"The Queen Root of This Clime": Ethnoecological Investigations of Blue Camas (*Camassia leichtlinii* (Baker) Wats., *C. quamash* (Pursh) Greene; Liliaceae) and its Landscapes on Southern Vancouver Island, British Columbia

by

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ABSTRACT

Bulbs of camas (*Camassia leichtlinii* and *C. quamash*; Liliacaeae) were an important native root vegetable in the economies of Straits Salish peoples. Intensive management not only maintained the ecological productivity of this valued resource but shaped the oak-camas parklands of southern Vancouver Island. Based on these concepts, I tested two hypotheses: Straits Salish management activities maintained sustainable yields of camas bulbs, and their interactions with this root resource created an extensive cultural landscape.

I integrated contextual information on the social and environmental histories of the pre- and post-European contact landscape, qualitative records that reviewed Indigenous camas use and management, and quantitative data focused on applied ecological experiments. I described how the cultural landscape of southern Vancouver Island changed over time, especially since European colonization of southern Vancouver Island. Prior to European contact, extended families of local Straits Salish peoples had a complex system of root food production; inherited camas harvesting grounds were maintained within this region. Indigenous peoples adapted their economic decisions and traditional food needs to fit shifting social and environmental parameters. Through ecological experimentation I examined the growth and development of camas in nursery cold frames and in simulated Indigenous management techniques of naturally occurring camas populations. These two studies showed that camas demonstrated a variety of growth patterns and maintained a range of developmental phases, leading me to conclude that this genus is a good candidate for regular management. The field study also confirmed a high degree of habitat heterogeneity characteristic of this region.

I developed a multiscalar model of integrated Indigenous root management and reconstructed the ethnoecological dynamics of former camas landscapes. From this I derived management recommendations for future camas landscapes. I elucidated how camas harvest grounds were essentially agroecosystems, maintained by a range of anthropogenic disturbance patterns. The evolution of camas cultivation was a continuum

of intensifying intervention between humans and a native root crop, a relationship of human-environment interaction that quickly ended, for the most part, soon after European contact. Successful restoration of today's degraded camas populations, and of the nationally endangered Garry oak ecosystems, in which *Camassia* is a major herbaceous component, is dependent on ethnoecologically integrated restoration initiatives based on multidisciplinary landscape reconstruction studies.

Examiners:

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DEDICATION

My cousin, Dan, was a kindred, and festive, spirit and one of the most dynamic and considerate people I have ever known. He shoved me out of my introverted shell on numerous occasions. I never had so much fun. In his honour, I will carry on the tradition of taking shower caps from hotels, and I dedicate this work to him.

Daniel Legg
Phoenix, Arizona
1964 - 1999

"The Blue Bird"
Poem written by Mary E. Coleridge
Musical composition by Charles V. Stanford

The lake lay blue below the hill,
O'er it, as I looked, there flew
Across the waters, cold and still,
A bird whose wings were palest blue.

The sky above was blue at last,
The sky beneath me blue in blue.
A moment, ere the bird had passed,
It caught his image as he flew.

The lake lay blue below the hill.

1.0 CULTURAL LANDSCAPES OF SOUTHERN VANCOUVER ISLAND: INTRODUCTION AND FOUNDATION

> land•scape (lændskeip) 1. *n.* a painting or photograph of a piece of inland scenery || such a piece of scenery...
>
> -- The New Lexicon Webster's Encyclopedic Dictionary of the English Language (1988:554)

> ...the landscape tells – or rather *is* – a story.
>
> -- Tim Ingold (1993:152)

This dissertation documents a study of cultural landscape reconstruction and restoration on southern Vancouver Island, British Columbia (Figure 1.1). When the British-based Hudson's Bay Company (HBC) was seeking a new outpost site in the 1840s they looked to the locality of what was to become Victoria, on the island's southern tip. Early written accounts of this region by European explorers, traders, and colonists often described the landscape as a mosaic of clearings and open woodlands. This parkland was an alluring landscape when compared to the densely forested wilderness throughout a large extent of the Pacific Northwest. The environment was perceived to be aesthetically similar to English parklands, and James Douglas, HBC Chief Factor, coined the now often-cited phrase, "a perfect Eden" (5 February 1843, in Lamb 1943:84) to describe this setting. Upon noting the rich vegetation and pleasant surroundings without any clear signs of civilization (e.g., row crops and fenced fields) this "natural" landscape, he reasoned, must be of heavenly creation. This was not seen as an anthropogenic landscape, or one modified by Indigenous peoples, and the subsequent events of colonial history reflect this early perception and interpretation.

The Coast Salish First Nations of southern Vancouver Island, specifically known as Straits Salish (Suttles 1951a) or "Northern Straits" (Suttles 1990b), like other Indigenous peoples of the Northwest Pacific Coast, are widely recognized for their predominant marine fisheries and sophisticated woodworking technology (Mitchell and Donald 1988; Suttles 1990a), but less is understood about their land stewardship practices and, specifically, their use and management of plant foods. The early views of the

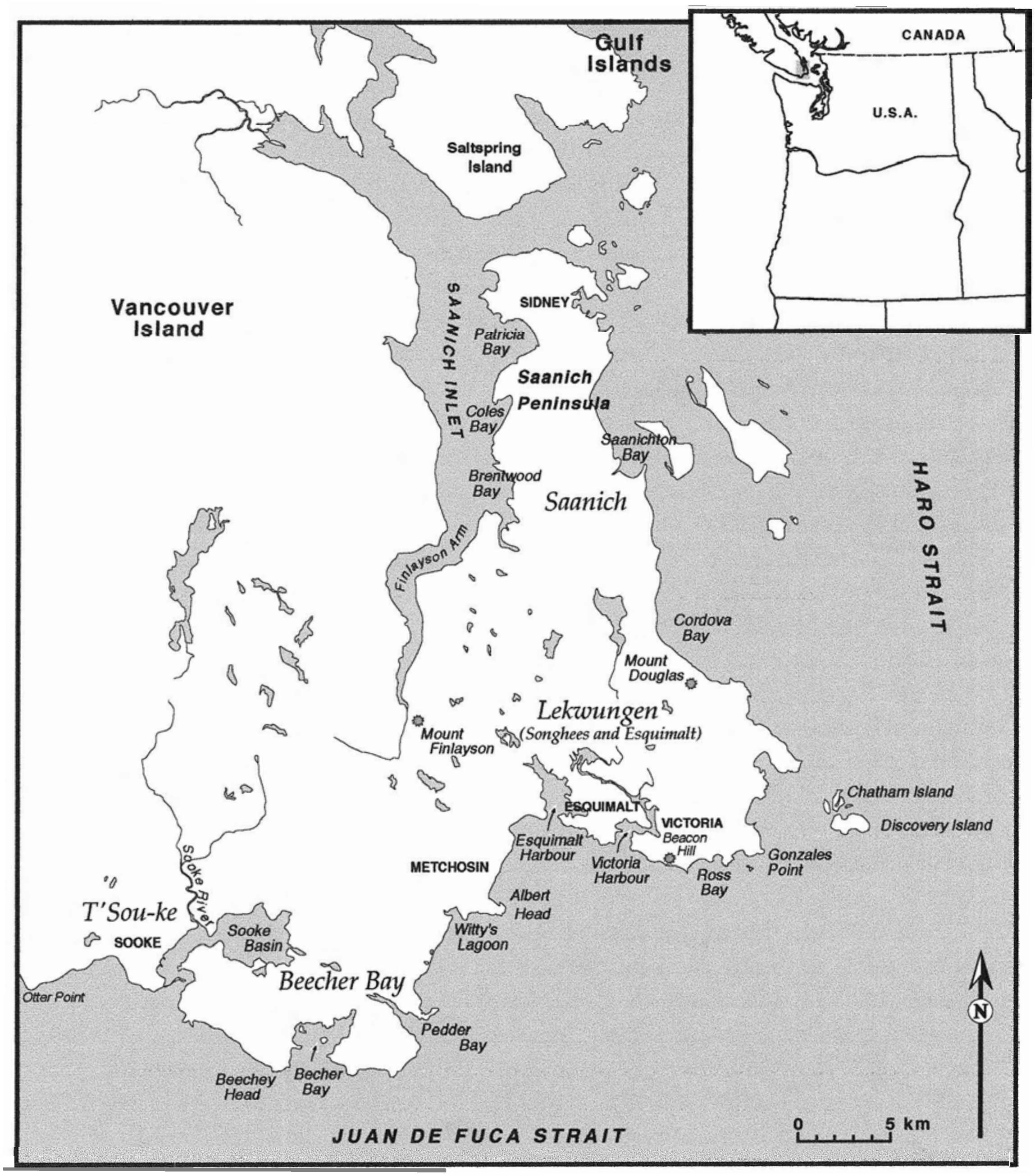

Figure 1.1 Southern Vancouver Island, British Columbia, showing the territories of the four prominent First Nations and contemporary place names used in the text to describe each group's territory.

culture area are reflected in the early ethnological works of Franz Boas, who first visited the region in 1886 and wrote extensively on the social structure, spirituality, economic patterns, and languages of the Indigenous peoples (Suttles and Jonaitis 1990). Boas described comparatively little about the traditional procurement of plant foods for the Coast Salish peoples. For example, of the staple root vegetable, camas (*Camassia* spp.), he wrote: "...the roots of... a species of onions... [were served] for food" by the "Lku'ñgen" [Lekwungen Straits Salish] peoples (1890:567). Boas described the name for this root vegetable as *k‹tlâ'ol*, a word that corresponds to the Lekwungen term for camas (*kʷɬáʔal*, Turner and Kuhnlein 1982). The use and management of plant foods, especially root vegetables, continued to receive modest attention in the works of other ethnographers (Drucker 1955; Barnett 1955; e.g., Deur 1999; W. Suttles pers. comm. 2003).

Although early historical accounts by explorers, naturalists, colonists, and settlers often included practical and descriptive information pertaining to the lifeways of the First Peoples, these writers, like the anthropologists, seemed to agree that the Indigenous inhabitants did not, in any way, cultivate the land (e.g., Brown 1868; Sproat 1868). The landscape of southern Vancouver Island was commonly viewed as a scenic and luxuriant parkland, and one of natural origins (e.g., Seeman 1846; Lamb 1943). The primary, and presumably only, practice used by the local Indigenous inhabitants to modify the landscape was periodic broad-scale burning (Finlayson 1846-49; Fitzgerald 1848; Grant 1849), a management tool widely applied in similar ecosystems in other regions (e.g., Douglas 1914; Habeck 1961; Sugihara and Reed 1987; Anderson 1993; Boyd 1999a), and for a range of ecosystem types around the world (e.g., Russell 1983; Pyne 1991; Gottesfeld 1994; Hudak 1999; Lewis and Ferguson 1999; Turner 1999a; Laris 2002). In short, subsistence patterns of the coastal Salish peoples were seen to be centred around the ocean; no agriculture or any technology associated with the harvesting of plant resources was thought to exist in pre-settlement times (Kruckeberg 1991).

Nevertheless, in addition to a diversity of marine resources, Indigenous peoples of southern Vancouver Island, and the Northwest Coast in general, depended on a wide range of other natural resources, including land mammals, birds, and plants. Plants were widely used for food (Turner 1995), for medicines (Turner and Hebda 1990), and in the manufacture of a wide range of products, from canoes, totem poles, and houses to household implements, bedding, clothing, baskets, nets, traps, dyes, and other technological uses (Turner 1998). Furthermore, hunting and fishing could not have occurred without the skillful manipulation of plants. Plants and plant communities had high importance for cultural sustainability and were, in many cases, tended through family-based tenure protocols and resource stewardship customs. Traditional systems of land use and resource management are becoming more widely recognized and researched as an integral and integrated component of Indigenous culture in this region (Deur and Turner in press, 2004a), and in other parts of North America (e.g., Gadgil and Berkes 1991; Blackburn and Anderson 1993; Berkes 1999; Minnis and Elisens 2000).

One particular plant food that was associated with systematic and intensive management on southern Vancouver Island was the edible bulb of the two species of camas lily (*Camassia leichtlinii, C. quamash* (Figure 1.2). This root vegetable has strong cultural value because the bulbs were the principal root vegetable in the diet of Straits Salish and other Coast Salish groups. The bulbs of both species of *Camassia* were prepared by prolonged pit-cooking, dried and stored for winter, used for traveling provisions and trade, and served as offerings at feasts and ceremonies. Furthermore, camas populations were actively managed on different environmental scales to maintain their productivity as an Indigenous resource crop (Turner and Kuhnlein 1983; Turner and Peacock in press). As paraphrased in the unpublished ethnographic notes of Marguerite Babcock (1967), the late Christopher Paul (Saanich) places camas as a staple food well before European settlement: "150 years ago, camas was still the 'number one' vegetable of the Indians." Additionally, in most regions of its western North America range, *Camassia* was the "queen root" -- a staple root food -- for many Indigenous peoples (Suttles 1951a; Gunther 1973; Hart 1976; Malouf 1979; Turner and Kuhnlein 1983; Thoms 1989; Kuhnlein and Turner 1991; Lutz 1995; Turner 1995).

Since the time of European contact the southern Vancouver Island landscape has changed dramatically and irreversibly. Despite the past significance of camas bulbs, the resource largely disappeared from regular Indigenous use by the turn of the twentieth

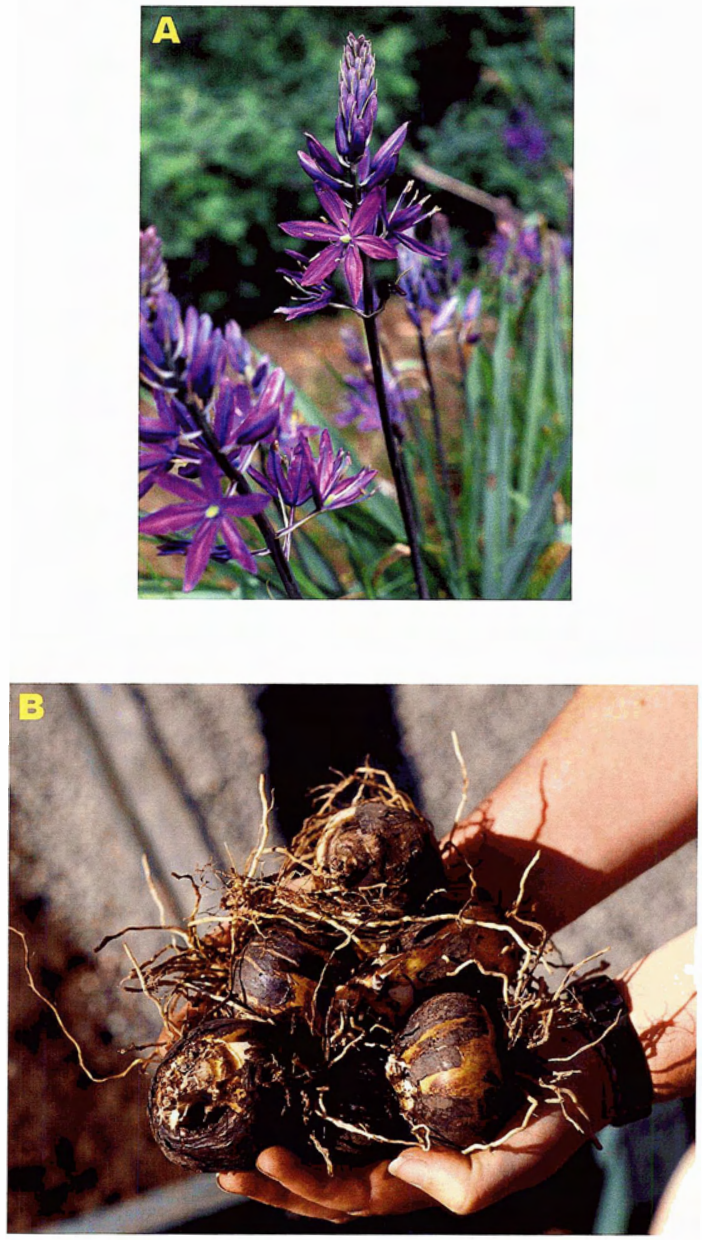

Figure 1.2 Flowers (A) and bulbs (B) of *Camassia leichtlinii*. The photograph of the camas bulbs was taken after growing the plants in nursery cold frames for five years. Bulbs of this size (5-6 cm in diameter) are rare in wild camas habitats (See Chapter 3).

century. The cessation of use of camas and many other resources was strongly affected by rapid social and environmental change, including the alienation of First Peoples from their traditional resource sites (Arnett 1999), the introduction of agricultural food alternatives (Suttles 1951b, in press; Deur 1999; MacDougall *et al.* 2004), and the decimation of large numbers of Indigenous practitioners and knowledge holders (Boyd 1990). Moreover, the active suppression of Indigenous management of resource plants and plant communities probably resulted in significant ecological consequences on a broader community or landscape scale as well.

