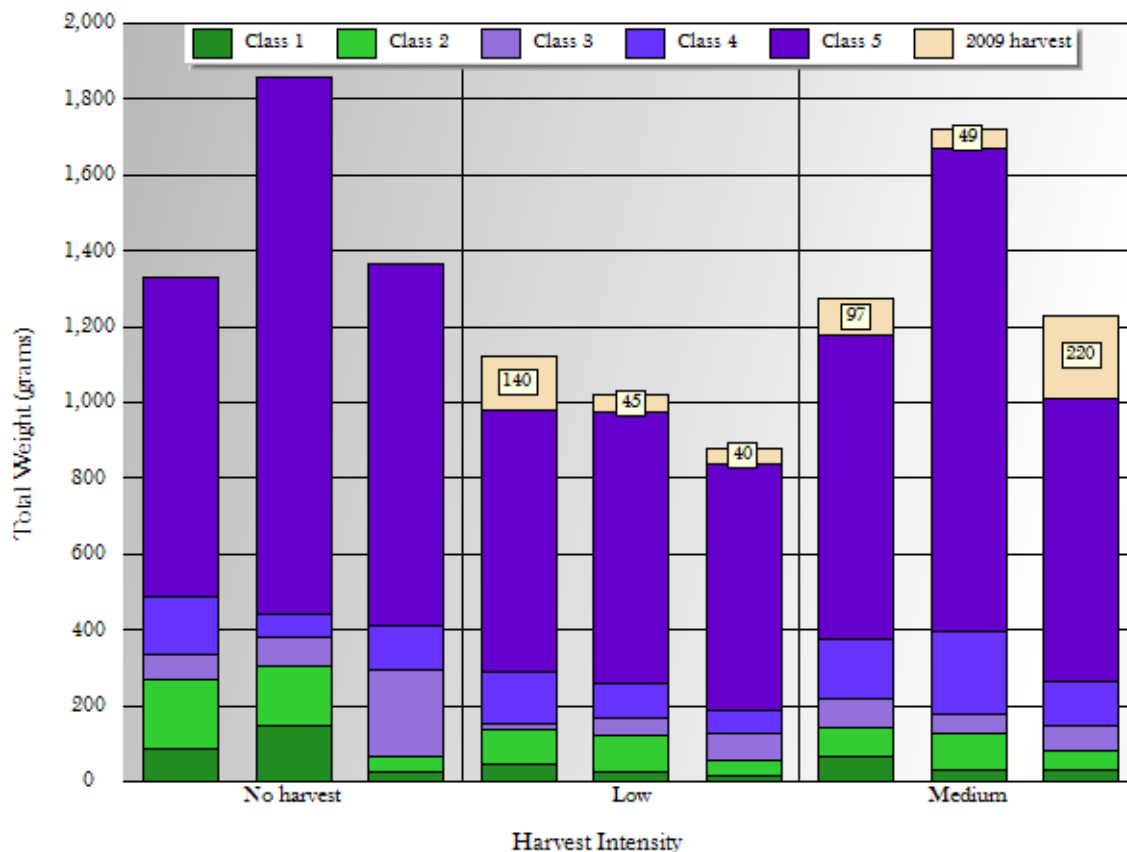


Figure 3.11 Histograms demonstrating the total weight of camas bulbs per plot by harvest intensity. (Note the low variability both within and between harvest treatments). The total weight of bulbs removed per plot in the 2009 harvest treatment is also included for comparison. (Note the total weight of bulbs removed in 2009 as compared with the total weight of size class 5 bulbs found in 2010).

The finding that camas harvesting at both intensities had no positive or negative impact on the residual camas bulb population should be carefully considered due to the low sample size (9 samples). It is possible that these samples were not representative of the camas bulb populations in the other plots. Because camas bulbs were not planted into plots there is no 'before-harvest' bulb data to make comparisons with. Instead, the residual camas bulb populations in harvested plots were compared with control plots.

Some pre-existing belowground variation within the bulb population between plots cannot be ruled out. For this reason, in future studies researchers could either plant

camas into experimental plots or use a larger sample size to verify that harvesting at these intensities will not negatively affect the camas bulb population. Relationships found between above and below ground camas established through other studies could be used to extrapolate the approximate volume of pre-harvest camas population in plots.

The measurements taken on the camas population imply that camas' response to harvesting is neutral or favourable. This effect is, perhaps, due to enhanced soil conditions (e.g., increased soil porosity as shown in this study), improved soil drainage, and/or increased water absorption. Increased seedling recruitment and decreased competition for ground water and nutrients also are potentially contributing to a neutral harvest effect (Castle 2006; Sinclair *et al.* 2006). In addition to loosening the soil, harvesting mixes soil nutrients into the ground, likely increasing their availability at the root level (Anderson and Rowney 1998). Moreover, when the bulbs are not restricted by soil compaction (e.g., when soil porosity is enhanced) their size may increase (Anderson and Rowney 1998).

3.4.2 Question 2

What effect does camas harvesting have on overall plant community composition within an herbaceous community currently supporting blue camas?

Prior to harvesting no significant differences in plant community composition among experimental plots were detected. The disturbance caused by camas harvesting (and potentially burning) apparently led to some subtle changes in the deep soil Garry oak plant community composition. Out of 45 species present in the plant community (Appendix 7), the one-way statistical analysis demonstrated significant changes in the *frequency* of six species. The multivariate analysis suggested significant, but minor changes in the plant community composition for the plots harvested at medium level intensity.

While the results of these two tests indicated similar changes in species frequency, the results cannot be directly compared because the two tests were looking at different measures. Additionally, the changes seen in plant community composition may be attributed to burning or differences in ecological conditions between years, as there were similar changes seen in the no-harvest plots (see Section 3.4.4).

Several of these changes in species frequency or composition could be beneficial. Multiple species demonstrated a reduction in abundance after harvesting in one or both tests: Kentucky bluegrass, sweet vernal grass, common vetch, and the native shrub common snowberry. Since three of these species are exotic (e.g. introduced) and the fourth is considered by some ecologists to be a weedy native species, a decrease in all four can be considered beneficial for the ecological restoration and management of Garry oak savannah and meadow ecosystems (MacDougall and Turkington 2004; Sinclair *et al.* 2006). Two native forb species, fool's onion and tall camas²⁸, showed an increase in abundance after harvesting in one or both statistical tests. These increases can be viewed as positive for the ecological restoration and management of Garry oak ecosystems since both species are ecologically limited at this time (Sinclair *et al.* 2006).

The increase of two exotic forbs (e.g., hairy cat's ear and nipplewort), one exotic shrub (e.g., Scotch broom), and one exotic (or weedy native) forb (e.g., cleavers) could be problematic (Sinclair *et al.* 2006). The three forbs have not typically been the focus of exotic or weedy species removal projects and, therefore, the methods for removing them are less clear (GOERT 2011). Some studies have shown an initial increase in these species right after disturbance, such as with prescribed burning, with a decrease in these same

²⁸ The multivariate analysis showed an increase in the *relative abundance* of tall camas (*Camassia leichtlinii*), though there was not an actual increase in the *frequency* of camas shown in the univariate analysis.

species over time with repeated disturbances (Agee 1996; GOERT 2011; MacDougall 2005; MacDougall and Turkington 2007). Repeated disturbances effectively work to eliminate these species' vegetation and short-lived seeds (GOERT 2011; MacDougall and Turkington 2007). It would be necessary to observe the effects of multiple years of harvesting on these species. It is possible that the repeated soil disturbance also may have a negative effect on their success over the long-term. Scotch broom is a commonly managed exotic species and is already pulled annually at the site (I. Banman pers. comm. 2009). As such, a slight increase in Scotch broom seedlings might not prove overly challenging to control. Additionally, fire, which is a management tool at this site, has been shown to be effective in controlling Scotch broom when treatments are repeated over several years (Dunn 1998; MacDougall and Turkington 2007).

3.4.3 Question 3

What effect does camas harvesting have on soil porosity?

Harvesting at medium intensity significantly increased soil porosity directly after harvesting. This increase in soil porosity in harvested plots was still significant when measurements were taken one year after harvesting occurred. While this increase in porosity was not surprising, the change is notable since it would mean that the remaining camas populations in harvested plots were growing under significantly less constrained conditions than non-harvested plots for the entire year. This may be one reason that the camas populations where camas bulbs were removed were able to 'recover' from harvesting and retain the same structure and abundance as non-harvested plots. It may also explain some of the changes in plant community composition, as low-level soil disturbance is thought to enhance conditions for certain plants to establish (Sinclair *et al.*

2006).

The increase in soil porosity in plots harvested at low intensity was less clear. Initially there was no significant difference between control plots and those harvested at low intensity. This could be due to where exactly the soil porosity pin was inserted. In other words, by chance we may have inserted the pin more frequently in areas that had not been disturbed in the plot. However, when measurements were taken one year after harvesting the plots at low intensity they did show a significant increase in soil porosity when compared with control plots. Again, by chance, we may have inserted the pin more frequently in areas that had been disturbed in the plot. This uncertain change in soil porosity is not surprising since the soil in these low intensity harvest plots was not completely turned over, but instead the low intensity plots, on a whole, experienced micro-site disturbance since less bulbs were removed.

Little is known about the ideal soil porosity for Garry oak ecosystems (Sinclair *et al.* 2006). However increased soil porosity may play an important role in the restoration in Garry oak ecosystems (Sinclair *et al.* 2006). Future studies involving greater replication (e.g., a larger sampling of soil porosity per plot) would be needed to understand the impacts of harvesting on soil porosity, and the connections between increased soil porosity and plant community composition.

3.4.4 Understanding the Between-Year Changes in the Camas Populations

Despite the fact that there were no statistical differences between the camas populations in harvested and un-harvested plots, both the camas populations and the plant communities changed significantly between years in the no-harvest, or control,

plots. There was a significant increase in number of flowering camas, as well as in the number of viable camas fruit. The number of aborted camas flowers was less in the second year than in the first. Many factors may have lead to these changes, including differences in yearly or seasonal rainfall and temperature. Dormancy of certain plant species also may have played a role in these changes. There may have been variation in the level of herbivory or in the availability of pollinators between years. Moreover, it is probable that the accidental prescribed burn contributed to the differences seen between years in control plots.

Potential Effects of Prescribed Burn

Historically, Indigenous burning of camas sites likely enhanced the availability, productivity, and yields of camas. Given the historical ecological changes that have occurred in Garry oak ecosystems, it is unclear whether burning would have the same effect on camas populations today. Some studies have shown a significant increase in the abundance of common camas (*C. quamash*) after prescribed fire (Agee 1996; MacDougall and Turkington 2007; Storm and Shebitz 2006). Storm and Shebitz (2006) noted that burning lengthened the flowering and fruiting period for common camas. Although I did not monitor flowering and fruiting period the increase in number of viable fruits and decrease in aborted flowers may reflect a comparable positive effect of fire on camas reproductive health. However, the majority of the species in my experimental plots were tall camas (*C. leichtlinii*), and therefore the results of these studies might not be applicable.

It is probable that the enhanced growth of the camas population is linked to fire substantially reducing the presence of standing dead grass that had been present in my first year of data collection, leaving the remaining camas to grow with less competition for

light, space, moisture, and soil moisture and nutrients (MacDougall and Turkington 2007). When I sampled the camas population and plant community the year after the fire, there was a notable reduction in dead standing grass. Although I could not detect a statistically significant difference in the height of the camas between years, there was a notable trend throughout all plots towards shorter camas in 2011. Whether these changes are due to the prescribed burns, or differences in ecological conditions between years, or perhaps both, is not clear. Further study is needed to understand how these factors might influence the stability of the camas population and the impacts of camas harvesting.

3.5 Summary

One of the most interesting outcomes of this study was the perceived lack of negative impact of harvesting on the above and below ground camas populations. The ability of camas (primarily tall camas) to respond neutrally, or favourably, to low and medium level disturbance is supported by this study. It appears that the harvesting of camas in a deep soil Garry oak savannah with a dense camas population can happen once at low to moderate levels with little effect on the camas population. It is premature though to assert that camas harvesting could be carried out for multiple years at this same site at similar levels. The prescribed burns may be responsible for the positive changes in the camas population seen in the no-harvest plots between years. A multi-year study is suggested to discover what harvest frequency and level intensity could be sustained, and what effects fire may have on the camas population.

Changes seen in the plant community composition were not drastic or necessarily negative. In fact some changes in species frequency could be viewed as positive for the restoration of ecological integrity in Garry oak ecosystems. The weedy introduced species

that showed an increase after harvesting and fire might be controllable through hand removal or with repeated large-scale disturbances such as fire (MacDougall and Turkington 2007). Overall, concerns about strong and immediate negative effects of camas harvesting at this particular site can be reduced. However, an argument for a strong and immediate positive effect on the camas population was not supported by this study. Carrying out similar studies at other sites with different plant species composition (i.e. a greater percentage of exotic species) is necessary before generalizing these results. Lastly, longer-term studies are necessary to understanding the cumulative effects and interactions between harvesting, post-harvest burning, and year-to-year environmental variability.

Chapter 4: Ethnoecological Restoration Support Model

I think there's a whole movement now towards parks that include people. For a long time parks, or at least the wilderness type parks or even city parks, were looked on as places where people are allowed to go and be observers but not participants in any of the processes, ecological or whatever. So you could destroy natural habitat and put in gardens or flowerbeds but [Indigenous] people weren't allowed to go in and harvest as they had done traditionally. But that's changing gradually (Dr. Nancy Turner pers. comm. 2011).

Whether Indigenous land management practices—practices that built diverse socio-economic systems from basic plant and animal resources—will be allowed to play a role in restoring biodiversity remains to be seen. If they are, it will change the context of park management by encouraging the interaction of biological and cultural resource professionals, and represent a huge step across the nature-culture divide (Dave Egan and M. Kat Anderson 2003, p. 246).

4.1 Introduction

Over the past decade and a half the field of ecological restoration has been expanding to include insights and resource management techniques from Traditional Ecological Knowledge (TEK) systems (Anderson and Barbour 2003; Garibaldi and Turner 2003; Higgs 2005; MacDougall *et al.* 2004; Martinez 2011; Senos *et al.* 2006; Turner *et al.* 2000; Wray and Anderson 2003). TEK can contribute valuable information to ecological restoration projects regarding the pre-contact species composition and ecosystem conditions, ecological succession and disturbance dynamics, sustainable harvesting and resource conservation techniques, plant and animal population enhancement, and time-tested approaches to ecosystem management (Anderson and Barbour 2003; Senos *et al.* 2006; Turner *et al.* 2000; Weiser and Lepofsky 2009; Wray and Anderson 2003).

Indigenous peoples offering their TEK and expertise to ecological restoration efforts expect and deserve reciprocal support for their cultural restoration efforts (Martinez 2011; Senos *et al.* 2006). Protected area officials acknowledging the desire, intention, and rights of Indigenous people to harvest resources, can allow for more transparency, communication, and ecological monitoring of harvested areas (Peepre and Dearden 2002; Ruppert 2003). This increased communication and partnership could foster better ecological protection and management, as well as improved relations between Indigenous peoples and park officials (Alcorn 1993; Peepre and Dearden 2002; Ruppert 2003; Underwood 2003). Conducted respectfully, TEK-based ecological restoration, or ethnoecological restoration, offers an important opportunity to restore both natural and cultural resilience (Anderson and Barbour 2003; Fowler and Lepofsky 2011; Higgs 2005; Joseph 2012; Ruppert 2003; Senos *et al.* 2006; Turner *et al.* 2000).

Traditional Central Coast Salish resource and land management strategies can provide important information for the restoration and maintenance of Garry oak ecosystems today (Anderson and Barbour 2003; MacDougall *et al.* 2004). While managers of protected areas already are simulating traditional burning by using fire as a restoration and management tool, the ecological role that Indigenous harvesting of root vegetables played historically, or might play today, on factors such as ecosystem composition and function is still largely un-explored (Anderson and Barbour 2003; Beckwith 2004). For Central Coast Salish people interested in renewing, continuing, and sharing camas food traditions with the next generation, interaction with Garry oak ecosystems and safe access to areas with significant populations of camas bulbs are fundamental (Corntassel and Bryce 2012; Turner 2005a). Since the majority of remaining camas habitat in British

Columbia is found in protected areas, the managers of these areas are in a unique position to support the renewal of Indigenous camas traditions.

In this chapter, I elucidate the opportunities, garnered from my research, for cultural and ecological restoration both inside and outside of protected areas. Using the information gleaned from my interviews and camas harvesting experiment, I propose a framework for setting up a longer-term Indigenous camas-harvesting program in protected areas. I discuss how protected areas can actively support the renewed use and management of camas in Central Coast Salish communities and, at the same time, maintain, and even expand upon current ecological restoration and conservation goals which aim to re-establish ecological integrity in Garry oak ecosystems. This chapter brings together key findings from my socio-cultural and ecological research on camas harvesting and protected areas, and suggests areas for future research.

4.2 Opportunities for Cultural and Ecological Restoration

Despite current Indigenous interest in the camas habitat found in protected areas, to my knowledge there are currently no formal camas harvesting and management arrangements for Central Coast Salish Peoples in protected areas within British Columbia. Valuable opportunities for cultural and ecological restoration could be explored by pursuing a formal agreement for camas harvesting and management. These opportunities might include:

- 1) Supportive environment for teaching and mentoring Indigenous youth in traditional plant harvesting and management;
- 2) Supportive environment for collecting adequate seed and bulbs for transplanting to new sites for ethnoecological restoration projects outside of protected areas;
- 3) Cross-cultural understanding and ethnoecological knowledge sharing;

- 4) Cross-cultural collaboration towards the ecological restoration of sites inside and outside of protected areas;
- 5) Ecological monitoring of protected areas for harvesting and management effects; and
- 6) Ecological benefits for protected areas through the reintroduction of camas harvesting disturbance.

The current Indigenous approach to ‘un-sanctioned’ camas harvesting potentially limits the extent of resource tending and intergenerational teaching that can be carried out due to conflict with other park users or managers who might see plant harvesting as illegal or ecologically damaging. Camas harvesting is not a speedy or un-obtrusive activity like berry picking or selective herb gathering. It requires identification of the standing or withered flowering camas stalk, digging into the earth, and carefully locating bulbs. Imagine trying to covertly pass on lessons about harvestable bulb size, proper digging technique, and other aspects of camas cultivation to a keen young person. These lessons take time and patience, which are less available without the consent of the protected area managers or acceptance of these activities by other park users.