Today, camas is a well-recognized wildflower often seen growing in natural areas, parks, and some gardens, and is a conspicuous lily of the internationally threatened Garry oak ecosystems of southwestern British Columbia (Hebda 1992; Dunn and Ewing 1997; Fuchs 2001). In Canada, there are less than 5% of Garry oak ecosystems remaining in a near-natural condition (GOERT 2003a). There has been limited research on the ecological dynamics of Garry oak ecosystems in British Columbia, including the role of fire as a natural or cultural disturbance factor (Fuchs 2001). Furthermore, there has been no applied ethnoecological research on the ecological effects of past Straits Salish land management on southern Vancouver Island or on the role of Indigenous camas cultivation practices as an anthropogenic disturbance regime. Although local Songhees (Lekwungen) peoples are beginning to reintroduce camas back into their diet, and manage its populations on nearby Indian Reserve lands, these initiatives are largely ceremonial and symbolic at the present time.

In this dissertation I investigate the human-environment interactions and cultural relationships that shaped the landscape of southern Vancouver Island. By using a interdisciplinary approach which incorporates the fields of ethnohistory, ethnography, ethnobotany, horticulture, and ecology, I elucidate how land management practices contributed to the sustainability of productive and reliable Indigenous root foods and describe the complex ethnoecology of camas cultivation in Straits Salish culture. Through the synthesis of an integrated and multiscalar ethnoecological model, I demonstrate how a patterned and coordinated Indigenous management system affected ecological structure and function, and contributed to the maintenance of a cultural landscape before the time of European contact. Additionally, I describe how the pressures and impacts associated with European contact and settlement caused rapid, dramatic, and irreversible shifts in the traditional economic structure, land use systems, social organization, and other cultural patterns and constructs of Straits Salish peoples.

This model has wide utility because it can be used to explain the dynamics of a landscape over time based on different cultural or environmental parameters (explanatory model) or to describe what parameters need to be considered or tested to achieve a prescribed landscape dynamic (predictive model). Because of the interdisciplinary framework employed in the formation of the model, it can also be generalized to include other Indigenous resources and can be utilized in landscape reconstruction and interpretation by scholars in different disciplines.

This study builds on and complements an emerging body of knowledge on the complexities of plant management by First Peoples on the Northwest Coast (e.g., Boyd 1999a; Deur 2002; Lepofsky *et al.* 2003; Deur and Turner in press, 2004a). This work emphasizes the relevance of plant foods and a terrestrially-based economy in Indigenous subsistence patterns which were likely maintained for at least the past 2000 years. This study provides comprehensive information toward a better understanding of the cultural landscape of southern Vancouver Island and the reference conditions and habitat characteristics needed for the ethnoecological restoration of degraded landscapes.

1.1 DEVELOPMENT OF AN ETHNOECOLOGICAL RESEARCH PROJECT

1.1.1 Conceptual Beginnings

Before launching into the specific context and structure of this dissertation, I introduce three basic questions. What is a cultural landscape and how does it differ from a natural landscape, or even just a landscape? If a landscape was cultural, or, in other words, influenced by regular human activities, what did these human-environment relationships entail? In other words, how did Indigenous peoples maintain and secure a living in "wild" environmental conditions? Finally, what role did root vegetables, specifically, play in First Peoples' economic pursuits? These three concepts, therefore, address and establish a range of scales, from plant resource to landscape, that will be a continual theme throughout this dissertation: ethnoecological scales of interaction which link people to their landscape.

1.1.1.1 What is a Cultural Landscape?

The concept of "landscape" has evolved over centuries. An early reference to landscape comes from the Book of Psalms (48.2) in the Bible where it had an aesthetic connotation equivalent to the word "scenery" (in Naveh and Lieberman 1990:3). This initial derivation is very similar to today's generally-used definition and use of the word; the aesthetic sense of landscape has been incorporated into the disciplines of landscape design and planning, as well as gardening (Naveh and Lieberman 1990).

The English word "landscape" came from the Dutch *landschap*, meaning commonplaces, or the everyday spaces associated with habitation, at the end of the sixteenth century (Tuan 1974; Whittey 1997). In the eighteenth and nineteenth centuries, however, Europeans had become passive or objective observers of landscape. In the Romantic sense, landscape (i.e. nature) became deified by the European elite and its sublime beauty was widely appreciated in art and literature (Nash 1973; Tuan 1974). As noted by Tuan (1974:125) for the romantics of this time: "Observing nature became a fashionable pastime, the thing to do." In the scientific communities, landscape developed a wider geographical connotation and came to be "...experienced as a spatial-visual whole reality of the total environment" (Naveh and Lieberman 1990:4). Hence, landscapes came to represent the integration of abiotic and biotic processes over a broad territory, usually as a result of some human-caused impact or alteration (Bell *et al.* 1997). In this sense, therefore, landscapes are often described by their structure, function, and rate of change (Bell *et al.* 1997).

The definition of a cultural landscape as developed in this dissertation has two parts: *the physical, ecological, and geographical manifestations of human occupation* *and interactions within a given territory, and the conceptual representations of a culture's spiritual, social, and practical relationships with the natural world* (c.f. Colorado 1988; Tyler 1993; Crumbly 1994; Greider and Garkovich 1994). Despite the long-standing tradition of Romanticism in which nature is seen to be separate from humanity in western culture, humans and landscapes are inherently interconnected. Cultural landscapes are shaped by "the integration of sociocultural and biogeoclimatic systems" (Tyler 1993:2). Human perceptions and values create landscapes from the natural environment, and within landscapes, humans can gain experience and gather meanings about the world around them. These insights subsequently influence cultural perspectives and economic choices (c.f. Ingold 1993; Greider and Garkovich 1994). In general, the spiritual, social, and symbolic contexts of long-standing environmental knowledge and wisdom can be, and have been, maintained over time (e.g., Turner *et al.* 2000). Hence, cultural continuity of a people's relationships with their cultural landscape can therefore be sustained even in the face of landscape change and the cessation of long-standing interactions between humans and the environment.

Although adding the modifier "cultural" to landscape, may appear redundant, the distinction between a cultural landscape and a "natural" landscape, a term commonly used today, is not always obvious. Landscapes exist as a continuum of varying levels of interaction between people and the environment. However, the above definition of a cultural landscape emphasizes a people's role and engagement within their environment, as opposed to that of a "natural" landscape in which people are seen as apart from, or as observers of, the environment. Through human-environment interactions people "move along *with* it," as opposed to "[acting] *upon* it, or [doing] things *to* it" (Ingold 1993:164). A group of people dwelling within a landscape over an extended period of time creates a cultural context. This coevolution of social-ecological mechanisms and processes (c.f. Berkes *et al.* 2000) establishes a locally-focused and integrated cultural memory and environmental history.

With use of the term "cultural" to describe the pre-European landscape, therefore, the landscape of southern Vancouver Island is clearly established within the Straits Salish context. Similarly, applying the term to describe modern-day landscapes, firmly place the role of Western society within, and not apart from, the landscape. The development of the landscape is recognized as a cumulative history of evolving cultural values and practices combined with shifting environmental dynamics. In particular, landscapes have been significantly affected as people shifted their economic modes of plant food production from diffuse patterns of plant foraging to systematic methods of land clearance and plant domestication.

1.1.1.2 Economic Systems of Indigenous Peoples

Human economic systems have been conventionally depicted as reflecting a dichotomy between wild plant procurement (i.e. the "hunter-gatherer" pattern) and plant domestication (i.e. agriculture), with little recognition of other approaches of land use and resource management (see Ford 1985; Harris 1989; Anderson 1993; Peacock 1998; Smith in press). These narrow interpretations of past Indigenous modes of subsistence have been primarily derived from the fundamental evolutionary mechanisms of how people acquired food and responded to their environment (see Anderson 1993; Peacock 1998).

First Peoples have often been portrayed as "noble savages" who lived in balance and harmony in an environment of natural productivity and abundance (see Redford 1990; Anderson 1993; Peacock 1998; Berkes 1999; Turner and Peacock in press). Hunter-gatherers, for example, were said not to impact ecological processes only because of specific socio-economic limitations, such as low population densities, and simple technologies and social organization incapable of more destructive exploitation (see Anderson 1993). The romantic notion that Indigenous peoples were primitive foragers living in an idealized Eden served to strengthen the colonial ethic and has proved to have great longevity in academic literature (see Redford 1990; Ostraff 2003). Regarding the First Peoples of the Pacific Northwest, for instance, anthropologist Ruth Underhill (1945:9) wrote:

> ...the Northwest had everything. ...People who lived in such a climate did not need to plant. They had more berries and roots than they could use, simply by going to places where nature had spread them. Most of

> them did not even hunt, unless they felt like a change in diet. ... The rest of the time they could give to art, to war, to ceremonies and feasting.

The management practices between foraging and farming are now generally recognized as a continuum of increasing intervention between humans and plants (Ford 1985; Peacock 1998; Smith in press). The development of plant food production is regarded as a continuous process without discrete boundaries between levels of human-plant intervention (Ford 1985; Harris 1989). As Smith (in press) states, "in-between" societies (i.e. neither hunter-gatherers nor agriculturists) have existed for centuries in Mesoamerica, the Near East, and eastern North America: all regions of the world considered to be major centres of domestication. Hunter-gatherer societies, in fact, have been successfully dwelling for millennia in productive landscapes with a high variability of plant and animal resources (e.g., Suttles 1987; Ingold 1996). The development of agriculture occurred over the last 10,000 years (Lee and Devore 1968; Smith 1995).

Models of plant food production are often based on levels of anthropogenic landscape manipulation or degrees of ecological disruptiveness (Ford 1985; Peacock 1998; Smith in press). Harris (1989) characterizes the relationship between humans and plant resources as an ecological and evolutionary model of increasing input of human energy (labour) for increased caloric output (yield). Each energy threshold represents increases in the scale and intensity of human-plant interactions (Harris 1989; Peacock 1998). Increasing human input in the maintenance of plant food production systems also corresponds to greater levels of intervention and disturbance (Ford 1985; Harris 1989; Smith in press), and, hence, increased ecological (e.g., landscape modification) and cultural (e.g., food yields) effects.

In general, the advancement of plant food production represents a shift from spatially diffuse activities which require minimal energy input by people to more focused activities that are increasingly labour intensive and ecologically disruptive (Ford 1985; Harris 1989). Plant foraging practices of hunter-gatherers (e.g., collecting, protective tending, and burning), for example, are the least disruptive level of interaction and are often interpreted as resulting in little or no lasting impact on a resource population, although incidental effects could occur (Turner and Peacock in press). Plant cultivation, on the other hand, generally takes on many different forms, but usually includes the systematic manipulation of the growth, abundance, and productivity of plant crops and focused soil modification, including land preparation or clearance, and tillage (Ford 1985; Harris 1989; Smith in press). The development of cultivation practices, including weeding, pruning, replanting (into the same resource site), transplanting (to a different resource site), and selective harvesting, emerged as applied techniques to facilitate easier plant food extraction and increase yields (Ford 1985).

The term horticulture has been widely used by ethnoecologist Kat Anderson (e.g., 1988, 1990, 1993, 1996, 1997) to describe the management practices of Native Californians. Anderson (1993:21) defines Indigenous horticultural ecology as:

> The human manipulation of native plants, plant populations, and habitats, in accordance with ecological principles and concepts, that effects change (either beneficial or negative) in plant abundance, diversity, growth, longevity, yield, and quality to meet cultural needs. ... The discipline... does not necessarily involve the use and management of domesticated plants.

In this sense, therefore, Indigenous horticulture could be described as small-scale agriculture (Ford 1985), or as an alternative form of an "agroecosystem" (Harris 1989:20). Agroecosystems are land use systems which are patterned after the natural environment (Anderson 1993), and often include a mixture of cultivated crops, tended wild plants, and weedy species (Harris 1989). Many examples of these polycultures exist from around the world and they are well recognized as successful cultural strategies of plant production and as resulting in anthropogenic landscapes of high environmental conservation value (e.g., Janzen 1988; Posey 1990; Balick and Cox 1996; Dunmire and Teirney 1997; Peña 1999; Bandeira *et al.* 2002).

The domestication of native plants, or the adoption of domesticated crops from other regions, are prerequisites for the development of agriculture, the ultimate level of plant food production (Harris 1989; Smith in press). The sustained maintenance of plant crops requires high energy inputs, such as fertilizer application, weed control, irrigation, and plant propagation and breeding (Ford 1985; Harris 1989). Because of continuous selection by humans for desirable phenotypic characteristics, domesticated plants are "cultural artifacts," and lose viability without human intervention (Ford 1985:6; Smith in press). However, amounts of genetic change vary because new plant production systems develop cumulatively over time as human societies develop new land use strategies to meet changing social and economic needs (Ford 1985).

Plant food production developed over the last 10,000 years and has changed in response to climate change. The stochastic nature of the environment, combined with increasing pressures from population growth, affected the certainty and dependability of plant resources, and contributed to a more finite resource base (Mulholland 1988; Smith 1995). People developed methods of beneficially disrupting the development and growth of important plant resources to reduce the risk of food scarcity or failure (Ford 1985; Smith 1995, in press; Peacock 1998).

The emergence of highly diverse and heterogeneous landscapes through the Holocene likely helped promote the development of complex socio-economic structures (e.g., Harris 1985; Mulholland 1988; Peacock 1998). Resource domestication generally arose among peoples who were, in fact, living in productive landscapes and who had access to a wide diversity of ecosystems (c.f. Smith 1995). A road to domestication occurred among relatively ecologically "affluent" hunter-gatherers where the possibility of economic shortfall encouraged the development of new social mechanisms and land use strategies that would balance resource productivity, availability, and reliability with changing population densities (Thoms 1989; Smith 1995).

In the Pacific Northwest region, socio-economic changes, including increased sedentism and social complexity, occurred as the pressures of an increasingly limiting resource space emerged (c.f. Suttles 1987). These changes lead to intensified use of biotic resources (Mulholland 1988; Nicholas 1999) and more elaborate methods of management, processing, and preservation of valuable plant resources (Smith 1995; Peacock 1998; Deur 1999). Management activities occurred on different ecological scales and ranged from spatially focused horticultural practices to broad landscape-scale patterns of seasonal movement and social responsibilities (Peacock 1998; Turner and Peacock in press). There were also increased regulation of resource sites, new patterns of ownership, and more limited resource space, especially of productive harvesting sites of staple resources (c.f. Suttles 1951b; Deur 1999; Turner *et al.* 2003).

Another aspect of plant food production includes the processing and preservation of plant foods. Food processing includes the activities used to prepare and cook resources and to turn natural botanical resources into edible, palatable, and nutritious food. Storage techniques were needed to preserve and maintain adequate supplies of plant foods through periods of food scarcity. Plant resources do not keep indefinitely after harvest and must be processed into preserved cultural products (c.f. Deur 1999). Each of the three components of plant food production - management, processing, and storage - served to maintain productive, available, and reliable plant resources within spatially heterogeneous and temporally variable environments.