As mentioned in Chapter 2, harvesters reported that sometimes other park users or managers who did not approve of their activities have approached them while they are harvesting. Some of these conversations led to arguments and threats to the harvester. At times the harvesters were even chased out of harvesting areas. In addition to the potential stress this kind of interaction involves, it is certainly not advancing the dialogue between Indigenous peoples, protected areas managers, and other park users about the potential role that traditional resource management could play today. Moreover, it is doubtful that under these circumstances Central Coast Salish harvesters obtain the quantity of camas bulbs and seeds that they would like for cooking, transplanting, and for seeding new areas (e.g., for ethnoecological restoration projects).

There are important opportunities to work cross-culturally toward restoring camas habitat inside and outside of protected areas. As I discussed in Chapter 2, some Indigenous people interested in renewing traditional harvesting and management practices are involved with restoring the habitat for culturally important resources. The Indigenous Peoples' interest in protected areas as camas bulb and seed banks for their own restoration projects offers a chance to restore and expand Garry oak ecosystems and camas habitat outside of protected areas. Given the capacity of some camas populations and plant communities to recover or undergo only slight changes after low and medium level intensity bulb harvesting (see Chapter 3), this interest seems to be compatible with current ecological restoration and conservation goals of protected areas (e.g., to restore and maintain species composition). A transplanting and seeding partnership with local First Nations could be a rewarding initiative for land managers and for Indigenous harvesters.

Additionally, managers of protected areas are unable to monitor the extent and the impact of unsanctioned camas harvesting. If managers don't know where, how frequently, or how intensively people are harvesting camas, it is almost impossible to determine the precise affects of harvesting on the local ecosystems. The chance of over-harvesting also may be greater, since a covert approach to harvesting likely means that there is limited communication between harvesters. So although some managers of protected areas might feel that entering into an agreement with camas harvesters is complicated and potentially expensive, and Indigenous community members might feel hesitant to discuss their harvesting practices (see Chapter 2), in the long run it might be beneficial to both the renewal of camas traditions and the ecological stability of protected

areas.

4.3 The Ethnoecological Restoration Support Model

I propose the “Ethnoecological Restoration Support Model” (Figure 4.1) as a way to advance both cultural and ecological restoration inside and outside of protected areas.

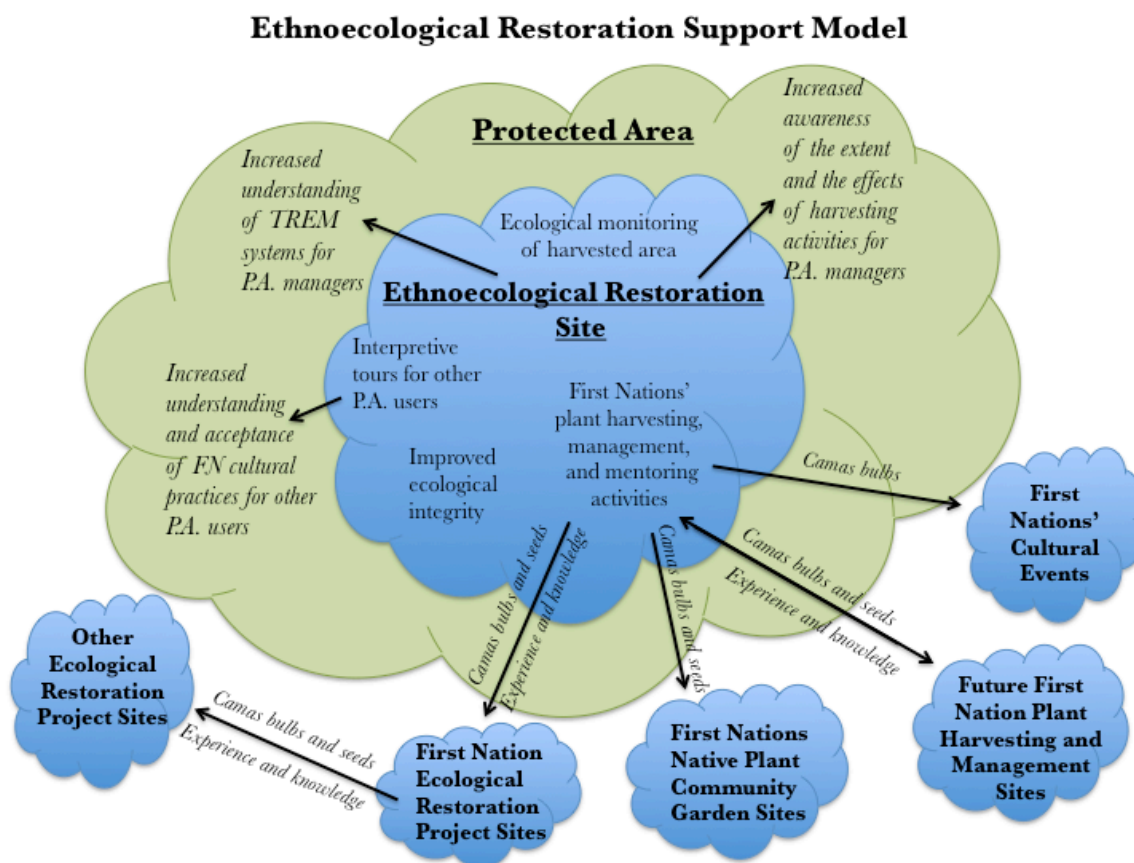


Figure 4.1 “Ethnoecological Restoration Support Model” showing the activities happening in an ethnoecological restoration site within a protected area, and how those activities can support cultural and ecological restoration and understanding both inside and outside of the protected area. This model uses camas as an example, however it could be applied to support the ecological and cultural restoration of other species, or multiple species (P.A. is used as an abbreviation for protected areas).

Under this model, Indigenous activities, such as camas harvesting and cultivation (e.g., weeding and camas harvesting), would be permitted and supported within some parks

and protected areas in mutually agreed upon sites. Camas bulbs and seeds could be harvested at a level pre-determined by both the park managers and harvesters with the understanding that some bulbs would go toward ecological restoration and establishment of new harvesting sites outside of the protected area (e.g., community gardens), and other bulbs could be consumed at cultural events. These sites could allow for the intentional experimental enhancement of camas populations. By allowing access to culturally important resources and ecosystems, protected areas could support the restoration of Indigenous cultural knowledge and practices.

In return, the protected area managers could benefit from cross-cultural collaborative efforts towards the ethnoecological restoration, maintenance, and enhancement of culturally and ecologically important resources. Harvesting areas would be monitored so it would be easier for managers of protected areas to regulate the frequency and intensity of harvesting. A greater understanding of the historical and current effects of harvesting disturbance might be gained through the process of monitoring harvesting and management activities; however, this would not be the primary goal. Instead this model would work to support the recovery and perpetuation of *both* natural and cultural diversity.

4.3.1 Implementing the Ethnoecological Restoration Support Model

A preliminary site assessment would be necessary to determine the suitability (e.g., ecological stability, safety) of a particular site within a protected area for camas harvesting. Some aspects to consider include the size of the site, the abundance of mature/flowering camas, the ratio of native to exotic plant species, the presence of dangerous (e.g., death camas) and/or rare species, soil conditions, and site history (e.g.,

risk of soil contaminants). Additionally, an ethnoecological assessment (see Anderson and Barbour 2003, p. 275) should be carried out with local First Nations and professional ethnoecologists regarding the historical and current resource management practices employed by local First Nations, and the objectives for these management practices. Such assessments would help guide the management plan for the project as well as to set guidelines about when, how, and how much camas can be harvested sustainably.

Chosen sites would be managed collaboratively by First Nations' harvesters and land managers to restore and maintain the health of camas populations. Camas bulbs could be harvested in these specified sites for cultural purposes. Intentional experimental enhancement of camas patches (e.g., weeding, soil aeration, mowing or prescribed burning) could be implemented to increase the quantity and quality of bulbs. Sites would be monitored collaboratively by both parties to gain a better understanding of the cumulative effects of harvesting and management, and to adapt future management or harvesting practices in accordance with these effects.

To ensure that both parties feel confident about the time-investment they would be making there would need to be a clear commitment or contract between the involved parties. Having a longer-term (e.g., five years or greater) commitment was stressed as necessary by two of the three managers I interviewed (Chapter 2). While this kind of arrangement might be preferable for some agencies, others may prefer issuing yearly harvesting permits to members of First Nations who approach them. Permitting might work best in city parks or with other organizations whose capacity for collaborative management is limited at this time (F. Hook pers. comm. 2011). Permitted individuals could gain a certain level of access to the site to do harvesting activities and teach the next

generation of camas harvesters about traditional management (Chapter 2). Interpretive signage or perhaps interactive eco-cultural tours could be used to make other park users aware of why Indigenous harvesting and management activities were occurring in protected areas, thereby avoiding such confrontations that were discussed by interview participants (see Chapter 2).

One concern expressed by protected area managers in my study was how they would decide which First Nation, or which people within a First Nation, to collaborate with. Given the current treaty negotiations in British Columbia, it might be best to contact any First Nation making a claim to a site where a collaborative camas-harvesting and management program is being considered. A dual-permitting system, as discussed by Ruppert (2003), could be a good way to recognize the First Nations system of designating appropriate individuals to do the harvesting and caretaking of culturally important plants. As Ruppert (2003, p. 262) explains: “The tribe issues a permit to tribal members who then present this permit to the park; the park then issues its own permit for the gathering of plants”. This kind of permitting system may be cumbersome, and could actually be problematic for members of some First Nations. For example, the structures that determine who is allowed to harvest might not be in place any more, or there may be internal disagreements about who is allowed to harvest. Despite this potential drawback, the dual permitting system transfers the power back to the First Nation to decide who they see qualified to harvest. For this reason it could prevent conflict between First Nations and land management organizations, which is certainly a concern.