1.1.1.3 Root Foods in the Indigenous Diet

Around the world, the intensification of perennial root foods (also called root vegetables, or simply "roots") to fully developed food production systems was established before 6000 years ago (Thoms 1989). Some regions have had a long history of domestication of root crops, such as Southeast Asia (e.g., taro, arrowroot, yam), the South American lowlands (e.g., sweet potato, manioc), and the Andean highlands of South America (e.g., potato), though very little is known regarding the early development of these crops (Smith 1995). Root foods were, and are, often staple resources. In western North America, prominent edible roots include genera in the Alismataceae (*Sagittaria*), Apiaceae (*Conioselinum, Lomatium, Perideridia, Sium*), Asteraceae (*Balsamorhiza, Cirsium*), Dennstaedtiaceae (*Pteridium*), Dryopteridaceae (*Dryopteris*), Fabaceae (*Lupinus, Psoralea, Trifolium*), Liliaceae (*Allium, Brodiaea, Calochortus, Camassia, Chloragalum, Dichelostemma, Erythronium, Fritillaria, Lilium, Triteleia*), Portulacaceae (*Claytonia, Lewisia*), Rosaceae (*Potentilla*), Typhaceae (*Typha*), and Zosteraceae (*Zostera*) (Norton *et al.* 1984; Turner 1995, 1997; Anderson 1997). In addition to food, roots can be used for dyes, glues, baskets, and medicines (Anderson 1997).

In botanical terms, root foods are also referred to as edible geophytes, or plants "with a life-form in which the perennating bud is borne on a subterranean storage organ" (Dafni *et al.* 1981:652). Root foods, therefore, include bulbs, corms, fleshy taproots, tubers, and rhizomes (Thoms 1989; Turner and Kuhnlein 1983). Root vegetables are a carbohydrate-rich food and fill an important dietary niche in many Indigenous economies (Thoms 1989; Kuhnlein and Turner 1991; Smith 1995; Anderson 1997; Turner and Peacock in press). Indigenous root foods have negligible fat content and limited quantities of protein and ash (e.g., Mullin *et al.* 1998), but tend to be good sources of calcium, magnesium. iron, and zinc (Norton *et al.* 1984), as well as carbohydrates and dietary fibre, and vitamins (Kuhnlein and Turner 1991).

Many root food species have wide regional distributions and ecological amplitude (e.g., Thoms 1989; Chambers 2001), and are commonly adapted to seasonal or unpredictable environmental conditions (Dafni *et al.* 1981; Thoms 1989). For many temperate climate perennials, including roots, there is a dormant phase in the lifecycle which usually coincides with unfavourable conditions due to seasonal changes in weather or to disturbance (Harper 1977; Dafni *et al.* 1981; Antos *et al.* 1983; Turner 1999). Geophytes tend to have a long maturation period, apparently needing to reach a critical size before flowering (Thoms 1989; Harper 1977). From an Indigenous resource management perspective, the slow developmental rate coincides with a significant wait time for bulbs of harvestable size (Thoms 1989). Root food plants, like other perennial species in general, are long-lived (e.g., 20 to 30 years) (Thoms 1989; Peacock 1998), although the optimal harvesting age may not be the oldest individuals.

Management of perennial plants, such as geophytic plants, is not limited to the continued maintenance of seed production and dispersal as with annual horticultural crop species. In addition to sexual reproduction, root food plants can also reproduce asexually from runners or underground meristematic tissues (Turner and Peacock in press): an important attribute for plant resources that are potentially heavily exploited (Thoms 1989). Sustainability of perennial crops is dependent on the capacity for these species to re-grow or regenerate through vegetative means (Turner and Peacock in press). Because these resources are long-lived, only selected plants or plant parts are generally harvested at any one time to ensure population recovery (Anderson 1993). The continued maintenance of vegetative offsets within a resource population is a widespread and long-standing practice in the cultivation of root resources around the world (e.g., wild onion [*Allium* spp.], taro [*Colocasia esculenta*], yam [*Dioscorea* spp.], Jerusalem artichoke [*Helianthus tuberosus*], sweet potato [*Ipomoea batates*], and potato [*Solanum tuberosum*]) (Ford 1985; Smith 1995). The replanting of vegetative propagules, juvenile roots, or root fragments within a harvesting plot is also widely reported from the Pacific Northwest (Turner and Efrat 1982; Loewen 1998; Deur 2000; Peacock and Turner 2001; Turner and Peacock in press).

1.1.2 Interdisciplinary Research Approach

The study of cultural landscapes, and of the economic systems and land management practices which serve to maintain them, involves analyzing how Indigenous or local peoples affected the ecological structure and function of their resource communities. This approach is often referred to as cultural ecology, historical ecology, or, as used in this dissertation, ethnoecology (e.g., Crumley 1994; Berkes 1999; Fowler 2000). Ethnoecology not only describes the effects of human interactions within the landscape but also a society's perceptions of their physical relationships and social responsibilities within environmental systems (Berkes 1999).

As noted previously, in the past the landscape-scale effects of First Peoples' land use of plant resource management have generally been misconstrued as natural or simply overlooked. Perhaps Indigenous peoples were adept at manipulating ecological processes, and in doing so, intentionally enhanced naturally-occurring productivity within a range of habitats (e.g., Deur and Turner in press, 2004b). Or, perhaps the scale of landscape manipulation was constrained and Indigenous peoples focused their food-getting energies only on resource-rich plant communities, leaving the greater landscape to run its natural course (e.g., Vale 2002; Whitlock and Knox 2002). With the passage of time, cultural landscapes of the past become increasingly blurred by cumulative environmental changes (Nicholas 1988). The apparent camouflage of physical evidence as to a people's environmental role has been presented as a "light footprint" on the landscape (e.g., Nicholas 1999; Lepofsky *et al.* 2003): a footprint which has proven difficult to detect and interpret by modern-day researchers.

The ambiguity regarding the detection of past anthropogenic effects of Indigenous plant food production has conventionally been advanced through "unidisciplinary" studies. Archaeology, for example, has been the singular approach for determining past Indigenous subsistence patterns (Ford 1985). The dualistic perception of forager-farmer commented on earlier largely came about because of limited relevant archaeological data (Smith in press). Artifacts and macroscopic faunal remains dominate archaeological research (Huelsbeck 1988; Nicholas 1988; Mitchell 1990; Matson 1992; Ames 1994), whereas plant resources tend to remain underrepresented or disregarded (Mitchell and Donald 1988; Thoms 1989; Deur 2000; Lepofsky *et al.* in press). For many decades, salmon has been considered by ethnographers to be the backbone of Indigenous economies on the Northwest Coast (Huelsbeck 1988; Matson 1992; Moss 1993) because of, in part, the exceptional preservation of technological artifacts and faunal remains which correlate with salmon intensification (Moss and Erlandson 1995). Perishable items typically associated with plant resources, such as digging sticks and baskets, typically do not persist in midden sites (Moss 1993). Additionally, well-preserved plant assemblages from wet archaeological sites are often comprised of wood or fibre products and shed little direct light on plant food use (Mitchell and Donald 1988).

Palaeoecologists reconstruct the past environmental conditions and processes, especially fire patterns, but using microscopic analyses to test for anthropogenic signals of landscape management remains fraught with challenges. Botanical remains (Wainman and Mathews 1987; Agee 1993; Allen 1995), microscopic pollen and spores (Birks and Birks 1980), and macroscopic charcoal fragments (Clark 1988; Harris 1989; MacDonald *et al.* 1991; Whitlock and Millspaugh 1996; Brown 2002; Brown and Hebda 2002) have all been used to interpret past vegetation structure and climate change. Although historical fire events can also be analyzed using tree scars from old-growth woods and forest sites (Agee 1993), low-intensity surface fires, the type commonly reported for Indigenous-set burns, do not generally leave a sufficient signal on trees or in soils

(Campbell 1978; Bellomo 1991; MacDonald *et al.* 1991). Even if an anthropogenic signal is suspected, it may be difficult to separate deliberate broad-scale management from unintentional cultural impacts (Head 1994), or from a natural disturbance of similar intensity. Soil disturbances associated with agricultural practices affect soil stratigraphy (Fargri and Iverson 1975; Bellomo 1991), thereby obscuring the palaeoecological record. Because empirical evidence of past anthropogenic plant communities remains elusive, suitable palaeoecological, archaeobotanical methodologies continue to be investigated in efforts to better understand these systems (see Heinrichs *et al.* 1999; Heitzmann 2001; Brown and Hebda 2002; Lepofsky *et al.* in press).

Researchers of past landscapes are recognizing the need to integrate qualitative and quantitative approaches, and to use empirical research to verify ecological expressions of cultural management practices (Clark and Robinson 1993). Furthermore, it is becoming more widely emphasized that studies of former and present-day landscapes should incorporate both multiscalar (Crumley 1994; Anderson 1997; Bell *et al.* 1997; Nicholas 1999; Peacock and Turner 2000; Walker 2000), and multidisciplinary and collaborative frameworks (Ford 1985; Suttles 1987; Crumley 1994; Cotton 1996; Boyd 1999a; Walker 2000; Striplen and DeWeerdt 2002). Multiscalar, in this context, refers to the recognition and integration of multiple scales (e.g., space, time) in landscape analysis. Indigenous environmental knowledge, also known as traditional ecological knowledge, or TEK, is becoming more widely consulted and incorporated into the academic realm as well (e.g., Johnson 1992; Kuhn and Duerden 1996; Stevenson 1996; Berkes 1999; Turner *et al.* 2000).

The disciplines of ethnohistory, ethnography, and ethnobotany can reveal clues and, in some cases, detailed information about the social and environmental changes which influence and shape a cultural landscape over time (Norton 1979; Dorney and Dorney 1989; Morrison 1994). However, these approaches are not without their pitfalls. As with archaeology, the use of plant resources by Indigenous peoples, for example, has been misjudged or generalized in ethnographic research. Norton (1980) describes this narrow focus as a lack of basic botanical understanding, ignorance of Indigenous patterns of nomenclature and applications of environmental knowledge, as well as the underestimation of the role of women's work in First Nations' economies and land use patterns. The important role of plant foods in Indigenous culture has also been frequently overlooked because of rapid acculturation during the early colonial period and the subsequent losses of managed harvesting sites, anthropogenic landscapes, environmental knowledge, and language (c.f. Norton 1980; Turner 2003). Qualitative sources, such as ethnographies, are inherently biased by the personal or professional objectives and values of the authors (Kennedy 1995) (discussed in detail in Chapter 2).

Research in the biological sciences, such as ecology, can provide modern-day analogs to help determine past cultural landscape dynamics and ecological effects of human-environment interactions (see Chapters 3 and 4). Ethnoecological field experiments that simulate Indigenous management practices can determine if the reintroduction of anthropogenic systems could enhance contemporary ecological dynamics and ascertain the extent and scale of management which would be suitable in future restoration initiatives (see Chapter 5).

For Indigenous resources, such as camas for First Peoples of southern Vancouver Island, which quickly fell from regular use after colonization, the reconstruction of the pre-European cultural and environmental contexts remains riddled with challenges. Data on traditional land management systems are underrepresented in the Indigenous studies of this region and available references lack detail and continuity regarding the use of many plant resources, specifically, and terrestrially-based economies in general. Only when references from multiple disciplines begin to corroborate each other in content do they carry greater weight as reliable sources (J. Lutz, pers. comm. 2003), and with these, a more accurate reconstruction, and restoration, can emerge.

1.1.3 Research Focus and Structure

Camassia is an apt ethnoecological indicator taxon for this study of cultural landscape reconstruction and restoration on southern Vancouver Island. No other food plant in the Garry oak ecosystems of southern Vancouver Island has such a long cultural history. Why did this highly significant plant food lose its staple role in the Indigenous diet over the relatively short course of colonial history? How has the subsequent cessation of its use and management affected the ecological dynamics of the plant populations, the peoples, and their landscape?

Southern Vancouver Island was, and still is, one of the most culturally and environmentally rich temperate regions in North America. Before European contact, the landscape supported an abundance of plants and animals which, together with the physical environment, shaped the social complexity and economic diversity of the Straits Salish peoples in the region. However, underlying the vast tracts of natural resources was a significant degree of environmental variability which the Indigenous residents adapted to and managed for through a variety of cultural means (see Suttles 1987). The Straits Salish sustained a diverse livelihood because of their environmental knowledge, oral traditions, and long-standing land management practices which included systematic seasonal movements over the cultural landscape in conjunction with active harvesting and stewardship of spatially and temporally variable resource sites.

This background information generates several questions regarding cultural landscape change. If a landscape is shaped and maintained by cultural values and human-environment interactions for hundreds, or perhaps even thousands, of years then the removal of these long-standing influences would result in landscape change. Furthermore, this change would have unfavourable consequences, from a Straits Salish perspective, on a resource population within that landscape. Second, would the larger ecosystem also be impacted by the termination of stewardship customs, if Indigenous management for plant resource productivity occurred over greater spatial scales? To what extent did Indigenous management for camas contribute to the greater landscape structure? How has the termination of Indigenous management contributed to landscape change and the state of the current landscape? Over time, and with new environmental and social parameters, will a contemporary camas population respond favourably to the reintroduction of Indigenous management activities?

Based on established ethnographic and ethnobotanical research, the following two hypotheses for camas use and landscape management on southern Vancouver Island were developed: (1) systematic Indigenous management practices maintained sustainable yields of camas bulbs, and; (2) specific human-environment interactions, such as those for staple root food resources, played a role in the continuation of a cultural landscape described by the European explorers and colonists as an open parkland.

The primary goal of this dissertation is to develop a better understanding of the ethnoecological structure and function of the southern Vancouver Island landscape through a integrative examination of the cultural objectives and activities of Straits Salish camas cultivation, and the resulting environmental effects of this management system on camas populations and habitats. An interdisciplinary research design was used to accomplish this goal.

The work includes four research strategies: (1) summarize the environmental and social histories of southern Vancouver Island as the foundation for this cultural landscape research (Chapter 1); (2) investigate the historical human-camas interactions on southern Vancouver Island through the interpretation of qualitative information from the disciplines of ethnohistory, ethnography, and ethnobotany, supplementing these data with information from unpublished research notes, interviews, and collaborative research with local Straits Salish peoples, specifically consultants with the Songhees (Lekwungen) Nation (Chapter 2); (3) describe camas growth and development through quantitative demographic analysis in a controlled (e.g., nursery) setting (Chapter 3); and, (4) quantitatively evaluate the ecological impacts of simulated Indigenous management methods, through selective digging and prescribed burning treatments, on the camas population and community in contemporary *Camassia* habitats (Chapter 3).

Two main outcomes are drawn from this research: (1) a description of the dynamics of cultural landscape change through the development of a comprehensive and multiscalar ethnoecological model of integrated Indigenous resource use and management, featuring *Camassia* as a case study for Straits Salish peoples (Chapter 4); and, (2) a discussion of the cultural and ecological parameters needed to address the re-implementation of ethnoecological management activities on present-day camas populations, and the restoration recommendations for the future cultural landscapes of southern Vancouver Island and adjacent areas (Chapter 5).

Scientific nomenclature for vascular plants in British Columbia follows Douglas *et al.* (1998) and Douglas *et al.* (1999-2002) throughout this dissertation.

1.2 ENVIRONMENTAL AND CULTURAL SETTING

Vancouver Island is located in southwestern British Columbia, Canada, and much of its southern tip, which falls below 49° N. latitude, is closer to Washington, United States, than to the BC mainland. Southern Vancouver Island is generally characterized by relatively mild temperatures (Nuszdorfer *et al.* 1991) and its environmental setting: a mosaic of parkland communities often noted by two broadleaf trees - *Quercus garryana* (Garry oak) and *Arbutus menziesii* (arbutus) (Nuszdorfer *et al.* 1991). These "Garry oak ecosystems" incorporate many different plant communities, some of which, such as coastal bluffs and rocky outcrops, are primarily herbaceous and do not actually include oak trees. The Garry oak ecosystems of western British Columbia, endangered in Canada, represent the northern-most extent of a larger ecological distribution extending southward into California (Erickson 1996; GOERT 2003a). The patchiness of habitats and the diversity of species in Garry oak ecosystems are well recognized over its full range (Voeks 1981; Sugihara and Reed 1987; Pojar and MacKinnon 1994; Erickson 1996; Dunn and Ewing 1997; Fuchs 2001).

Keeping within the general theme of this dissertation, however, Garry oak ecosystems could be re-categorized by their *cultural* keystone species (c.f. Garibaldi and Turner 2004). Hence, the emphasis of the biota within these ecosystems could reflect historically sustainable resources, and the ecosystems referred to by how the Indigenous management for these resources affected the function and structure of the greater cultural landscape. Humans could themselves be the keystone species within a cultural landscape (Minnis and Elisens 2000). Therefore, the ecosystems of southern Vancouver Island would include culturally-driven ecological interfaces, such as "camas-harvesting meadows," "deer-hunting prairies," and "cattail-gathering wetlands." It is probable that a greater range of culturally integrated ecosystems might be included in this sort of classification (Turner and Peacock in press). Therefore, this diverse biogeoclimatic sub-zone will be referred to as "oak-camas parklands," reflecting its natural, cultural, and historical significance.

1.2.1 Pre-European Contact Environmental History

1.2.1.1 Palaeoecology

Southern Vancouver Island emerged from the last glacial period (Fraser Glaciation) between 14,000 and 12,000 BP (years before present). The initial post-glacial climate (ca. 11,450 – 10,350 BP) was cooler and drier than today, supporting a landscape which was dominated by pine (*Pinus contorta* type, shore pine), Poaceae (grasses), and *Pteridium* (bracken fern) (Pellatt *et al.* 2001). Herbaceous taxa, such as Liliaceae (e.g., *Camassia* type), were also relatively abundant in this early period (Pellatt *et al.* 2001). Camas pollen has been found in sediments dating back as far as 70,000 BP in other regions of the Northwest United States (Thoms 1989). Barnosky (1985a) documented *Camassia* pollen from two time periods - 33,000-23,500 BP and 8500 BP-present - in the southwestern Columbia Basin, Washington. *Camassia* is thought to originate from southwestern Oregon where three *Camassia* species and five *C. quamash* subspecies occur (Gould 1941, 1942).

Oak-camas parklands developed over the course of the Holocene. The early Holocene, or the Xerothermic period (ca. 10,350 to 8300 BP), was characterized by strong summer drought conditions and a park-like landscape with *Pseudotsuga* (Douglas-fir) and *Alnus* (alder) (Pellatt *et al.* 2001). Fires likely played a role in shaping the landscape at this time as well (Brown and Hebda 2002). Garry oak was a dominant feature of the regional landscape from 8300 to 7040 BP, and Garry oak communities continued to occupy much of the southern and southeastern areas of Vancouver Island through the more moderate and moist climate of the mid-Holocene (Mesothermic period, ca. 7040 to 3800 BP) (Pellatt *et al.* 2001). High oak pollen levels have been found in sediments from various sites on southern Vancouver Island for this period (e.g. Heusser 1983; Allen 1995; Hebda 1995; Pellatt *et al.* 2001). Pollen assemblages from the southwestern Washington show abundant *Quercus* and *Camassia* pollen and savanna-like or prairie communities during the mid-Holocene as well (Barnosky 1985b; Leopold and Boyd 1999b).

After 3800 BP the climate grew wetter and cooler and the modern coastal Douglas-fir forests became established. Pellatt *et al.* (2001) found that oak and grasses communities maintained their importance locally near Saanich Inlet on southern Vancouver Island, an indication that factors other than climate (e.g., topography, Indigenous landscape burning) influenced the persistence of open savanna or prairie ecosystems in the region.

1.2.1.2 Environment and Biota

Southern Vancouver Island falls within the Coastal Douglas-fir (CDF) Biogeoclimatic zone (Nuszdorfer *et al.* 1991:82). The CDF zone is generally restricted to below 150 m elevation and includes part of the Gulf Islands archipelago and the Sechelt Peninsula on the British Columbia mainland. Precipitation primarily occurs in the mild winter months followed by warm and relatively dry summers. The mean annual precipitation and temperature range from 647 to 1263 mm, and from 9.2°C to 10.5°C, respectively (Nuszdorfer *et al.* 1991:82). Areas of neighbouring Washington State which fall within the rainshadow of the Olympic Mountains, specifically the San Juan Islands and the Puget Sound region, also exhibit similar climatic and vegetation associations (Nuszdorfer *et al.* 1991). The CDF is most often characterized as a dry temperate forest, or "rainshadow forest," within the wetter and cooler rainforests of the Pacific Northwest (Pojar and MacKinnon 1994:18). The principal trees are the coastal variety of *Pseudotsuga menziesii* var. *menziesii* (Douglas-fir), *Thuja plicata* (western red-cedar), *Abies grandis* (grand fir), and *Alnus rubra* (red alder).

The oak-camas parklands of the CDF include a mosaic of ecosystems from coastal bluffs and rocky knolls to deep-soiled grasslands and savannas. There are over 490 plant taxa associated with today's recognized "Garry oak ecosystems" (Fuchs 2001). Plant communities generally have a patchy distribution and vary greatly in composition. Of the 43 plant communities currently inventoried, 26 are dominated by native species

(Erickson 1996; Fuchs 2001). Erickson (1996) described, for example, both forb (*Camassia*) and grass-dominated (*Festuca idahoensis* and/or *Elymus glaucus*) early season communities. Although both species of *Camassia* are currently described as significant forbs in oak-camas parklands (Nuszdorfer *et al.* 1991; Erickson 1996; Fuchs 2001), camas, principally *C. quamash*, can be found growing in a wide range of other habitats, including vernal pools, peat bogs, and estuarine meadows (Chapter 3).

Oak-camas parklands play an important ecological role as habitat for fauna and invertebrates (Fuchs 2001). Over 100 native vertebrates are recognized in Garry oak and associated ecosystems (Fuchs 2001). The heterogeneity of these ecosystems is critical for providing a range of habitat features for wildlife, including food resources, breeding and nesting sites, and thermal and security cover (Fuchs 2001).

Currently, in Garry oak ecosystems, there are "approximately 100 species of plants, mammals, reptiles, birds, butterflies and other insects, and an earthworm" listed as "at-risk" in Canada (GOERT 2003a). Over 173 exotic and invasive species (excluding invertebrates) have also been recorded (GOERT 2003b). The Garry Oak Ecosystems Recovery Team has recognized three "essential ecosystem characteristics" -- spatial integrity (in relation to the effects of habitat fragmentation), the role of fire, and biotic integrity (in relation to the effects of exotic species) -- as significantly threatened in a modern context (Fuchs 2001:71).

1.2.1.3 Soils

The typical soils for oak-camas parklands of southern Vancouver Island are classified as Brunisols (Jungen 1985). These soils are characterized by a mild mesic soil temperature and a semiarid moisture regime (Jungen 1985), reflecting the semi-Mediterranean climate found in this region. The parent materials consist of mostly glacial till of variable textures and fine textured marine sediments (Jungen and Lewis 1978). Roemer (1972:241) described the soils of the "*Quercus* alliance" as Sombric Brunisols. Robert Maxwell (retired pedologist; pers. comm. 1998), speculates that the local soils associated with oak-camas parklands would probably include the Cadboro, Tolmie, and Saanichton soils. These three soil associations, which are in the Nanaimo

Lowland physiographic subdivision (Jungen 1985), are well represented throughout southern and southeastern Vancouver Island especially in greater Victoria and on the Saanich Peninsula (Table 1.1).

Brunisolic soils of the oak-camas parklands often have a well-developed top horizon (Ah) that is usually black in colour (Roemer 1972; Erickson 1996). According to Douglas *et al.* (2001:16): "Chemical data of the soils [of the Cowichan Garry Oak Preserve]… shows the relatively high levels of organic carbon, calcium and pH levels, throughout relatively deep (16 to 38 cm) Ah horizons, which are likely indicative of long established 'woodlands or meadows.'" Shallow soils associated with coastal, rocky outcrop habitats (Devonian and Witty's Lagoon Regional Park, in Metchosin), tend to be higher in sand content and more acidic, but similar organic carbon and calcium levels as the deeper soils of the Cowichan Preserve (R. Maxwell, pers. comm. 2000).

Table 1.1 Local soil types of southern Vancouver Island (Jungen 1985:36, 151, 179; R. Maxwell, pers. comm. 2004).

Local Name	Cadboro	Saanichton	Tolmie
Soil Type	Duric Sombric Brunisol	Orthic Sombric Brunisol	Orthic Humic Gleysol
Development	Deep gravelly sandy morainal (till) deposits	Deep, silty and/or clayey marine deposits	Shallow sandy deposits which overlie deep, silty and/or clayey marine deposits
Slope	Varies between 2% and 10%	Level to gently sloping areas	Normally level to very gently sloping
Elevation	Sea level to 300m	Sea level to about 100m	Sea level to about 150 m
Drainage	Well drained	Moderately well drained	Poorly drained
Texture	Gravelly sandy loam or gravelly loamy sand	Clay loam or silty clay loam	Sandy loam or loamy sand
Colour of A horizons (moist)	Black to brown	Very dark grayish brown	Black and dark brown
Acidity	Medium acid	Strongly acid	Medium to slightly acid

Figure 1.3 Historical maps of the Victoria region. The 1861 map (above) was created by Day & Son (Firm), London (Scale: ca. 1:28,000). The 1888 map (below) was created by the British War Office (Scale = 1:10,560). Because of the different scales, community names have been added in purple. Both maps courtesy of the University of Victoria Map Library.

Today's agricultural soils, often described as Metchosin muck with very dark and often black colour, could be converted marshland because of evidence of sedge, peat, and other wetland vegetation (Maas n.d.), or former Indigenous camas harvesting sites. A survey of historical maps revealed that wetlands were once more extensive in the Victoria area in 1861 (Day & Son Ltd.) were converted into farmland by 1887-88 (British War Department) (Figure 1.3). The blackness of the agricultural soils could also be the result of fine charcoal found in the surface soil horizons (Beckwith 1998, unpublished data), possibly resulting from the landscape burning practices of Straits Salish peoples.

1.2.2 Pre-European Contact Cultural History

1.2.2.1 Archaeology

First Peoples, or "Paleoindian peoples," began inhabiting the Northwest Coast region in the early Holocene (Matson and Coupland 1995; Moss and Erlandson 1995:11). Physical evidence of these early cultures is sparse (Moss and Erlandson 1995). The advancement of the Developed Northwest Coast Pattern economy, the pattern commonly recognized in the ethnographic record, likely began during the mid- Holocene. Significant climatic and environmental conditions, primarily ocean stabilization (Matson 1992) and shifting climate (Hebda and Mathewes 1984) contributed to this cultural development. This coastal culture area extends from northern California to the Yukon border (Suttles 1990a; Moss and Erlandson 1995).

Around 5000 BP, Indigenous peoples were likely more nomadic, with lower population densities (Suttles and Ames 1997). This time is characterized by a "collector" subsistence strategy evidently without long-term storage of resources, although there was a shift towards coastal settlement and increasing population densities, and to a heavier reliance on salmon and marine resources. Components of this phase (St. Mungo) have been found from at least 15 sites from the lower Fraser River and Gulf of Georgia regions (Matson and Coupland 1995; Moss and Erlandson 1995).

Cultural complexity, similar to today's Indigenous social diversity, emerged about 3500 BP (Matson and Coupland 1995). Changing climate, conducive to the establishment of *Thuja plicata*, likely led to the development of the distinctive woodworking culture (Hebda and Mathewes 1984). Large-scale procurement and processing of salmon became established during this time (Matson 1992). A shift to increased sedentism emerged, with the construction of permanent winter villages and the increasing capability of claiming and protecting local resource harvesting sites (Matson and Coupland 1995).

The establishment of tenured resource patches, as well as the intensive procurement, production, and storage of plant and animal resources, were key to the development of the Developed Northwest Coast Pattern. Thoms (1989:9) suggests that there are significant ethnographic data which "clearly illustrate the potential for camas to have played an important role in the evolution of community seasonal sedentism" throughout the Pacific Northwest. Although data on specific economic pursuits are limited in the archaeological record, inherited and managed resource sites for the harvesting and processing of plant and animal resources were likely established for at least 2000 years. It is probable that increased population densities, resource intensification, and social stress contributed to the emergence of inter-community conflicts (Matson and Coupland 1995; Moss and Erlandson 1995). Defensive sites across the region are recognized from oral history and ethnography, and in the archaeological record (1500-2000 BP) (Moss and Erlandson 1995).

Archaeological evidence of Indigenous settlement on southern Vancouver Island is limited. The oldest archaeological records of Indigenous settlement on southern Vancouver Island date to approximately 4100 BP (DcRu5, DcRu20; G. Keddie pers. comm. 2004). These sites coincide with the original settlement localities described by Indigenous descendents. Defensive sites (e.g., fortified villages or refuge camps), all no more than 2000 years old, are known from various places on southern Vancouver Island (Owens *et al.* 2001; G. Keddie pers. comm. 2003).

Overall, there is little archaeological evidence of camas processing or other direct indicators of camas use in the greater Victoria region. However, an archaeological site with a shallow shell midden and "rock ovens" (DcRt-71) was excavated in Victoria, along Beach Drive near Cattle Point, in 1999 (Eldridge 2000). This coastal site, dating to approximately 2000-3500 years ago, was likely used as a cooking place for root vegetables, such as camas. Although no charred *Camassia* bulbs were recovered, an earth oven, with fire-cracked rock and charcoal, was excavated (Eldridge 2000). However, an entire charred camas bulb was excavated from another Victoria site (DcRu-92) in 1997. This site, on Portage Inlet, was a large shell midden site with many cultural layers (Millennia 1997). This bulb is the only *Camassia* bulb recovered from an archaeological site in BC to date of which this author is aware. Even though the bulb appears not to be associated with the rock ovens on-site, the presence of a variety of other plant remains (e.g., charred *Quercus garryana* acorns, *Prunus* sp., *Rubus* sp., *Rhamnus purshiana* [cascara] charcoal) indicates a possible large-scale processing site (Millennia 1997). Camas earth ovens have been dated to between 5800 BC and 4880 BC in the Willamette Valley, Oregon (Cheatham 1988).

Possible anthropogenic soils, characterized as "generally dark brown to black, commonly greasy, with pebbles or pea gravel, little to no shell and no visible charcoal," have been found along the waterfront near Beacon Hill Park (e.g., DcRu-023, DcRu-024) (Owens *et al.* 2001:17).

1.2.2.2 Indigenous Residence Patterns and Economic Infrastructure

Straits Salish is a sub-group within the Central Coast Salish language branch, and includes speakers of six distinct dialects: T'Sou-ke (Sooke), Senoten (Saanich), Lekwungen (Songhees), Semiahmoo, Lummi, and Samish (Suttles 1951). Other Central Coast Salish peoples include the Squamish, Halq'emeylem (Halkomelem), Nooksack, and Tla'lam (Clallam) (Suttles 1990b). The Straits Salish of southern Vancouver Island live within the Gulf Islands Biotic Area, whereas their Salish neighbours in Washington are situated within the Puget Sound Lowlands Biotic Area (Suttles 1987).
Today, the Songhees and Esquimalt (Lekwungen collectively), Saanich, T'Sou-ke (Sooke), and Beecher Bay (Becher Bay) are the prominent Indigenous groups of southern

Vancouver Island (Table 1.2, Figure 1.1). In pre-contact times, the territorial boundaries were not distinct and extensive family connections and social unity existed among them and with other Coast Salish groups (Suttles 1987c). Therefore, the following territory designations represent core areas for each group.