4.3.2 Supporting the Renewed Use and Management of Camas

How might establishing a formal arrangement for harvesting within protected

areas benefit people in First Nations who are working to restore camas traditions? Setting up an agreement for camas harvesting in protected areas would allow for discussion regarding the history and future of Garry oak ecosystems. This could lead to a greater degree of protection and restoration of culturally important plant species. Additionally, it could help the wider public to better understand the ongoing importance of camas harvesting and management for Central Coast Salish communities. Having a harvesting permit or agreement for collaborative management will likely reduce the degree of harassment from other park-goers, creating an environment that is more conducive for harvesting, cultivating, and passing on cultural and ecological knowledge to the next generation. Moreover, having an agreement between Indigenous people and protected area managers for ongoing use of a site would provide a degree of certainty that the work being done by Indigenous users to cultivate a site would not be in vain.

It is possible that a greater quantity of camas bulbs could be harvested at one time since there would be no pressure to harvest quickly and leave. This could make more camas bulbs available for pit-cooking events and transplanting to new sites for restoration or future harvesting. Overall, having secure access to these valuable bulbs and seeds could help to expedite both ecological and cultural restoration of camas for Central Coast Salish peoples.

4.3.3 Maintaining and Expanding Restoration and Conservation Goals

Aspects of the traditional Central Coast Salish camas management system could be applied to Garry oak ecosystems today as a restoration and maintenance technique (Beckwith 2004). The question is, ‘Would these traditional management activities have the same impact if carried out today in ecologically altered Garry oak landscapes?’

Experimental harvesting of camas bulbs (primarily of tall camas, *C. leichtlinii*) in a deep soil Garry oak savannah at low and medium intensities for one season does not appear to negatively, or positively, affect growth, abundance, or reproduction of tall camas populations (Chapter 3). These results suggest that a population scale management approach might be applicable to, or at least compatible with, current restoration and management goals in protected areas. It is possible that camas bulbs may be harvested at a similar intensity and the population would remain stable, although perhaps not over the long-term. It is also important to emphasize that harvesting of common camas (*C. quamash*) bulbs at the same intensity in shallow soil sites could likely result in very different outcomes.

In terms of plant community composition tall camas harvesting and prescribed burning appeared to result in only subtle changes, despite the presence of invasive exotic species. Some of these changes would actually be considered beneficial to the restoration of Garry oak ecosystems (e.g., the reduction of the exotic orchard grass). Other undesirable changes in species frequency (e.g., an increased frequency of Scotch broom) may be managed through integrated weeding, fire or grazing treatments. Further studies, however, would be needed to determine the cumulative effects of tall camas harvesting and associated plant community management over the long term (e.g., at least five years or more), in a variety of ecosystem types. As my field plots contained almost exclusively tall camas, more ethnoecological research focusing on common camas (*C. quamash*) is warranted.

Given the seemingly small number of Central Coast Salish Peoples currently interested in harvesting camas (Chapter 2), and the apparent ability of at least some

camas populations (e.g., the tall camas populations in deep soil sites) to recover from low to medium level harvesting disturbance (Chapter 3), it looks as if ecological restoration or conservation goals could be maintained using the Ethnoecological Restoration Support Model.

How could this model expand upon the current ecological restoration and conservation goals in protected areas? To start with, people interested in harvesting camas bulbs at a site over the long term will probably have a vested interest in helping to maintain the productivity and ecological integrity of the site, just as they did in the past. If protected areas support Indigenous harvesting of camas bulbs (or other culturally important resources), harvesters will be more likely help with tasks such as exotic species removal and prescribed burns, potentially increasing the volunteer team. Additionally, having traditional camas harvesting and management occurring in a protected area would lead to increased opportunities for researching the role of human disturbance in maintaining ecosystem structure. This could potentially provide new insights for restoring and maintaining the structure of Garry oak ecosystems. For example, harvesting tall camas bulbs could actually increase the productivity of *in situ* camas populations over time, yielding higher numbers of bulbs and seeds that could then be planted or transplanted to other sites for restoration purposes (Beckwith 2004).

Moreover, providing access to tall camas bulbs and seeds in protected areas for Central Coast Salish restoration projects and community garden sites elsewhere could expand the reach of the conservation for this suite of ecosystems. Since camas bulbs and seeds are difficult to find at local plant nurseries (see Chapter 2), establishing a transplanting program (for camas and other Garry oak associated species) could be of

great benefit to the overall goal to protect and restore the range of Garry oak ecosystems. If there are new sites with camas being established *outside* of protected areas, this could theoretically reduce the extent of harvesting happening within protected areas in the long-term.

4.3.4 Elements of Compromise

While I believe that the Ethnoecological Restoration Support Model would address many of the interests and concerns of Central Coast Salish Peoples and land managers, there certainly would be elements of compromise. When a park manager and a member of a First Nation community begin a dialogue around harvesting of traditional foods, they find themselves faced not only with the questions of the ecological sustainability of harvesting, but also with a history of colonial policy and treatment, including questions of land entitlement and treaty rights. Sorting out issues of governance would be vital to the success of this ethnoecological restoration support model.

While this model attempts to address the need for access to camas in a small way, there are much larger issues to be discussed. On a fundamental level most, if not all, protected areas are part of some First Nations' traditional territory. Creating camas management and harvesting sites in protected areas would not address the issues of Indigenous land tenure or ensure the rights of aboriginal peoples to harvest traditional resources on unoccupied lands directly. With the treaty process still evolving in British Columbia, some protected areas could potentially be returned to the control of First Nations communities. So entering into a collaborative management agreement may feel like a concession to some Indigenous people who are working towards full control of their traditional territory.

4.4 Future Research

This research can be considered an initial exploration of the potential for collaboration between Indigenous peoples and managers of protected areas towards the ethnoecological restoration of camas habitat and traditions both inside and outside of protected areas. There is enough interest for the restoration of camas traditions within Central Coast Salish communities to proceed with finding support for their endeavours. In future studies researchers would need to interview a larger group of Indigenous people to gain a more complete understanding of the quantities of camas that would be desired for restoration projects and cultural events, or whether there is an even broader interest. Longer-term studies are necessary to understanding the cumulative effects of camas harvesting, as well as the interactions between harvesting, post-harvest burning, and ecological variation. More specifically, further studies are needed to understand the potential role that camas harvesting might play in the ecological integrity of Garry oak ecosystems. Experimental harvesting studies, similar to the one carried out for this research, could be conducted at other sites with different plant species composition (i.e., with a dominance of common camas or a greater percentage of exotic species). If a camas harvesting and management program were to be experimentally implemented in a protected area, it would be necessary to develop a collaborative plan for adaptive management, harvesting, and monitoring. The “Ethnoecological Restoration Support Model” can demonstrate how to design a project that would support restoration both inside and outside of protected areas.

In conclusion, harvesting of tall camas bulbs at low to medium intensity for one year in a deep soil Garry oak savannah does not seem to effect (either positively or

negatively) the next years camas population. However, it does seem to have minor effects on the plant community composition. While long-term studies are necessary to replicate and expand upon these findings, this study suggests that some level of camas harvesting is compatible with the conservation and restoration of ecological integrity of Garry oak ecosystems. Protected areas might be able to provide support for the restoration of Central Coast Salish camas traditions while maintaining and even expanding upon ecological conservation and restoration goals.

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Appendix

APPENDIX 1 Interview Participants Grid

Participant	Affiliation	Title	Relevance to Study
Dr. Brenda Beckwith	University of Victoria, School of Environmental Studies	Senior Lab Instructor; Ethnoecology and Ecological Restoration Instructor; Adjunct Professor	Specialist in the ethnoecology and ecological restoration of camas and Garry oak ecosystems
Cheryl Bryce	Member of the Songhees (<i>Lekwungen</i>) First Nation; <i>VIPiRG</i>	Traditional Resource Manager, Harvester, and Educator; Coordinator for the “ <i>Lekwungen</i> Food Systems Project”	A local leader in the cultural restoration of camas; Coordinating volunteer ecological restoration projects in local protected areas
Fiona Devereaux	Vancouver Island Health Authority, Aboriginal Health Dept.	Nutritionist; Lead Coordinator for the “Feasting for Change” Project	Works with local First Nations through “Feasting for Change” project to bring back knowledge and use of traditional foods
Ken Elliott	Member of Cowichan Tribes (<i>Hul’qumi’num</i>)	Native Plant Nursery Manager	Involved with ecological restoration (including native plant propagation, and teaching in local schools)
Tim Ennis	Nature Conservancy of Canada (NCC)	Director of the NCC Land Stewardship Program for the British Columbia	Interested in incorporating traditional ecological management strategies (and potentially camas harvesting) at the sites he oversees
Fred Hook	City of Victoria Parks, British Columbia	Environmental Technician	Oversees city parks that encompass important traditional camas harvesting grounds
Dr. Nancy Turner	University of Victoria, School of Environmental Studies; Hakai Institute	Researcher and Professor of Ethnoecology and Ethnobotany; Hakai Chair in Ethnoecology	Specialist in the traditional ecological knowledge and resource management systems of the Indigenous Peoples of western Canada
Rob Walker	The Gulf Islands National Park Reserve (NPR)	Manager of Resource Conservation at the Gulf Islands NPR; Fire Manager	Interested in collaborating with local First Nations on ecocultural restoration projects
JB Williams	Member of the <i>Tsawout</i> First Nation; Sea Change	Ecological and Cultural Restoration Coordinator; Native Plants Specialist and Educator	Involved with ecological and cultural restoration, including restoration of camas habitat

APPENDIX 2 Interview Recruitment Materials and Ethics Application Form

Section 2.1 Telephone Script

Kate: Hi, my name is Kate Proctor and I am a student in Environmental Studies at the University of Victoria. My advisor(s) (Brenda Beckwith and/or Nancy Turner) gave me your name because she (they) thought you might be interested in participating in my study.