The territory of the Lekwungen peoples extends from Albert Head to Cordova Bay, and includes many smaller islands, Chatham and Discovery islands, and localities in the western San Juan Islands (Suttles 1951a). The Lekwungen incorporate several self-governing family groups -- Kakyaakan, Teechamitsa, Whyomilth, Kosampsom, Swenwhung, Chilcowitch, and Chekonein (Bryce 1997).

Table 1.2 Straits Salish peoples of southern Vancouver Island (Jenness 1934-35; Suttles 1951a; Bryce 1997).

Modern Name	**Other Names**	**Dialect of Straits Salish Language**	**Principal Families or Villages**	**Territory or Location**
Lekwungen	Songhees, Esquimalt, Songish	LEKWUNGEN	Kakyaakan Teechamitsa Whyomilth Kosampsom Swenwhung Chilcowitch Chekonein	Albert Head Esquimalt Harbour to Albert Head Top of Esquimalt Harbour Esquimalt Harbour to Victoria Harbour Victoria Harbour to Ross Bay Ross Bay to Gonzales Point Gonzalez Point to Cordova Bay
Saanich	Saanich, Sanetch	SENCOTEN	Tsawout Tseycum Pauquachin Tsartlip	Saanichton Bay Patricia Bay Cole Bay Brentwood Bay
T'Sou-ke	Sooke, Sook, Soke	T'SOU-KE	Sooke	Mouth of Sooke River
Beecher Bay	Becher Bay, Clallam Klallam	TLA'LAM	Kakayaakan Chewhaytsum	Albert Head to Pedder Bay Pedder Bay to Sooke Inlet

The territory of the Saanich comprises the Saanich Peninsula south to Mount Finlayson and to Mount Douglas on Vancouver Island. Principal villages on the Saanich Peninsula include Tsawout (Saanichton Bay), Tseycum (Patricia Bay), Pauquachin

(Coles Bay), and Tsartlip (Brentwood Bay) (Jenness 1934-35.; Suttles 1951a). They also hold territorial rights to portions of many smaller islands, including Salt Spring Island and the other eastern Gulf Islands, the San Juan Islands.

The T'Sou-ke and Beecher Bay peoples reside in the western part of the study region. T'Sou-ke territory includes a broad region from Beechey Head to Otter Point with their principal winter village at the mouth of the Sooke River (Suttles 1951a). The collective group of people known today as Beecher Bay are likely descended from several different dialect groups, including Tla'lam (Clallam), Nitinaht (Ditidaht), Makah, and Lekwungen (Chipps 2001; P. Chipps, pers. comm. 2003). Their territory ranges from Albert Head to Beechey Head (Chipps 2001). The majority of information included in this dissertation focuses on the known economic activities of these four Indigenous groups of southern Vancouver Island (Table 1.2).

Salmon is generally seen as a predominant dietary component, but Indigenous peoples of the region utilized a wide diversity of animal and plant resources. In addition to the five species of salmon (*Oncorhynchus* spp.), men fished for halibut, herring, and rock cod, among others. Mammals of the sea (e.g., seals, sea lions, and porpoises) and land (e.g., deer and elk) were hunted, as were waterfowl and other gamebirds (e.g., grouse). Women gathered intertidal resources, such as crabs, sea urchins, mussels, and clams. A variety of plant resources were locally abundant and were utilized for food, technology, and medicine. Women gathered the shoots, leaves, fruit, underground parts (e.g., bulbs, corms, roots), and, in some cases, inner bark of plants for food. Root vegetables were the principal carbohydrate source in a diet rich in protein and fat. Western red-cedar was a prominent resource; its wood and bark were utilized for a multitude of purposes, including the construction of both winter and summer dwellings, canoes, household implements and tools, clothing, and mats and baskets (Suttles 1990b; Turner 1995, 1998).

Integrated family networks and a complex social organization governed the harvesting of a highly variability of biotic resources of southern Vancouver Island (Suttles 1987a; Turner 1997; Turner *et al.* 2000). Bilateral descent recognition allowed for highly mobile family alliances, enhancing the relative accessibility of their potential resource base. In addition, the diversity and availability of productive resource sites was broadened by affinal and kin ties, intermarriage affiliations, trade relationships, and ceremonial obligations, all of which served to direct and control the movement of people across the landscape and the flow of food resources and cultural products (Suttles 1987a, 1987b, in press).

Despite these broad socio-economic networks, each Indigenous group has a specific home territory. Families generally maintained resources through hereditary land tenure and resource stewardship practices (Peacock and Turner 2000; Turner and Peacock in press; Turner *et al.* in press). Long-standing residence patterns, as well as a shared cosmology, rituals and customs, and dialectal patterns, helped to maintain an infallible sense of place and cultural history (Suttles in press).

1.2.3 European Contact and Colonization (1790-1911)

The time of European contact, corresponding with the establishment of first-hand accounts and written records, marks an important point of elucidation regarding the land use patterns and resource management practices of Straits Salish peoples. The following section develops the regional framework of social and environmental history since the time of European contact (1790-1843) and during the early colonial period (1843-1900).

1.2.3.1 Pre-Colonization Period: Eighteenth Century

The time of original "contact" with First Peoples by newcomers on southern Vancouver Island occurred in the late eighteenth century (Figure 1.4). Even though the British made headway into the region under the leadership of Captain James Cook, the first recorded detailed descriptions of the Straits Salish landscape on southern Vancouver Island came from the Spanish in 1790 (Floyd 1969; Keddie 2004). There were also descriptions from the Puget Sound area from Captain George Vancouver, and naturalist Archibald Menzies, about this time (e.g., Gorsline 1992b).

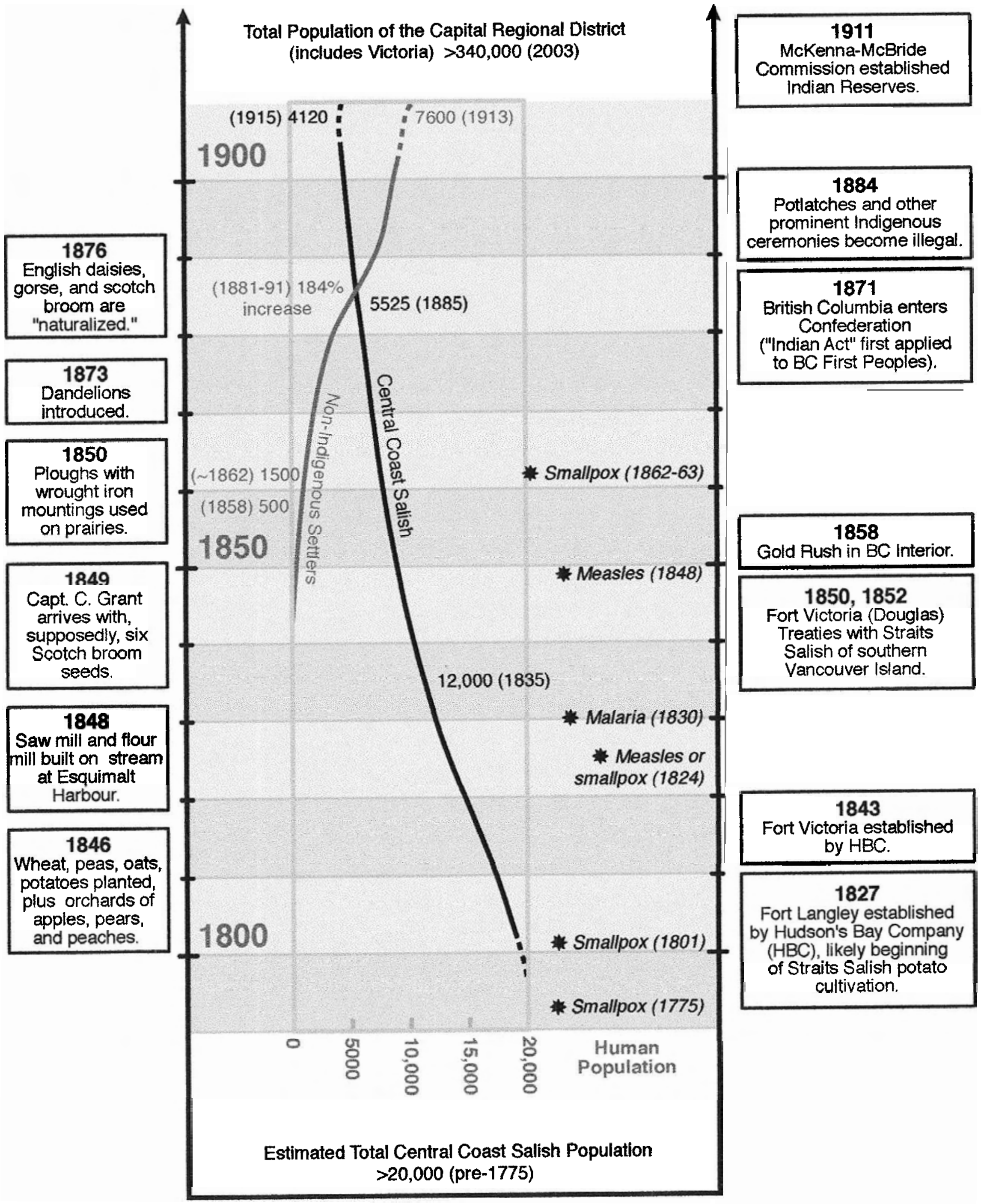

Figure 1.4 Population changes in the nineteenth century showing fluctuations in the numbers of Central Coast Salish peoples and Non-Indigenous settlers, and including examples of environmental and social changes (Duff 1969; Boyd 1990; Lutz in press).

In the early 1800s, a British fur trading enterprise, the Hudson's Bay Company, was developing its presence in the region: Fort Vancouver on the Columbia River was established in 1824, followed by Fort Langley on the Fraser River in 1827, and Fort Nisqually on the Nisqually River in 1833 (Mackie 1997).

By the time Fort Victoria was established on southern Vancouver Island in 1843 First Peoples in many regions, especially in the mainland interior, had been in contact with European and British fur traders, explorers, and settlers for several decades, and the influences of their presence, in particular alcohol and firearms (Duff 1969), had been trickling through Indigenous social and trade networks for perhaps much longer. Undoubtedly, however, the most devastating impact on Indigenous peoples was made by disease. In general, by the mid-1800s coastal Indigenous peoples had suffered through several major epidemics, in 1775, 1801, 1824, and 1830, and 1862-63 (Figure 1.4). Smallpox, malaria, measles, influenza, and whooping cough, among others, accounted for a devastating number of deaths among the First Nations. This series of disease outbreaks threatened each new vulnerable generation (Boyd 1990; Lutz in press).

Another European introduction that likely preceded the European colonization on southern Vancouver Island was the field potato (Suttles 1951b; Mackie 1997; Deur 2000). Chief Factor of the Hudson's Bay Company, James Douglas, noted, on 12 July 1842: "We are certain that Potatoes thrive and grow to large size, as Indians have many small fields in cultivation…" (The Beaver 1943:6). Although the Spanish and the Russians first introduced potatoes to the Indigenous peoples along the northern Pacific Coast in the late 1700s, potatoes likely came to southern Vancouver Island from Fort Langley where they had been cultivated since its establishment (Suttles 1951b; Floyd 1969; Mackie 1997). During a period when Indigenous peoples found their lives in upheaval the potato may have been a promising and welcomed addition to their diet because it is easy to prepare and store (e.g., Deur 2000). Potatoes, as well as other crop plants, probably became a new symbol of status in the cash economy (Deur 1999). By the mid-1800s, potato patches were likely widespread and would have been located in natural or cultural clearings, such as former camas harvesting grounds (Suttles 1951b).

In summary, demographic and economic patterns, and social organization of the Straits Salish of southern Vancouver Island had changed dramatically by the time of colonization by the Hudson's Bay Company (Duff 1969; Floyd 1969). The structure and function of the cultural landscape may have already been markedly altered with respect to resource management practices, shifting patterns of seasonal movement, and the introduction of foreign crop plants.

1.2.3.2 Post-Colonization Period: Nineteenth Century

The expansion of American settlement in the early 1800s increased the pressure on the Hudson's Bay Company to move further north. Governor George Simpson sought a new depot which would continue to supply the fur trade, as well as serve as a port for the emerging fisheries and whaling industries (Floyd 1969). Furthermore, the Columbia River, on which Fort Vancouver was situated, proved consistently difficult to navigate (Lutz 1995). A northern site must have a good harbour, water power, timber, and be "well adapted for tillage and pasture Farms on an extensive scale" (Chief Factor John McLoughlin, 1 March 1842; in Lamb 1943:81). There were an estimated 2000 Salish residents on southern Vancouver Island at this time, occupying several coastal villages, the largest of which were at Sooke (T'Sou-ke), at Cadboro Bay (Lekwungen), and on the Saanich Peninsula (Saanich) (Floyd 1969).

The first detailed reports describing the development potential of the southern Vancouver Island landscape were written in 1838. W.H. McNeill, captain of the H.M.S. *Beaver*, optimistically surmised that the open parklands would eventually attract hundreds, and then thousands, of new residents. The landscape would have a prime aesthetic appeal to the British colonists. These reports were probably influenced and enriched by the earlier regional accounts written by Captain George Vancouver. Berthold Seeman (1853:102), naturalist on H.M.S. *Herald*, wrote in 1846, just three years after the establishment of Fort Victoria:

> ...we thought we had never seen a more beautiful country; it quite exceeded our expectation; and yet Vancouver's descriptions made us look for something beyond common scenery.

The environment soon became the working foundation for the launching of a new civilization.

Indigenous peoples, considered "exceedingly useful to the colonists" (J. Douglas 1853, in Lutz 1995:34), participated in the development and economy of the Fort as labourers, as well as merchants of salmon and potatoes. The Lekwungen saw the relationship with their new neighbours as reciprocal in both commerce and protection (Baskerville 1986), and established a new village adjacent to the Hudson's Bay Company fort. After a short period, however, they were moved across the harbour from the fort (Floyd 1969). This new site became the main "Songish" or Songhees village. Another Indigenous village was established across James Bay. The members of this village were moved to Esquimalt Harbour some time before 1855 (Duff 1969).[1]

As pressures mounted for British sovereignty in the region, James Douglas was determined to make Fort Victoria succeed. He wrote, on 5 December 1848: "We have been straining every nerve since last year to improve and develope [sic] the resources of Fort Victoria..."(Bowsfield 1979:25). There was considerable demand for the production of agricultural crops by the late 1840s (Floyd 1969) and hundreds of the surrounding acres were coming under the plow and producing bushels (bushel = 23 kg) of wheat, peas, oats, and potatoes (Baskerville 1986). Between 1843 and 1850, the Hudson's Bay Company claimed approximately 452 ha (1118 acres) east of Foul Bay Road, including Uplands Farm (Baird 1979). The remaining lands within a eight-km (five-mile) radius were taken up by the Puget Sound Agricultural Company, or were held in reserve for future agricultural use (Floyd 1969). Horses and cattle were imported from mainland farms (Floyd 1969). The region was described at this time as "a very scattered and largely pastoral settlement" (Gregson 1970:5). With the success of Fort Victoria as

[1] The Indigenous people of the James Bay village became known as the present-day Esquimalt Nation. Members of the Songhees Nation were moved to adjacent lands in Esquimalt in 1911. Songhees also have title to Indian Reserve Lands on Discovery and Chatham islands.

the emerging centre of the whole of Northwest operations, the Hudson's Bay Company took formal possession of Vancouver Island in 1849 (Baskerville 1986).