Potential interviewee: OK. Tell me more about the study.

Kate: I am hoping to learn more about the current interest, opportunities and challenges surrounding the reintroduction of camas harvests to parks and ecological preserves on Vancouver Island. As part of my graduate research I am interviewing people who are either involved with managing blue camas populations in parks or preserves or they are First Nations peoples who are interested in having access to places where they can help manage and harvest blue camas.

Potential Interviewee: OK

Kate: Would you be interested in participating in a one-hour interview with me this spring, and an informal group discussion about the potential for co-management of camas populations this summer?

Potential Interviewee: Yes I would be willing. Can you send me more information though?

Kate: Great. Yes I will send you a one page informational letter about my project and an informed consent form. After you read over these forms we can talk about setting up a time and a place for the interview. If you decide you would still like to participate in this study we can go over the forms when we meet. Thanks for your time. Have a great day.

Section 2.2 Free and Informed Consent Form (Part 1)

Social Dimensions of Reintroducing Blue Camas (*Camassia sp.*) Cultivation: An Exploration of Local Interest, Opportunities and Challenges

You are invited to participate in a study entitled “Social Dimensions of Reintroducing Blue Camas (*Camassia sp.*) Cultivation: An Exploration of Local Interest, Opportunities and Challenges” that is being conducted by Kate Proctor. Kate Proctor is a graduate student in the School of Environmental Studies at the University of Victoria and you may contact her if you have further questions by phone: _____, or email: _____.

As a graduate student, I am obliged to conduct research as part of the requirements for a degree in Ethnoecological Restoration. My research is being conducted under the supervision of Dr. Brenda Beckwith and Dr. Nancy Turner. You may contact Brenda Beckwith at _____, or Nancy Turner at _____ if you have questions beyond what I can answer.

Purpose and Objectives

The purpose of this research project is to explore the social dimensions of reintroducing blue camas cultivation and harvest to ecological preserves and parks on Vancouver Island. The proposition of integrating blue camas harvesting with the restoration and management of Garry oak ecosystems brings up questions regarding the current interest, opportunities, challenges and potential approaches to making this integration a reality. To investigate these questions I will interview Coast Salish First Nations and land managers on Vancouver Island. I will also organize an informal discussion, which will take place at a pit cook with interested First Nations peoples and land managers. Through this discussion I aim to explore the potential avenues for re-integrating blue camas harvesting into traditional areas that are currently being restored and managed for ecological purposes.

Importance of this Research

Research of this type is important because it attempts to document the current opinions and spark meaningful conversation between local people on management of a traditionally used plant and plant community. This research is vital to furthering communication between First Nations communities and the people who are involved in managing natural areas.

Participants Selection

You are being asked to participate in this study because you have expressed an interest in restoring your culture’s traditional blue camas harvesting practices.

What is Involved

If you agree to voluntarily participate in this research, your participation will include an hour-long interview with Kate Proctor. We would schedule an interview sometime during the months of October or November 2010. This interview will take place in the location of your choosing (such as your home or a neutral location like the University of Victoria

campus). I will ask open-ended questions about your experience with harvesting blue camas, interest in harvesting blue camas, and your interest in co-managing camas populations in local parks and preserves. I will take notes during the interview and tape-record the interview with your permission.

Inconvenience

While I do not foresee any large inconvenience caused by participation in this study, the time it takes to set up and conduct the interview should be considered.

Risks

There are no known or anticipated risks to you by participating in this research.

Benefits

The potential benefits of your participation in this research include having a space to share your opinions and desires about the future of blue camas management on Vancouver Island, hearing about other peoples opinions and desires surrounding blue camas management and making contacts with other people interested in the future of blue camas populations.

This project will contribute to the state of knowledge related to potential avenues for ethnoecological restoration of blue camas in B.C. This project will also contribute to understanding of the present interest, challenges and opportunities for co-management of blue camas populations.

Compensation

As a way to compensate you for any inconvenience related to your participation, you will be given small gift. If you agree to participate in this study, this form of compensation to you must not be coercive. It is unethical to provide undue compensation or inducements to research participants. If you would not participate if the compensation were not offered, then you should decline.

Voluntary Participation

Your participation in this research must be completely voluntary. If you do decide to participate, you may withdraw at any time without any consequences or any explanation. If you do withdraw from the study your data will be used only with your permission. If you decide that you would like your data removed from the study, then I will destroy all of your data by shredding any notes and paper copies and erasing all electronic documents. You can keep the small gift of compensation even if you chose to withdraw from the study.

Consent

To make sure that you consent to participate in this research, I will ask you to fill out a consent form. You can choose to participate in this study, or decline. I will know that you have consented according to whether or not you sign the consent form.

Anonymity

I will ask you whether or not you would like your anonymity protected. If you wish to

Section 2.3 Informed Consent Form (Part 2)

I, _____ on this _____ of _____:
 (participants full name) (day) (month and year)

- a. have read and understood the information sheet provided by Kate Proctor titled, “Social Dimensions of Reintroducing Blue Camas (*Camassia* sp.) Cultivation: An Exploration of Local Interest, Opportunities and Challenges”.
- b. am aware that my participation in an interviews with Kate Proctor is completely voluntary, that I can withdraw participation at any time without consequences.
- c. am aware that the information that I provide in this interview with Kate Proctor 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.
- d. consent / do not consent (*please check one box*) that this interview with Kate Proctor be recorded on audio cassette. I am aware that the interview can proceed without the interview being recorded on audio cassette. 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.
- e. consent / do not consent (*please check one box*) that the informal group discussion with Kate Proctor be recorded on video cassette. I am aware that the discussion can proceed without the discussion being recorded on video cassette. Even if I do consent to have the informal discussion video-recorded, I am aware that I am free to request that the video recording be turned off at ay point during the discussion. The video tape from the group discussion may be shown publicly.
- f. consent / do not consent (*please check one box*) that this interview with Kate Proctor be photographed and that photographs from this interview may be used in publications and presentations pertaining to the specific information that I provide in the interview. Even if I do consent to have this interview photographed, I am aware that I am free to request that photographs not be taken at any point during the interview.
- g. consent / do not consent (*please check one box*) that information from this project may be used for future projects conducted by Kate Proctor that are related to traditional preparation, harvest, and management of culturally important resources.
- H. consent / do not consent (*please check one box*) That I waive my right to confidentiality.
- I. consent / do not consent (*please check one box*) That the interview material (on audio tape, video tape or in written form) may be given to Kate Proctor’s supervisors. If

you consent this data may be used for their own publications.

(Participant)

(Date)

(Kate Proctor)

(Date)

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

APPENDIX 3 Example Interview Questions

Section 3.1 Questions for First Nations Members

Have you, or anyone in your family, ever harvested or eaten blue camas? Do you know other people who harvest and eat camas?

Do you know if there was traditionally a preference for common or great camas?

Do you remember anyone in your community talking about tending camas meadows?

When and how was camas harvested? How was it cooked and stored? Were other plants harvested at the same time camas was harvested?

Do you think that harvesting and eating camas is worthwhile in these modern times? Why or why not?

Can you talk about your connection with camas and its significance to you?

If you were to harvest camas, where would you like to access it? Do you have access to a place near your home where you can harvest blue camas?

Do you feel like it would be beneficial for you to have access to other places where you could harvest camas? Why or why not?

Do you believe that public parks are an important space for modern-day camas harvesting? Are there other places that you think would be good to establish harvesting sites for camas?

I hear First Nations people say that they still maintain the right to harvest in their traditional territories, especially in public parks. What are your perspectives about this? Under the current laws what rights do First Nations peoples have to harvest resources on public lands?

If there are First Nations people who want to harvest in parks and park managers are becoming more open to this idea, why do you think this isn't it happening more frequently in the open?

Are you or someone else you know interested in collaborating with people at local parks and preserves to manage camas populations? Why or why not?

Have you ever had someone in a park or preserve ask you if you want to harvest camas there? How would it make you feel if someone invited you to harvest camas in a park in your traditional territory?

What would collaborative management of blue camas populations look like to you?

What do you think are the most important components of restoring the health of camas meadows for future harvesting?

From your perspective, why is the size of camas bubs growing in the wild is so much smaller today than historically? How can we work on increasing the size of camas bulbs in parks?

What are some of challenges that you see with harvesting camas in today's world?

How do you feel about harvesting plants from territories other than your traditional territory? How would you go about seeking permission to harvest camas or other plants in someone else's traditional territory?

What if no one from the traditional territory is found that is interested in harvesting camas? Is it okay for non-FN land managers to invite FN from other places that are interested in harvesting?

Section 3.2 Questions for Managers of Protected Areas

What are the current ecological restoration and conservation activities taking place on the property you help to manage?

Is there blue camas growing on the property you help to manage?

How are the blue camas populations being managed at present?

How critical do you believe burning is to the health of camas meadows?

Is there currently a burning regime on the properties?

Do you know what the history of camas harvesting and fire is at the sites you manage?

Do you believe that harvesting camas is compatible with your conservation and restoration activities?

Has anyone approached you to request to harvest camas or other plants on the properties you manage?

Is there currently any collaboration between Local First Nations regarding the management of the camas populations?

Is there interest in collaborating with local First Nations peoples on managing camas populations?

What would collaboration of blue camas management look like to you?

Are concepts drawn from local Traditional Ecological Knowledge incorporated into the park's/preserve's management plan?

I hear First Nations people say that they still maintain the right to harvest in their traditional territories, especially in public parks. Under the current laws what rights do First Nations peoples have to harvest resources on public lands?

If there are First Nations people who want to harvest in parks and park managers are becoming more open to this idea, why do you think this isn't it happening more frequently?

What are some of the challenges you see to co-managing conservation areas?

Section 3.3. Sample Interview Questions for Other Involved Community Members

What do you believe are the greatest motivations driving the renewal of local traditional harvesting practices?

How much local interest you have witnessed around renewing traditional food harvesting and use (more specifically camas?)

Do you believe that public parks are an important space for modern-day camas harvesting?

Is camas is something that is served at traditional foods events? If so how is it prepared?

Are there people that you know of that are propagating traditional foods for traditional foods events?

What are some of the challenges you have witnessed around the renewal of traditional food use (more specifically camas?)?

I hear First Nations people say that they still maintain the right to harvest in their traditional territories, especially in public parks. Under the current laws what rights do First Nations peoples have to harvest resources on public lands?

What is the current state of treaties for First Nations peoples of BC?

If there are First Nations people who want to harvest in parks and park managers are becoming more open to this idea, why do you think this isn't it happening more frequently?

Do you see FN communities collaborating with the managers of public parks for the renewal of camas harvesting grounds? What would collaborative management of blue camas populations in public parks look like to you?

What do you think are the most important components of restoring the health of camas meadows for future harvesting?

What have you learned along the way about cooking camas in the kitchen? Can you please describe the recipe you learned for pit-cooking?

APPENDIX 4 Interview Themes and Subthemes

Theme and sub-themes	Findings
1) Cultural Renewal a) Current Knowledge and Use of Camas	<ul style="list-style-type: none"> - Most Straits Salish and <i>Hul'qumi'num</i> people do not have first hand experience with harvesting or eating camas; - Some Straits Salish and <i>Hul'qumi'num</i> people are familiar with the traditional cultivation and use of camas; - Camas is often lacking or sparse at traditional food gatherings, perhaps due to limited interest, socio-economic barriers, or lack of availability; - Only one person in my study harvesting and cooking camas on a regular basis; - A number of people interested in seeing aspects of traditional camas culture restored.
1) Cultural Renewal b) Camas as a Modern Food	<ul style="list-style-type: none"> - Camas is considered a 'healthy food' that could reduce incidence of chronic disease; - Camas is a practical food as it is adapted to local climate, and easy to cultivate in a garden or wild setting; - Not realistic as a <i>staple</i> food at this time due to lack of abundance on the landscape and small size of home gardens; - Creating new sites through seeding and transplanting bulbs is an essential step to making camas a modern food; - The size of pits and duration of time for pit-cooking camas bulbs has decreased, perhaps creating a less tasteful food; - Need to refine the process of cooking to make it more palatable.
1) Cultural Renewal c) Re-instating Camas Culture and Teaching a New Generation	<ul style="list-style-type: none"> - The indigenous people I spoke with expressed to me a great deal of enthusiasm for bringing forward many elements of traditional camas culture; - The desire to revive the indigenous relationship with camas involves much more than cultivating a nutritious food; - Re-instating cultural roles was emphasized—particularly the role of ecological caretaker and plant specialist; - Invasive plant removal, native plant propagation, habitat restoration, <i>in situ</i> cultivation and harvesting of native plants characterize this role of traditional ecological care-taker; - Participants stressed the importance of teaching the next generation about sustainable harvesting and cultivation techniques, native ecology, cooking, as well as the traditional languages and songs; - School visits, native plant walks, community pit-cooking and ecological restoration events are all part of this education.
2) Protected Areas as Sites for Cultural Renewal a) Interest in Protected Areas	<ul style="list-style-type: none"> -Participants expressed a desire to keep cultural plants and habitats under protection, though didn't view this protection as necessarily in conflict with indigenous plant harvesting; - Having access to camas bulbs in protected areas for personal consumption and community feasting events was one interest participants discussed; - Collecting camas bulbs and seed in protected areas for restoration efforts and transplanting into community gardens was emphasized as more important than harvesting bulbs for food at this time; - Access to a source of camas bulbs and seeds was depicted as central to accelerating the restoration of camas habitat and culture outside of protected areas; - Protected areas are seen as important outdoor classrooms for teaching the next generation about camas habitat, harvesting and cultivation techniques; - Participants expressed that protected areas are important sites to show the general public that First Nations still retain traditional plant knowledge and are actively practicing their role as ecological caretakers.

<p>2) Protected Areas as Sites for Cultural Renewal</p> <p>b) Current Use of Protected Areas</p>	<ul style="list-style-type: none"> - Protected areas are currently used by some as sites for harvesting culturally important plants; - Decisions about where to harvest are guided by traditional boundaries and protocols, as well as the perceived stability of the plant populations and safety of the harvesting site; - Asking permission to harvest in federal, provincial, or municipal lands is seen as unnecessary; - Through direct action harvesting some indigenous people are demonstrating their indigenous treaty rights; - Un-authorized harvesting might potentially limit the extent of resource tending and teaching that can be carried out due to conflict with other park users or managers who might see plant harvesting as illegal or ecologically damaging.
<p>2) Protected Areas as Sites for Cultural Renewal</p> <p>c) Willingness to Collaborate with Current Managers</p>	<ul style="list-style-type: none"> - Participants all agreed that discussions need to happen with the current managers of protected areas to ensure that the native plants and ecosystems are protected, and that sites are safe for harvesting; - Some expressed hesitation about collaborating, and skepticism that staff of protected areas would be willing to collaborate; - A history of cultural appropriation, misrepresentation, and ‘tokenization’ of indigenous knowledge were discussed as reasons why some indigenous people may feel hesitant about working with scientists or land managers; - The lack of continuous paid work for indigenous people, leading to an imbalance in power dynamics, was seen as another deterrent from collaboration at this time.
<p>3) Supporting Renewal of Camas Culture in Protected Areas</p> <p>a) Receptivity to Indigenous Camas Harvesting in Protected Areas</p>	<ul style="list-style-type: none"> - The land managers I spoke with were all receptive to the idea of people in First Nations communities harvesting camas in the protected areas where they work; - In the Gulf Islands National Park Reserve, First Peoples who want to come and harvest traditional resources are welcome to harvest now without seeking a permit; - The NCC staff see camas harvesting as compatible with their restoration and conservation objectives, and have already helped to facilitate multiple camas harvests; - Getting permission before harvesting on the NCC properties is necessary; - Having a camas harvesting program that incorporates ecological monitoring and ongoing collaborative management, as opposed to occasional harvesting requests is seen as the best approach; - The Victoria City Parks employees are open to the idea of camas harvesting, though they suggested establishing a permitting process, which would be established at a level higher up in government (e.g. Provincial or Federal); - Currently there is an \$85 fine for anyone who removes plant material from the Victoria City Parks without asking first.
<p>3) Supporting Renewal of Camas Culture in Protected Areas</p> <p>b) Collaboration</p>	<ul style="list-style-type: none"> - Two of the managers I spoke with were enthusiastic about the idea of working with local indigenous people to manage the resources in the protected areas; - NCC is hoping to co-manage a section of the CGOP with people interested in doing traditional harvesting who are willing to commit to a more long-term project with an experimental research component; - GINPR staff suggested working with the local First Nations to first create an experimental pilot project and eventually a program around camas harvesting and management.
<p>3) Supporting Renewal of Camas Culture in Protected Areas</p> <p>c) Integrating Camas Harvesting into Existing</p>	<ul style="list-style-type: none"> - The land managers I spoke with are already making efforts to incorporate or mimic traditional management of Garry oak ecosystems, including the use of fire, mowing, and grazing to control encroachment of trees and shrubs in open areas; - Management specifically aimed at enhancing camas populations could be applied within this existing framework; - Managers suggested incorporating a camas harvest into their yearly prescribed burn