The expansion of the Crown colony required more official recognition and administration of the area's Indigenous peoples. On southern Vancouver Island, eleven land purchases were made from Lekwungen, Clallam (Beecher Bay), and T'Sou-ke families in 1850, and from South and North Saanich groups in 1852 (Figure 1.1) (Duff 1969). The Fort Victoria, or Douglas, Treaties "...extinguish[ed] the proprietary rights of the native people," in exchange for compensation in the form of blankets (in Duff 1969:6). Each treaty reserved Indigenous rights to "Village Sites and Enclosed Fields," as well as "to hunt over the unoccupied lands, and to carry on... fisheries as formerly" (in Duff 1969:9,11). These treaties were based on similar agreements made with the Maori of New Zealand in the Treaty of Waitangi in 1840 (Arnett 1999).

Fort Victoria became more formally established in the 1850s, as the European land holdings increased into the thousands of acres (Baskerville 1986). In 1853, about three-quarters of the population on southern Vancouver Island was First Nations (Floyd 1969). Indigenous peoples from northern coastal regions – Haida, Tsimshian, Heiltsuk, and Kwakwa̱ka̱'wakw - often camped near the fort for inter-community trading. Under these new living conditions, venereal disease and tuberculosis accounted for many Indigenous peoples' deaths, as did alcohol, one of the most popular commodities for both First Nations and settlers in the Fort Victoria region (Lutz in press). In 1858, the British Columbia gold rush dramatically increased the non-Indigenous transitory population at Fort Victoria. The Fort was booming as thousands of fortune seekers from California and elsewhere passed through the area on their way to the Fraser River gold fields (Mayne 1862; Baskerville 1986). It is estimated that the permanent settler population was probably well over 500 people at this time, taking into account women and children (Baskerville 1986). However, during the years of the gold rush the Fort Victoria population fluctuated between 3000 and 6000 permanent residents and land sales increased significantly. In the wake of optimistic prosperity and rocketing immigration the British Columbia mainland was declared a British Colony in 1858 and James

Douglas, who was already Governor of Vancouver Island, became Governor of both colonies at this time (Baskerville 1986).

On a fateful day in March 1862, a man carrying the smallpox virus arrived in Victoria from San Francisco sparking a rampant epidemic which affected the many Indigenous peoples who were camped at Fort Victoria. Factions of visiting northern tribes were quickly infected and subsequently evicted from the fort in an apparent bid to stop the spread of the disease among the Indigenous people. Consequently, members of these bands on returning to their homeland territories transmitted the disease to practically all areas of north coastal British Columbia (Boyd 1990). Over 19,000 First Nations individuals died as a result of the 1862-63 smallpox epidemic (Boyd 1990). The Lekwungen, and probably other southern Vancouver Island bands, it seems, were somewhat spared from the smallpox epidemics of 1853 and 1862-63 because of a vaccination program in Victoria. The latter epidemic also marked the time when some Lekwungen families moved back to the Discovery Island area (Duff 1969).

Further displacement and isolation of local Straits Salish peoples came in the 1860s and 1870s when the population balance shifted substantially. The pre-epidemic population the larger Central Coast Salish of well over 20,000 (Suttles 1990b) likely dropped to 12,000 by 1835, and then to 5525 in 1885 (Duff 1969) (Figure 1.4). Grant (1849) noted:

> The Natives of any of the Districts which I have mentioned are not robust either in frame or constitution. From what I have Witnessed among the Soake [T'Sou-ke] Nation I [should] say that at least two thirds of the population were diseased… The annual mortality is considerable & reasoning from analogy we may say that it will probably increase in a numerical ratio proportionate to the increasing influx of White population.

In contrast, the settler population growth rate continued to rise. The two colonies of Vancouver Island and the British Columbia mainland merged in 1866, and British Columbia entered the Confederation in 1871. Within one decade, Victoria increased its population size ranking from the 27th largest city in Canada in 1881 to the 11th largest city. This dramatic demographic jump, which equates to an increase of 184%, has not been duplicated in Victoria's history. The city doubled its landbase, diversified its economy, and increased its manufacturing potential. Seal hunting and salmon canning were largely responsible for this affluence. Many Straits Salish peoples from southern Vancouver Island found paid work in canneries on the Fraser River (Lutz in press). The opening of the Canadian Pacific Railway (CPR) on the BC mainland in 1886 also lead to great influxes of new residents who settled in Victoria's rapidly expanding residential neighbourhoods (Baskerville 1986).

Until the early 1860s the principal land owners (in the European sense) on southern Vancouver Island were Hudson's Bay Company employees and their families (Mackie 1992-93). Captain Walter Colquhoun Grant, arriving in 1849, was the first official surveyor for the Hudson's Bay Company and the area's first independent settler (Hendrickson 1975). He was also credited with being the first person to introduce the invasive exotic shrub *Cytisus scoparius* (Scotch broom) into the region (Ireland 1953). Grant wrote extensively about Vancouver Island for the Royal Geographic Society but lacked skill as a surveyor, colonist, and farmer. He left the region for California in October 1851. Joseph D. Pemberton arrived in June 1851 and subsequently surveyed the whole of southern Vancouver Island districts by December 1853 (Floyd 1969).

By 1865 many independent settlers were effectively farming a total of about 40,500 ha (100,000 acres) of agricultural land in the Victoria region (MacFie 1865). The shifting demographic patterns resulting from the growing influx of new settlers, coupled with the continual economic deconstruction of local Indigenous cultures, fueled increasing racial conflict and social inequality. The Indigenous peoples' labour and merchandise valued by the early Hudson's Bay Company colonists was becoming obsolete in light of widescale agricultural expansion. Moreover, the rampant appropriation of Indigenous lands was advanced by a general belief that Native peoples knew little of cultivation and, "[did not] in any civilized sense, occupy the land" (Sproat 1868:8). The *British Colonist* actively campaigned against Indigenous labour: "It is Caucasian-Anglo-Saxon bone, muscle, and intellect that we want" (in Baskerville 1986:44). Joseph Trutch (in Kew 1990:159-160), who became Chief Commissioner of

Lands and Works in 1864, formalized this sentiment, and in turn, clearly disregarded the Douglas Treaties of the early 1850s:

> The Indians have really no rights to the lands they claim, nor are they of any actual value or utility to them; and I cannot see why they should either retain these lands to the prejudice of the general interests of the Colony, or be allowed to make a market of them either to Government or to individuals.

Settlers went to great lengths to clear away vegetation. Special ploughs were created "with wrought iron mountings" to fragment the rocky prairie ground (Douglas, 22 December 1850; in Bowsfield 1979:141). Both open and forested ecosystems were converted to agricultural fields and pasturage. Matthew MacFie FRGS, resident of Victoria for five years, (1865:201-202) recommended:

> Where loose surface stones or small boulders happen to be imbedded [in the prairie soil], they should be first carefully removed. If there be no dense weed or stumps, the land should be broken up, in the first instance, by one or more yokes of oxen, as the farmer may deem necessary
>
> If [bracken] fern prevail on the land, it should be ploughed up in the heat of the summer, in order, by exposure of the roots to the rays of the sun, to destroy them. These with all bulbous weeds, such as crocuses, kamass [camas], &c., should be collected and burned. Fern-land, not required for immediate use, may with advantage be left for hogs to burrow in, as they form valuable pioneers.
>
> Land covered with pine [Douglas-fir] is not difficult to clear. That tree, being of a resinous description, burns freely, and its roots creep close to the surface. ...The roots of oak descending more vertically into the ground are not so easily eradicated.
>
> After clearing, draining and ditching should receive early attention.

Grant appeared to share MacFie's opinion of camas, remarking that it should be "exterminated as a noxious weed," even though it was known to be a highly significant resource for Indigenous peoples (Grant 1861:210).

The region's settlers quickly imported many quantities and varieties of agricultural crops, seeds, and livestock, and substantially changed the composition of vegetation, the structure of soils, and the patterns of hydrology (Figure 1.4). Additionally, the nearby Gulf Islands were not immune to settlement's sprawl from the adjacent southern Vancouver Island landscape. Sheep ranching, which began when John Tod bought a large portion of Pender Island in 1855, soon became the predominant industry on the islands (Eis and Craigdallie 1980). As in the Victoria region, sheep and hogs quickly decimated the native herbaceous vegetation of the islands (Suttles 1987). By 1900, "most of the land [of the Gulf Islands] suitable for agriculture was permanently cleared and settled" (Eis and Craigdallie 1980:9).

At the beginning of the twentieth century the traditional land use patterns and economic structure of the Straits Salish was greatly altered and their rights as sovereign nations and cultural continuity were threatened. In April 1911, the province took possession of the Lekwungen village area near downtown Victoria and established a new reserve of 69 ha (170 acres) in Esquimalt (Baskerville 1986; Lutz in press). The McKenna-McBride Commission formalized the Indigenous land issue and established the reserves which exist today within the Province (Kew 1990). Access to land-based resources was essentially denied since the Commission could see no clear evidence of pre-colonization Indigenous cultivation (Deur 2000).

1.3 CHAPTER CONCLUSIONS

The cultural landscapes of southern Vancouver Island have changed dramatically in the last 160 years. Environmental change was not only influenced by shifting climatic and ecological processes, but by the behaviour, practices, and economic choices of humans who dwelled within the environment. The post-colonization cultural landscape was, and still is, governed by a society with environmental values and economic policies very different than those of the Indigenous peoples of pre-colonization times.

Today, species endemic to this region are highly restricted in a mosaic of urban, suburban, and rural communities. Although there are still visible clues to the earlier expanses of open parklands, such as the large savanna-form oaks associated with many of the local agricultural fields and the pockets of dark prairie-type soils, the greater landscape mosaic has all but disappeared. The Indigenous person's role within the landscape has largely been eliminated. Native plants and animals are important to our quality of life, but are not vital to our daily livelihood: they have aesthetic, but little economic, nutritional, material, or medicinal value to most of us.

Landscapes have an established, but not often recognized or agreed upon history. The original Dutch definition of landscape, however, remains the constant. Cultural landscapes are commonplaces -- those everyday spaces associated with habitation. People can dwell, and have dwelled, within visually picturesque and ecologically productive places. Straits Salish peoples did not live in wilderness in the colonial sense, but interacted with their environment to maintain culturally important measures of landscape productivity. How Straits Salish interacted with their oak-camas parklands, and how they used and managed camas specifically, is developed in the next chapters.

2.0 SUMMARY AND INTERPRETATION OF *CAMASSIA* USE AND MANAGEMENT: QUALITATIVE EVIDENCE

> You will remember that the Districts for which the Indians received payments in blankets were the main producers of the Kamass root for the whole surrounding country. The destruction of this plant by cattle and sheep caused a great loss to the Songhees, Saanich and Sooke Indians as it was the most important article of trade which they had to offer in dealing with the neighbouring tribes.
>
> Joseph MacKay, letter to John Helmcken regarding the Fort Victoria Treaties, 1888 (G. Keddie, pers. comm. 2003)

2.1 INTRODUCTION

This chapter is a synthesis and interpretation of the available qualitative evidence on former camas use and management among Straits Salish peoples. *Camassia* is one of the most important plant genera for First Peoples in western North America. Over 60 Indigenous groups utilized camas bulbs (Gritzner 1994) (Figure 2.1). On southern Vancouver Island it appears that regular use and management of this important root food ended by the beginning of the twentieth century. As with other Indigenous foods, much can be learned about the procurement and production of camas bulbs from the anthropological literature. Although traditional Indigenous resource management faded over time, Straits Salish peoples adapted to the shifting social and physical environments and continued to seek out and use camas, albeit in lesser quantities, well into the mid-1900s. Most of the contemporary research on camas, therefore, tends to follow an integrated ethnobotanical design, drawing on recorded oral histories and supplementing these data with the available environmental knowledge and recollections of living First Nations consultants or co-researchers.

Three largely qualitative disciplines - ethnohistory, ethnography, and ethnobotany - provide valuable evidence to aid in the interpretation of cultural, or anthropogenic, landscape change over time and the depiction of the shifting economic choices and land

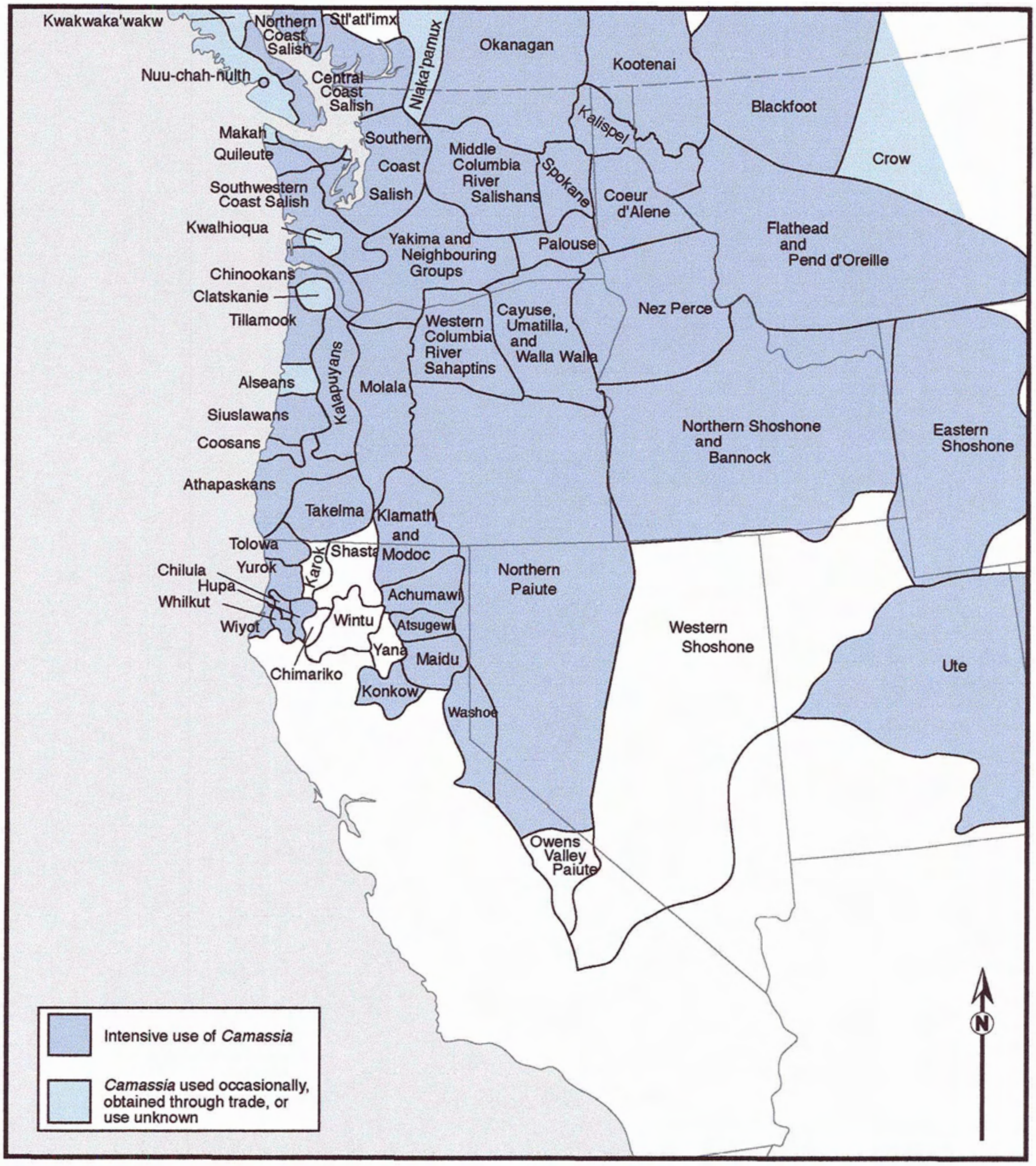

Figure 2.1 *Camassia* use by First Nations in western North America (c.f. Loewen 1998: 90; boundaries and use designations based on Hart 1976; Johnston 1982; Turner *et al.* 1980; D'Azevedo 1986; Thoms 1989; Turner *et al.* 1990; Suttles 1990a; Walker1998; DeMallie 2001).

management options of local Indigenous peoples. Ethnohistory is the study of Indigenous lifeways as principally seen through historic and archival records (Duff 1969). These early written accounts provide first-hand, detailed observations of, and interactions with, Aboriginal peoples at a given point in history (although many were not published until decades later as historical anthologies or analyses). Ethnographic research documents Indigenous cultures through participant observation and in-depth personal interviews with First Nations consultants. Although this anthropological field has its roots in the nineteenth century, it is largely a twentieth century approach which focuses, as much as possible, on the events of the past. However, given the timeframe for most regional ethnographic work, for example, Indigenous consultants were primarily recounting an era after the establishment of Indian reserves, and details on subsistence and other traditional economic pursuits were likely reconstructed from cultural memory (Kennedy 1995). Ethnobotany was first described in the late 1800s (Ford 1994; Balick and Cox 1996), but has only become more integrative and expansive in the latter part of the twentieth century (Ford 1994; Cotton 1996). This discipline seeks to understand the people and plant relationships (e.g., classification) in Indigenous or traditional societies (Berkes 1999). A multidisciplinary field of study, ethnobotany draws from the social, as well as the applied, sciences.