Management	<p>programs, with an ecological monitoring component;</p> <ul style="list-style-type: none"> - Another option would be to offer a harvesting permit that would allow indigenous management or removal of bulbs and seeds to take place alongside existing management.
4) Existing and Anticipated Challenges a) Ecological Concerns	<ul style="list-style-type: none"> - One concern is that soil disturbance might provide enhanced conditions for invasive exotic plant seeds to germinate and grow; - Another concern is that harvesting could demolish rare plant populations, or cause harmful soil compaction to native biota more generally; - Through adaptive management, experimentation and monitoring managers suggested that many of these risks could be eliminated or mitigated by planning where, when and how frequently these activities would take place; - The quantity of camas bulbs desired at this time seems to be relatively low, implying there would be a low level of impact of camas populations.
4) Existing and Anticipated Challenges b) Safety	<ul style="list-style-type: none"> - Because complete site histories aren't available for all protected areas there is a risk that people could harvest in areas with dangerous levels of toxins including pesticides or herbicides; - While sites could be tested, who will be logistically and financially responsible for these tests? - The presence of poisonous plants, such as death camas, could make harvesting of edible camas bulbs dangerous and legally daunting; - Weeding out death camas is possible, though it will take time; - Asking people to sign legal waivers might be necessary.
4) Existing and Anticipated Challenges c) Challenging Social Norms	<ul style="list-style-type: none"> - Other park-goers might find camas harvesting and cultivation disruptive or 'out of place' and confront the harvester of protected area staff; - Participants emphasized that public acceptance of indigenous harvesting (such as salmon fishing in public spaces) is growing; - Tapping into the local food movement for support might be one way to reach across cultural boundaries.
4) Existing and Anticipated Challenges d) Finding Funding	<ul style="list-style-type: none"> - Funding for new and innovative programs within protected areas is very limited at this time; - Protected areas could actively seek out indigenous people to participate in the programs with a management modeled off of TEK that they already have funding for.
4) Existing and Anticipated Challenges e) Respecting Indigenous Protocol	<ul style="list-style-type: none"> - Another challenge for current park managers involves the desire by some indigenous harvesters to maintain privacy around harvesting and management practices, and cultural events; - A concern that managers have with opening up their space for camas harvesting, or choosing to collaborate with certain people, is that it might spark conflict with people in another Nation who feel they have more rights to that piece of land; - The indigenous people I spoke with were not concerned with this potential conflict as they said they would seek permission to harvest outside of their traditional territory; - A dual-permitting system where a park offers permits to a tribe and then lets the First Nation choose who they feel is qualified to harvest and manage the camas site might work well.
4) Existing and Anticipated Challenges f) Gaining Trust	<ul style="list-style-type: none"> - Some indigenous people are concerned that non-indigenous managers will completely direct collaborative management projects; - Non-First Nations may feel that they are in the position of defending themselves for the actions of their ancestors; - There is some fear that inviting indigenous people to harvest camas, or other plants, could be used as an acknowledgement of traditional territory rights in court cases, and eventually end in a complete take-over of a protected area, or the firing of non-native employees; - A certain level of commitment will be required to gain the trust needed to collaborate.

APPENDIX 5 Stove-Top and Oven Camas Recipes

Section 5.1 'Modern' Kettle-Steam-Cooking of Root Vegetables

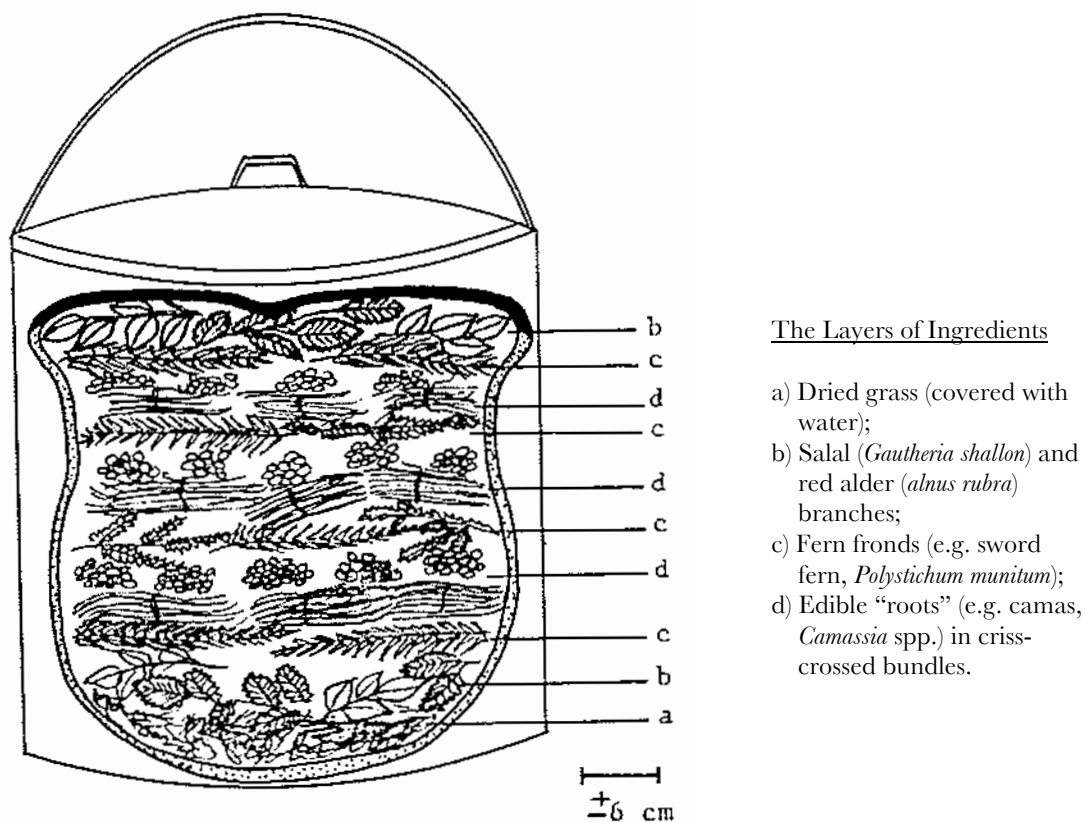


Figure 5.1 Kettle-Cooked Camas. This figure depicts a stove-top steaming method that mimics pit-cooking. The image was drawn by Turner and Kuhnlein (1983, p. 425). The 'recipe' used in their cooking pot is of Nitinaht origin. The vegetation is layered much like it would be in a pit cook.

Section 5.2 Pressure Cooked and Fried Camas Recipe

Instructions:

- 1) Place camas bulbs in a pressure cooker with enough water to cover them;
- 2) Pressure cook camas bulbs for nine hours at 257 degrees Fahrenheit, or cook overnight at 220 degrees Fahrenheit;
- 3) Open the pressure cooker and drain water. Allow the bulbs to cool down;
- 4) Slice the bulbs and fry them in oil or lard.
- 5) Serve and enjoy!

Figure 5.2 Pressure Cooked and Fried Camas Recipe. This recipe was found on the Hunter Angler Gardener Cook website, found at <http://honest-food.net/2011/07/26/cooking-blue-camas>.

Section 5.3 Camas Jerky Recipe

Instructions:

- 1) Harvest 1-2 litre of moderately sized camas bulbs (*Camassia quamash* or *C.leichtlinii*) at the end of their flowering season;
 - 2) Wash bulbs thoroughly and peel off the dirty outer skin, but leave the rest of the skin on;
 - 3) Place in a slow cooker and fill the slow cooker with another 1-2 litre of water;
 - 4) Cover with a lid and cook for 24-48 hours (yes that's right!) checking every 4-6 hours to refill with water if necessary; cook until the camas caramelizes to a dark brown color. (When properly caramelized, the camas is very sweet. If you stop cooking it before the camas turns black, it will be tasteless);
 - 5) Poor off the extra water and allow the camas to cool;
 - 6) Peel off and discard the remaining skin on the camas;
 - 7) Squish the camas flat with the bottom of drinking glass or the palm of your hand;
 - 8) Dry in a food dehydrator or on a cooking sheet at the lowest possible temperature (checking every 20 minutes).
-

Figure 5.3 Camas Jerky Recipe. This recipe was developed and contributed by Abe Lloyd. (For more information on Abe's camas cooking experiments see <http://arcadianabe.blogspot.ca/search?q=camas>).

Section 5.4 Camas Bulbs Baked in Chicken Broth

Instructions:

- 1) Place whole camas bulbs in roasting pan or Dutch oven;
 - 2) Cover bulbs completely with chicken broth;
 - 3) Bake in the oven [at 350 degrees Fahrenheit] for three hours or longer.
 - 4) Serve and enjoy!
-

Figure 5.4 Recipe for camas bulbs baked in chicken broth. This recipe was contributed by Dr. Brenda Beckwith. Inspiration for the recipe came from chefs at the Sooke Harbour House on Vancouver Island, British Columbia.

APPENDIX 6 Data Summary Tables

Section 6.1a Camas Population (Above-Ground) Data Summary Table

Measure	Treatment Intensity	N	Pre-Harvest (2009)				Post-Harvest (2010)			
			Mean	Stand. Dev.	Min.	Max.	Mean	Stand. Dev.	Min.	Max.
Number of Flowering Camas Plants/Plot	No harvest	20	39.45	16.29	21	77	68.75	21.14	31	112
	Low	20	35.30	15.57	16	64	58.15	28.88	20	149
	Medium	20	38.05	13.11	13	62	59.30	28.32	11	122
Height of Flowering Camas Plants (Metres)	No harvest	20	0.56	0.09	0.32	1.10	0.55	0.09	0.27	0.84
	Low	20	0.54	0.09	0.32	0.89	0.51	0.09	0.26	0.90
	Medium	20	0.54	0.08	0.31	0.91	0.52	0.08	0.27	0.85
Number of Fruits/ Camas Plant	No harvest	20	4.78	2.61	0	19	7.80	4.80	0	34
	Low	20	4.02	2.46	0	17	6.58	4.65	0	35
	Medium	20	4.33	2.43	0	14	7.14	4.11	0	25
Number of Aborted Fruits/Camas	No harvest	20	1.61	2.00	0	12	1.43	2.07	0	15
	Low	20	1.80	2.11	0	14	1.39	2.04	0	14
	Medium	20	1.07	1.66	0	12	1.24	2.00	0	19
Number of Aborted Flowers/Camas	No harvest	20	4.10	3.39	0	21	1.81	2.56	0	20
	Low	20	4.10	3.02	0	20	2.00	2.81	0	25
	Medium	20	4.51	3.24	0	33	1.72	2.46	0	15
Number of Potential Fruit/Camas Plant	No harvest	20	10.48	4.02	3	33	4.47	2.00	36	4
	Low	20	9.92	3.55	0	27	4.09	2.00	35	4
	Medium	20	9.90	3.86	0	35	3.81	2.00	40	4
Number of Camas Seeds/Pod	No harvest	20	N/A	N/A	N/A	N/A	16.52	5.22	5	31
	Low	20	N/A	N/A	N/A	N/A	15.37	5.38	4	37
	Medium	20	N/A	N/A	N/A	N/A	16.29	5.60	5	39