These disciplines are complementary components of cultural landscape, or ethnoecological, research and can be synthesized to form a backbone of valuable cultural knowledge that would otherwise remain unavailable and inaccessible. Evaluating each resource within its historical context, these works depict episodes in a continuum of cultural change, adaptive Indigenous environmental knowledge and practice, and shifting environmental dynamics (see Chapter 4).

Detailed reviews of ethnohistorical, ethnographic, and ethnobotanical research comprise the bulk of this chapter. Although southern Vancouver Island is the focus of this dissertation, supporting references from other relevant geographic regions and from other Indigenous groups are included in this analysis. The discussion following the reviews addresses the inherent pitfalls and challenges associated with the interpretation of this research and assesses the qualitative evidence for camas use and management. A detailed examination of the ethnoecological effects of Indigenous camas use and management, based largely on information presented in this chapter, is included in Chapter 4.

2.2 DEVELOPMENT AND RESOURCES

Qualitative references were compiled and analyzed for details and clues to Straits Salish *Camassia* use and management at given points in history, with specific focus on how and why resource use changed over time. In addition, three criteria were evaluated for each reference: the author's objectivity and background knowledge; the original purpose and intent of the written information; and the social context and degree of historical continuity (c.f. Russell 1983). In general, the early writers were traders, explorers, surveyors, and biologists, and their accounts reflected their level of academic training and environmental knowledge. Furthermore, an author's understanding of Indigenous foods or native flora could be correlated with the extent of previous exploration within this geographically broad region. For instance, frontier scientist James Swan, who had wide knowledge of western Washington, wrote in 1857 that camas "…is spelled by different writers as *Kammœus, Lackamas, Camarus, Camash*, and *Kamas*, but they all mean the same. Every tribe, in its own peculiar language, has a different name for this root…" (Swan 1989:90). Swan appears to not only be familiar with the regional linguistic variation of Indigenous peoples but also with the literature produced by fellow explorers and scholars of the time. Alternatively, many of the early historic accounts were simply a means of correspondence with relatives or colleagues, formal or informal. The original authors may not have paid particular attention to details that are now seen as having ethnohistoric significance.

The ethnographic and ethnobotanical information cited here is extracted from a number of key published and unpublished works. The primary sources of Coast Salish camas use data include Wayne Suttles' Ph.D. Dissertation, *Economic Life of the Coast Salish of Haro and Rosario Straits* (1951a), the unpublished ethnographic research materials of Marguerite Babcock (1967), and the extensive ethnobotanical research of Dr.

Nancy Turner and her colleagues (e.g., Turner 1995, 1997, 1998, 1999a; Turner and Bell 1971; Turner and Kuhnlein 1983). Additional information was compiled from contemporary consultations with members of the Songhees (Lekwungen) Nation, specifically with Cheryl Bryce, Lands Manager and descendent of Cheetlum, a Douglas Treaty signatory (pers. comm. 2001, 2002), and with Bob Akerman, a descendent of a Cowichan (Hul'qumi'num) grandmother, and a long-time resident of Salt Spring Island (pers. comm. to B. Beckwith and N. Turner 1999).

Much of the ethnographic literature cited contains direct quotations from interviews with Indigenous consultants. The names or initials of all consultants originally cited, if recorded, are included in this review to preserve the original cultural "voice" as much as possible. Many First Nations people have provided pertinent information about camas use, and they should continue to be recognized as valuable holders of ecological knowledge and cultural memory. The work of Marguerite Babcock requires special mention. In her ethnographic research materials, Babcock (1967) paraphrased camas use information recorded from interviews with three Saanich consultants -- Christopher Paul, Johnny Sam, and Ernie Olsen – designated throughout her notes by their initials: CP, JS, and EO. This highly beneficial research was not published by Babcock and has been cited in part with Babcock's permission by Drs. Nancy Turner, Doug Deur, and Wayne Suttles (e.g., Turner and Kuhnlein 1983; Deur 2000; Deur and Turner in press, 2004a; W. Suttles, pers. comm. 2003). The knowledge of camas use provided by these three Indigenous consultants includes useful and unique information on camas, therefore, much of Babcock's careful and systematic work is integrated into my analysis.

Additional contributions to this body of work came directly from Drs. Turner and Suttles. Dr. Suttles provided me with copies of his original interview notes (1946-52) and a preview of his up-coming book (pers. comm. 2003), which integrates his previously unpublished and published ethnographic information on the Indigenous peoples of Haro and Rosario straits, and includes the knowledge of Mary George (T'Sou-ke), Tom James and his wife (Lekwungen), Louie Pelkey (Saanich), Julius Charles (Semiahmoo), and Annie Lyons and Charlie Edwards (Samish). Dr. Turner (1996) offered me her field notes of an interview with Elsie Claxton (Saanich; L. Pelkey's sister). To maintain clarity within this chapter, the initials of all Indigenous consultants are included in the citations for each author, if available and where their names are not used.

2.3 QUALITATIVE EVIDENCE

2.3.1 Ethnohistory

2.3.1.1 Indigenous Camas Use and Management on Southern Vancouver Island and Adjacent Areas

Some of the earliest accounts describing *Camassia* tended to focus on the presentation and taste of camas bulbs, a probable indication of the importance of the resource as a gift or offering. The Spanish explorers of the late eighteenth century, for example, noted that the Indigenous peoples of the lower west coast of Vancouver Island (T'Sou-ke) "have come out with salmon berries [*Rubus* sp.], some cooked roots like onions which are very tasty, and another fruit like a grape [possibly *Gaultheria shallon* (salal)]" (Wagner 1971:100). The appetizing "cooked roots" were most likely camas bulbs, as indicated in an editorial footnote accompanying Wagner's report. Camas was often characterized as onion-like in the historical literature (see Hazlitt 1858; Swan 1989). Camas and onion (*Allium* spp.) are both in the lily family (Liliaceae) and are similar in bulb morphology. The edible camas of Vancouver Island was also often described as "esculent," with early species designations of *Camassia esculenta* Lindley (Wood 1849; Hazlitt 1858), *Scilla esculenta* Ker-Gawl (Mayne 1967), and *Gamassia esculenta* Lindl.[1] (Brown 1868). Some writers included comments about the appearance and taste of the cooked camas bulbs, and many described camas as tasting "sweet," or palatable (Wood 1849; Brown 1868; Wagner 1971; Mayne 1967). Swan (1989:91) claimed that he did "not know any vegetable, except fried bananas, so delicious."

[1] Evinger (1928:4) notes that the genus name *Gamassia* was an alternative spelling for *Camassia* used in "popular writings." Hence, *Gamassia* is not a recognized classification in the synonymies of Evinger (1928) or Gould (1941, 1942).

Camas use was also recognized among Indigenous groups who obtained camas bulbs through trade. Both Sproat (1868) and Jewitt (Stewart 1987) commented on the importance of camas in the diet of the Nuu-chah-nulth peoples of the Vancouver Island west coast. In 1824, Jewitt (in Stewart 1987:100) described camas:

> ...an excellent root called by the Kla-iz-zarts *Quawnoose*. This is the size of a small onion, but rather longer, being of a tapering form like a pear, and of a brownish colour. It is cooked by steam, is always brought in baskets ready prepared for eating, and is in truth a very fine vegetable, being sweet, mealy and of a most agreeable flavour. It is highly esteemed by the natives...

The word for the camas bulb used by the Nuu-chah-nulth at Hesquiat is k^{w}an̓us (Turner and Efrat 1982:54), which could be written approximately as "quawnoose."

There were numerous accounts commenting on the relative amounts of camas bulbs that were commonly used by Straits Salish peoples. Spanish explorer Manuel Quimper wrote of the Indigenous peoples located on the Strait of Juan de Fuca on 1 July 1790:

> They have... the advantage that their country consists of level thickets with few trees and is very prolific in roots and fruits on which they all maintain themselves. Even those who live at the mouth of the strait and outside of it [e.g., Nuu-chah-nulth] come to provide themselves with what they need to pass the winter (Wagner 1971:108).

Mayne (1967:412) stated in his survey of the resources of Vancouver Island: "There are also several kinds of the bulbous roots, the commonest is the camass... of which the Indians eat a great deal;..." Artist and traveler Paul Kane linked camas to the cultural landscape and to cultural ceremony, both in writing and in art (Figure 2.2). While at Fort Victoria on 8 April 1846, Kane reported:

> These Indians have a great dance, which is called 'The Medicine Mask Dance;' this is performed both before and after any important action of the tribe, such as fishing, gathering camas, or going on a war party, either for the purpose of gaining the goodwill of the Great Spirit in their

Figure 2.2 Painting by Paul Kane, circa 1847. Original caption reads "An Indian village, Esquimalt, with canoes returning from gathering camas" (Image courtesy of Dr. Wayne Suttles and the Stark Museum of Art, Orange, Texas [31.78/58, WWC 58]) .

> undertaking, or else in honour of him for the success which has attended them (Harper 1971:101-102).

The ethnohistorical documentation on Indigenous camas use appeared to peak significantly during the middle of the nineteenth century. This was an important time of exploration and information gathering for the new European residents of Fort Victoria. As well, for the first decades after the time of contact the non- Indigenous population was still low, and, as a result, the local Straits Salish were likely still capable of and active participants in procuring native plant foods at their traditional sites on southern Vancouver Island. As a result, local Indigenous peoples were also able to maintain a comprehensive traditional ecological knowledge and time-honoured cultural relationships with their landscape. Captain W. C. Grant (1849) wrote, for instance, that the Straits Salish peoples had "names for every fowl of the air, every fish of the sea & every herb & Tree of the ground which are to be found in their Country." Hence, this was a unique period when the colonists could directly witness and record Indigenous land use practices and economic patterns.

Notably, William Hazlitt, author of a comprehensive "historical sketch" of Vancouver Island (1858), Robert Brown, explorer for the Botanical Association of Edinburgh (1868), and Gilbert Sproat, government agent and businessman (1868), all reported on *Camassia*, including comments on the ecological and cultural aspects of the genus. The accounts of these three men represent some of the most comprehensive ethnohistoric records available on camas for this region. I found Brown's and Sproat's accounts to be strikingly similar (c.f. Sproat 1868:42; Brown 1868:378-379). Since it was likely that Sproat could have borrowed from the earlier written description of Brown (G. Keddie pers. comm. 2003), only the part of Sproat's text that is novel will be presented in this review.

Hazlitt (1858:179-180) noted in his survey southern Vancouver Island:

> The open prairie ground, as well as the patches of soil which are met with in the clefts of the hills, are principally covered with the camass [sic], a small esculent root about the size of an onion, with a light-blue flower, the *Camassia esculenta* of botanists. The camass constitutes a favourite

> article of food with the savages, and they lay up large quantities of it for winter consumption, burying it in pits in the ground in the same way as they keep potatoes. This root has strong astringent qualities; the savages prepare it for food by digging large holes in the ground, throwing in hot stones, on the top of the stones placing quantities of camass, and covering the whole up with sticks and mats until the root is sufficiently baked. The camass-digging is a great season of 'reunion' for the women of the various tribes, and answers with them to our hay-making or harvest home.

Brown (1868:378-379) wrote of camas use within a more general context:

> Nearly all of the tribes, from the coast to the Rocky Mountains, use as food more or less of the blue lily, the Gamass or *La Gamass* of the voyageurs (*Gamassia esculenta*, Lindl.), which, in the spring, lends a characteristic aspect to the Western Pacific prairies and open grounds. In Vancouver Island this plant [camas] comes into flower about the middle or end of April, and remains in flower until June, when, just as it is fading, the roots are in a condition to be gathered. Until that time it is watery and unpalatable.
>
> The gathering is nearly wholly done by women and children, who use a sharp-pointed stick for the purpose; and it is surprising to see the aptitude with which the root is dug out. A botanist, who has attempted the same feat with his spade, will appreciate their skill. About this period the Indians come from their permanent village, and encamp under the shade of trees in little brush camps. It is the time when, away from the filth of villages, Indian life appears in its most picturesque aspect; and the twinkling of the Gamass camp fires, as you pass along through the wood at night, have a very pleasing effect. To the Gamass gathering come sober-minded young hunters and salmon-fishers to select a partner; for the hard-working, skilful squaw is looked upon by an Indian of right constituted mind as a much more desirable acquisition than a mere gawky thing, gay in vermilion, brass wire, and hawk bells. In Oregon I have seen the bulbs roasted until they became black. They are then pounded up and preserved in cakes. In Vancouver Island, and generally throughout the country, the roots are roasted to convert the starch [actually inulin] into sugar (though, of course, the Indian knows not the *rationale* of the process), and are preserved whole in bags for winter use. They are sweet to the taste, and appear to be a nourishing, and far from unpalatable article of food.

Sproat's (1868:42) adds the following on the importance of camas as a commodity:

> [Camas] grows only in small quantities on the west coast [of Vancouver Island], and is taken thither as an article of traffic from the south of the island, particularly the neighbourhood of Victoria, where there are excellent camas districts.

Although the above quotations contain valuable information on the topic of camas use, they are noticeably vague regarding management practices utilized for the resource. Sproat (1868:42) furthered his earlier statement with: "[the Indigenous peoples of the Victoria region] never attempted to increase the production of camas by any kind of cultivation." Such statements are now generally recognized as inaccurate and misleading, principally because of the extensive evidence of purposeful resource manipulation from the ethnographic and ethnobotanical literature, and the widely cited use of intentional landscape burning by Straits Salish groups in the ethnohistoric record.

Although not often attributed to a specific resource or management goal, fires routinely set by Indigenous residents drew the understandable attention and concern of the Fort Victoria settlers. For example, comments on the extensive burning were included in daily weather records for the Hudson's Bay Company's Fort Victoria Journal:

20 August 1846	The weather is now getting very hazy in consequence of the smoke from the fires which the Natives make in all directions.
23 August 1847	The Fires are now beginning to [spread] over the *Country*, ...
20 July 1848	Very dry weather & [h]azy owing to the fires that now run in various directions through the woods and prairie.

Similar accounts documenting summer burns were recorded from Fort Nisqually and personal journals in western Washington as well (Norton 1979; Gorsline 1992a).

Hazlitt (1858:160) also described the effects of the fires on the weather: "The natives all along the coast [of Vancouver Island] have a custom of setting fire to the woods in the summer, which doubtless adds to the density of the fogs, and increases the temperature..." In 1848, J.E. Fitzgerald (1848) commented that there was "...a plain of some miles in extent, on the south side of the [Vancouver?] island, which had not a blade of grass growing, owing to it having lately been burnt by the Indians,... "

Some accounts of Indigenous burning methods were more specific. In the Metchosin area, Grant (1849) explained that the goal of the use of high frequency fires was to "...clear away the thick fern and underwood in order that the roots and fruits on which they in great measure subsist may grow the more freely and be the more easily dug up." Also in 1849, an anonymous piece in the London Times (in Turner 1999a:194-195) recounted:

> Miles of the ground were burnt and smoky, and miles were still burning. The Indians burn the country in order to [promote] ... more especially, the roots which they eat. The fire runs along at a great pace, and it is the custom here if you are caught to gallop right through it; the grass being short, the flame is very little; and you are through in a second.