Section 6.1b Camas Population (Below-ground) Data Summary Table

Post-Harvest (2010)						
Measure	Treatment Intensity	N	Mean	Stand. Dev.	Min.	Max.
Total Bulb Weight/Plot (Grams)	No harvest	3	1519.04	295.60	1330.03	1859.69
	Low	3	930.21	80.92	836.80	978.80
	Medium	3	1286.12	344.33	1010.17	1671.99
Total Number of Bulbs/Plot	No harvest	3	2279.67	1081.10	1257	3411
	Low	3	1114.67	350.60	769	1470
	Medium	3	1430.00	275.29	1113	1609
Total Bulb Weight in Size Class 1	No harvest	3	86.27	62.55	23.90	149.00
	Low	3	28.13	15.45	12.90	43.80
	Medium	3	42.64	18.76	31.60	64.30
Total Bulb Weight in Size Class 2	No harvest	3	127.20	76.78	40.05	184.85
	Low	3	76.84	27.59	44.98	92.90
	Medium	3	74.90	23.37	50.15	96.60
Total Bulb Weight in Size Class 3	No harvest	3	124.41	91.05	66.47	229.35
	Low	3	43.96	25.84	16.80	68.23
	Medium	3	63.88	14.08	50.10	78.25
Total Bulb Weight in Size Class 4	No harvest	3	108.67	47.83	57.29	151.90
	Low	3	95.39	36.54	62.28	134.60
	Medium	3	163.32	49.03	117.72	215.18
Total Bulb Weight in Size Class 5	No harvest	3	1072.50	305.92	840.91	1419.30
	Low	3	685.88	35.21	648.41	718.28
	Medium	3	941.37	292.72	747.40	1278.08
Total Number of Bulbs in Size Class 1	No harvest	3	1242.33	862.42	527	2200
	Low	3	490.00	220.68	280	720
	Medium	3	704.33	188.43	540	910
Total Number of Bulbs in Size Class 2	No harvest	3	598.33	337.87	210	825
	Low	3	367.33	114.53	247	475
	Medium	3	311.67	122.51	190	435
Total Number of Bulbs in Size Class 3	No harvest	3	155.33	113.98	71	285
	Low	3	48.67	25.01	20	66
	Medium	3	73.00	20.66	54	95
Total Number of Bulbs in Size Class 4	No harvest	3	89.67	33.65	65	128
	Low	3	90.33	60.50	51	160
	Medium	3	147.00	30.35	112	166
Total Number of Bulbs in Size Class 5	No harvest	3	194.00	71.27	147	276
	Low	3	118.33	20.82	95	135
	Medium	3	194.00	49.52	156	250

Section 6.2 Plant Community Data Summary Table

(* Includes species that showed significant changes in one or more statistical test).

Species*	Growth Form	Treatment Intensity	N	Pre-Harvest (2009)				Post-Harvest (2010)			
				Mean	Stand. Dev.	Min.	Max.	Mean	Stand. Dev.	Min.	Max.
Tall camas (<i>Camassia leichtlinii</i>)	Native perennial forb	No harvest	20	53.65	14.18	33	83	60.85	13.65	41	89
		Low	20	59.55	17.11	24	86	62.95	15.55	29	83
		Medium	20	60.75	19.47	32	99	61.25	13.51	26	83
Gairdner's yampah (<i>Perideridia gairdneri</i>)	Native perennial forb	No harvest	20	2.10	5.69	0	25	3.35	5.28	0	19
		Low	20	0.95	1.90	0	7	1.25	2.22	0	8
		Medium	20	0.60	1.35	0	6	2.10	2.55	0	8
Fool's onion (<i>Triteleia hyacinthina</i>)	Native perennial forb	No harvest	20	4.25	9.62	0	35	7.40	9.06	0	34
		Low	20	1.79	3.34	0	14	6.30	4.33	0	17
		Medium	20	2.10	3.42	0	12	5.80	5.78	0	23
Common snowberry (<i>Symphoricarpos albus</i>)	Native shrub	No harvest	20	7.78	0.00	26	7.78	9.00	7.78	0	27
		Low	20	12.07	0.00	48	12.07	7.65	10.74	0	39
		Medium	20	13.55	0.00	42	13.55	6.65	7.56	0	27
Kentucky bluegrass (<i>Poa pratensis</i>)	Exotic perennial grass	No harvest	20	17.95	13.69	0	51	26.20	14.87	4	57
		Low	20	17.35	12.18	2	38	20.20	14.21	3	43
		Medium	20	12.80	10.64	0	37	10.75	8.53	1	34
Nipplewort (<i>Lapsana communis</i>)	Exotic annual forb	No harvest	20	5.70	7.06	0	30	8.06	0.00	31	8
		Low	20	8.00	9.87	0	35	12.54	1.00	38	13
		Medium	20	3.10	4.06	0	16	14.10	0.00	45	14
Hairy cat's ear (<i>Hypochaeris radicata</i>)	Exotic annual forb	No harvest	20	0.20	0.70	0	3	0.52	0.00	2	1
		Low	20	0.05	0.22	0	1	1.02	0.00	3	1
		Medium	20	0.30	0.57	0	2	1.32	0.00	4	1
Common cleavers (<i>Galium aparine</i>)	Exotic or weedy annual forb	No harvest	20	1.80	2.84	0	11	1.55	1.79	0	6
		Low	20	2.25	2.36	0	9	2.50	3.09	0	12
		Medium	20	1.95	3.66	0	14	3.80	4.82	0	17
Common vetch (<i>Vicia sativa</i>)	Exotic perennial forb	No harvest	20	20.30	10.30	1	40	8.65	5.22	2	20
		Low	20	15.80	10.57	3	38	9.00	5.68	2	22
		Medium	20	19.75	10.11	8	41	7.25	4.24	0	17
Scotch broom (<i>Cytisus scoparius</i>)	Exotic shrub	No harvest	20	1.15	2.89	0	13	0.10	0.31	0	1
		Low	20	0.40	0.68	0	2	1.40	1.90	0	7
		Medium	20	0.95	2.35	0	9	3.15	3.92	0	11

Section 6.3 Soil Compaction Data Summary Table

Measure	Treatment Intensity	N	Post-Harvest (December 2009)				Post-Harvest (July 2010)			
			Mean	Stand. Dev.	Min.	Max.	Mean	Stand. Dev.	Min.	Max.
Soil Compaction	No harvest	20	4.25	0.95	2.60	5.85	9.31	1.04	7.54	11.29
	Low	20	3.75	0.82	2.65	5.75	7.81	1.46	5.29	10.50
	Medium	20	3.25	1.08	1.45	5.10	7.38	1.54	3.21	10.75

APPENDIX 7 Complete Plant List

Alopecurus pratensis (meadow foxtail)*
Anthoxanthum odoratum (sweet vernalgrass)*
Bromus carinatus (California brome)
Camassia leichtlinii (tall camas)
Camassia quamash (common camas)
Cerastium arvense (field chickweed)*
Cirsium arvense (Canada thistle)*
Claytonia perfoliata (miner's lettuce)
Crataegus monogyna (common hawthorn)*
Cytisus scoparius (Scotch broom)*
Dactylis glomerata (orchard grass)*
Dodecatheon hendersonii (broad-leaved shootingstar)
Fritillaria lanceolata (chocolate lily)
Galium aparine (cleavers)*
Geranium molle (dovefoot geranium)*
Hedera helix (English ivy)*
Hypochaeris radicata (hairy cat's ear)*
Lactuca muralis (wall lettuce)*
Lapsana communis (nipplewort)*
Lathyrus nevadensis (purple peavine)
Lithophragma parviflorum (small-flowered woodland star)
Lomatium utriculatum (spring-gold)
Lotus crassifolius or *pinnatus* (deer-vetch)
Lupinus micranthus (small-flowered lupine)
Mahonia nervosa (Oregon grape)
Mimulus breweri (Brewer's monkey-flower)
Myosotis discolor (forget-me-not)*
Oemleria cerasiformis (Indian-plum)
Osmorhiza purpurea (sweet cicely)
Perideridia gairdneri (Gairdner's yampah)
Piperia martima (rein-orchid)
Plantago lanceolata (English plantain)*
Poa pratensis (Kentucky bluegrass)*
Pseudotsuga menziesii (Douglas-fir)
Quercus garryana (Garry oak)
Ranunculus occidentalis (western buttercup)
Rubus discolor (Himalyan blackberry)*
Sanicula crassicaulis (Pacific sanicle)
Stellaria media (common chickweed)*
Symphoricarpos albus (snowberry)
Taraxacum officinale (common dandelion)*
Trifolium dubium (small-hope clover)*
Triteleia hyacinthina (fool's onion)
Vicia americana (American vetch)
Vicia sativa (common vetch)*

Figure 7.1 A complete list of the 45 plant species recorded in my experimental plots at the Cowichan Garry Oak Preserve, a Nature Conservancy of Canada property. (* = Exotic plants).