This narrative is an informative account of fire use and fire behaviour in the ethnohistoric record. The "roots which they eat" were undeniably mostly camas (Turner 1999a), although these fires could have also promoted the growth of other native resources as well. The actual description of the burn – "runs along at a great pace" and "flame is very little" – indicates a low-intensity, flash burn. This would be the expected fire behaviour of a plant community which experiences fires at a high frequency. The phrase, "the grass being short," also supports this interpretation. Lastly, the curious word "custom" is also used; this term implies that the fires are a routine event to which the settlers had adapted.

In short, anthropogenic, or human-created, fire clearly appears to have been a regular, and probably annual, occurrence on southern Vancouver Island. It is highly probable that First Peoples in the region have used fire as a customary land management tool for centuries (Brown and Hebda 2002) (see Chapter 4). On nearby Whidbey Island, Washington, James G. Cooper (1853, in White 1999) was precise in his account of fire use, explaining that the Salish peoples there " burned to preserve their open grounds for game, and for the production of their important root, the camas." Fire has been identified as a widely used resource in many other regions of northwestern North America (Norton 1979; Agee 1993; Gottesfeld 1994; Boyd 1999a; Turner 1999a).

As an additional note, no references to lightning –caused fires were found in the historic record. Lightning is rare on southern Vancouver Island. The natural fire frequency for this region (Coastal Douglas-fir Forest Biogeoclimatic Zone, see Chapter 1) is estimated to be 100-300 years on average (Parminter 2004).

2.3.1.2 Indigenous Camas Use and Management in Other Regions

Ethnohistoric references describing camas use and management in other regions of the Pacific Northwest are numerous. In the US, early historical accounts of camas use were recorded from Washington (Gunther 1973; Norton *et al.* 1984; Gorsline 1992a; White 1999), Idaho (Nelson 1937; Statham 1982), Montana (Geyer 1946; Hart 1976; Malouf 1979), and Oregon (Boyd 1999c). In 1805, Captain William Clark wrote that the Nez Perce at Weippe Prairie, Idaho, were gathering large amounts of camas bulbs "in heaps… those people have an emence [sic] quantities of Roots which is their Principal food" (in Sappington 1989:8). Regarding the dry prairies along the Klikitat Trail, Washington, Cooper stated in 1855: "the whole tribe resorts to them and encamps during June and July to gather the kamass root" (in Norton *et al.* 1999). David Douglas (1914:215) noted, in 1826, that "some Indians [were] digging the roots of *Phalangium Quamash* [*Camassia quamash*] in one of the low plains" near the Umpqua River, Oregon. Douglas (1914) also mentioned eating camas on numerous occasions during his travels through southern Washington and Oregon.

Camas bulbs were not only an ubiquitous staple food for Indigenous peoples throughout the Pacific Northwest (Figure 2.1), but were also important regional fare for the early Europeans, including trappers and settlers (Haskin 1934; Kinucan and Brons 1979; Theodoratus 1989). Lewis and Clark were first offered native foods by the Nez Perce at Weippe Prairie on 20 September 1805 (Spinden 1964; Sappington 1989). They received:

> ...a Small piece of Buffalow [sic] meat, some dried Salmon beries [sic] & roots in different States, Some round and much like an onion which they call Pas she co [quamash. the Bread or Cake is called Pas-shi-co] Sweet, of this they make bread & Supe [sic] they also gave us, the bread made of this root all of which we eate hartily [sic]... (Sappington 1989:10).

It has been recorded that early explorers and settlers made resourceful products with camas bulbs, although many of these preparations were already Indigenous innovations (see Ethnography and Ethnobotany section). Prolonged boiling, for example, resulted in the conversion of the camas bulbs into a molasses, which could have been used as a sweetener for coffee (Johnston 1982) or for making pies (Sweet 1962). Father Anthony Ravalli recalled that he "made two gallons of splendid alcohol from about three bushels of camas by fermenting" (in Hart 1976:15). Despite all their inventiveness, however, the settlers quickly recognized the digestive side effects of camas over-consumption. Father Nicolas Point explained" ...the digestion is accompanied by very disagreeable effects for those who do not like strong odors or the sound that accompanies them" (in Hart 1976:15). David Douglas (1914:106) also commented on the flatulence caused by eating too much camas, saying that the "strength of wind" almost blew him out of a Indigenous (Chinook) dwelling.

2.3.1.3 Landscape Descriptions as Evidence of Camas Use and Management

There were many historical accounts which describe the landscape of southern Vancouver Island and the adjacent areas as a mosaic of habitats consistent with an environment maintained by regular disturbance, such as anthropogenic fire. Berthold Seeman described the Victoria area in 1846:

> In walking from Ogden Point round to Fort Victoria, a distance of little more than a mile, we thought we had never seen a more beautiful country; it quite exceeded our expectation;... It is a natural park; noble oaks and ferns are seen in the greatest luxuriance, thickets of the hazel and the willow, shrubberies of the poplar and the alder, are dotted about (Seeman 1846:103).

W.H. McNeill wrote in 1838:

> On reaching the south end of the [Vancouver] island, a decided improvement was observed in the appearance of the country. ...the forest is replaced by a more open and beautifully diversefied [sic] country presenting a succession of plains with groves of oaks and pine [Douglas-fir] trees for a distance of 15 to 20 miles... The plains are said to be fertile and covered with the most luxuriant vegetation (Rich 1941:286-287).

Clearly, the early British settlers were taken by the high aesthetic values of the southern Vancouver Island parklands, a landscape that reminded them of their homeland. In 1858, Hazlitt (1858:217) thought that the landscapes of Scotland and England were both represented within the Victoria region:

> The scenery of the inland country round Victoria is a mixture of English and Scotch. Where the pine (they are all "Douglas" pines) [*Pseudotsuga menziesii* ssp. *menziesii*] prevails you have the good soil broken into patches by the croppings [sic] of rock, producing ferns, rye grass, and some thistles, but very few. This is the Scottish side of the picture. Then you come to the oak [*Quercus garryana*] region; and here you have clumps, open glades, rows, single trees of umbrageous form, presenting an exact copy of English park scenery. There is no running water; unfortunately, but the meadows and little prairies that lie ensconced within the wood*s* show no signs of suffering from lack of water.

The descriptions of the landscape were markedly similar in many localities in the vicinity of Victoria. The scenery of Esquimalt, for example, was "charmingly diversified" (MacFie 1972:45). Hazlitt (1858) made comparable notations for the regions of Nanaimo, Cowichan, Metchosin, and Pedder Bay. From Salt Spring Island, Jonathan Begg (2002) wrote on 10 March 1860: "I have about 80 acres of prairies on the farm. It is not exactly a prairie as it more resembles an English park or pleasure ground as here and there is a clump of beautiful balsam [possibly grand fir, *Abies grandis*, or balsam poplar, *Populus balsamifera* ssp. *trichocarpa*] growing." In 1792, Archibald Menzies, naturalist on George Vancouver's voyages, wrote that Whidbey Island had "a most delightfull [sic] & extensive landscape, a large tract of flat country coverd [sic] with fine Verdure & here & there interspersed with irregular clumps of trees" (Gorsline 1992b:42).

In 1826, David Douglas (1914:213-214) ascribed a park-like structure to the Willamette Valley, Oregon. Moreover, Douglas linked the characteristics of the landscape and Indigenous fire practices:

> Country undulating: soil rich, light, with beautiful solitary oaks and pines interspersed through it, and must have a fine effect, but being all burned and not a single blade of grass except on the margins of rivulets to be seen. [September 27]
>
> Most parts of the country burned; only on little patches in the valleys and on the flats near the low hills that verdure is to be seen. Some of the natives tell me it is done for the purpose of urging the deer to frequent certain parts, to feed, which they leave unburned, and of course they are easily killed. Others say that it is done in order that they might better find wild honey and grasshoppers, which both serve as articles of winter food. [September 30]

Cooper (1859, in Peter 1998:3) also remarked on a similar landscape dynamic on the Puget Sound lowlands:

> ...the abruptness of the forests which surround them, giving them the appearance of lands which have been cleared and cultivated for hundreds of years. ...The Indians, in order to preserve their open grounds for game, and for the production of their important root, the camas, soon found the advantage of burning, and when they began this it was only those trees already large that could withstand the fires...

2.3.1.4 End of the Ethnohistoric Camas Record

There is a notable reduction in ethnohistoric accounts of Indigenous camas use in the late nineteenth century. *Camassia* had been commonly cited by European explorers, colonists, and settlers as an important Indigenous staple food before this time. Even though few authors wrote extensively about the plant's role in the Straits Salish economy, some interesting patterns emerged in the ethnohistoric literature. The earliest records in 1790 (e.g., Wagner 1971) indicated that camas bulbs were widely traded and offered to visitors. That these references came from the west coast of Vancouver Island where camas is uncommon suggests that an Indigenous system of exchange for plant resources, especially camas, was fully operational at that time. It was not until after the establishment of Fort Victoria that details about camas harvesting and cooking were recorded in both writing and art (e.g., Hazlitt 1858; Brown 1868; Harper 1971; Sproat 1868). This was a time when colonists could witness, and in some cases experience, Indigenous lifeways firsthand. In fact, the crux of this review was the many descriptions of the landscape and of Indigenous use of fire, establishing *Camassia* within a culturally-influenced local environment.

The establishment and growth of the Euro-Canadian society, however, proved detrimental to the perpetuation of regular camas use by Straits Salish peoples (Babcock 1967) (Chapters 1, 4). Hazlitt (1858:181) noted, as early as 1858, that: "Potatoes and dried salmon form the staple food of all the natives who can procure them, the camass being by them considered more as a delicacy." Some years later, Sproat wrote (1868:42): "One of the bitterest regrets of the natives is that the encroachment of the whites is rapidly depriving them of their crops of this useful and almost necessary plant [camas]." This encroachment included the decimation of camas populations by introduced livestock (c.f. Suttles in press). Charles Bayley (1878:28) suggested, for instance, that camas was good food for both Indigenous peoples and also for "pigs of the settlers as they fatten on it..." Similarly, on Whidbey Island, Washington, a settler explained that camas "was excellent for Indians and hogs" (in Lutz 1995:31).

Furthermore, features on the landscape were noted as possibly resulting from past Indigenous use or activities, but no direct interaction between Straits Salish peoples and the camas resource were recorded. For example, George Dawson proposed that the small inland middens which he discovered could have been "...formed no doubt by parties of Indians hunting, hiding from enemies, or digging Kamass Root" (Cole and Lockner 1989:171). In addition, George Gibbs (1877:223) wrote:

> There are also, near Victoria, a number of small mounds,... Governor Douglass [sic] mentioned that one had been dug into without finding anything. Some of the gentlemen of the [Hudson's Bay] company supposed them to be kamas ovens.

Camassia remained, however, an often cited plant of the region with a long cultural history (e.g., Harrington 1967; Balls 1962; Sweet 1962). Haskin's *Wild Flowers of the Pacific Coast* (1934:29-30) stated, for camas (noted as *Quamasia quamash* (Pursh) Coville):

> Of all the food plants used by the Western Indians the camas was the most important and widely known. There is more romance and adventure clustered about the camas root and flower than about almost any other American plant. Hardly one of the early Pacific explorers but records how at some time the camas has saved him from extreme hunger, if not from actual starvation, and in the traditions of the Indians it was given a prominent place; many mythical tales are told of its origin and uses.

Other accounts from the early twentieth century also described the former romantic park-like landscape within which camas occurs. Charles C. Pemberton (1941), son of surveyor Joseph Pemberton, wrote: "That Beacon Hill [Park, Victoria] originally possessed a marvelous natural parkland is a matter of history." A similar sentiment was shared by Mrs. Edward Mohun (formerly Emmaline Tod, daughter of John Tod) regarding the area once known as "Langford Plains" [Langford or Colwood]. She described it as "... a stretch of park-like country that reminded one of English scenery. I am afraid all that locality has lost its former beauty. ... There is no romance in a new country" (in Ludrin 1928:39).

Within approximately four decades after European colonization, regular camas management had ended on southern Vancouver Island. This timing coincides with significant restrictions on and loss of camas harvesting areas, and with increasing socio-environmental tensions in other regions of the Northwest as well. In southern Idaho, for instance, wars (e.g., Bannock War) occurred in the 1870s as a result of encroaching European development into Indigenous camas meadows (Brimlow 1938; Gritzner 1994). Camas bulbs, however, remained a significant Straits Salish resource into the twentieth century. It appears that Indigenous peoples adapted to the growing Euro-Canadian presence by shifting their focus of the locations and methodologies for camas harvesting. Although becoming much reduced in use and trade, camas remained a sought after native root food through much of the 1900s, and its cultural value is well-recognized in the ethnographic and ethnobotanical literature of this time.

2.3.2 Ethnography and Ethnobotany

2.3.2.1 Cultural Significance of Camas

The cultural importance of *Camassia* in the Indigenous diet is widely recorded throughout northwest North America. As noted in the title of this dissertation and in Chapter 1, edible camas bulbs were called "the queen root of this clime" by the Jesuit missionary Father De Smet (in Lutz 1995:18) and "the 'number one' vegetable" by Saanich Elder Christopher Paul (Babcock 1967). The bulbs have also been noted as "[a] favourite food" (Nuu-chah-nulth, Turner *et al.* 1983:83), "by far the most important [lily]" (Straits Salish groups, Suttles 1951a:58), "universally used" (western Washington groups, Gunther 1973:24), "a staple food" (Nez Perce, Alcorn and Alcorn 1974:8), the "queen of all bulbs in the Inter-Mountain region" (Murphey 1987:14), and "the great northern Plateau staple" (Turney-High 1941, in Malouf 1979:36) (refer to Figure 2.1). On southern Vancouver Island, camas bulbs formed the principal source of carbohydrate in a protein-rich diet (Turner and Bell 1971; Kuhnlein and Turner 1991) (Chapter 4).

The term "camas" has a complex and debatable etymology. It has been proposed that the term camas, for example, could have come into usage from the Nuu-chah-nulth word *cha-mass* meaning "sweet" or "fruit" (see Hartley 2001). It is also commonly theorized that the English word "camas" came from the Chinook trade language of the 1800s, and the earlier term, *lecamas*, with the French article "*le*," often displaced earlier used names (Malouf 1979; Turner and Kuhnlein 1983). Camas likely found its way into the Chinook Jargon from the Nez Perce word *quamash* as recorded by Captain William Clark in 1805 (Hartley 2001; see *Indigenous Camas Use and Management in Other Regions* section in this chapter).

The most appropriate representation for camas in Straits Salish is *qʷɬáʔəl*, which Suttles also translates as *qɬSáʔəl* (W. Suttles, pers. comm. 2003) (Table 2.1). The

Table 2.1 Coast Salish terms for *Camassia* plants, bulbs, or harvesting sites on southern Vancouver Island and adjacent areas (c.f. Turner and Kuhnlein 1983:204-205).

Group (dialect)	Indigenous Name	Reference
Songhees (Lekwungen)	*kʷɬáʔal (? qʷɬáʔal)*	Turner and Bell 1971:74; Suttles, W. 1982, pers. comm. to N. Turner in Turner and Kuhnlein 1982:204
Saanich	*kʷɬá·l* (bulb)	Suttles interview notes (LP, 1949)
	qʷɬáʔal (bulb) *spɛnəxʷ* (plant)	Turner and Bell 1971:74; Suttles, W. 1982, pers. comm. to N. Turner in Turner and Kuhnlein 1982:204
	spɛ(æ)/nəxʷ (C. Paul) *sqʷɬá·l* (E. Olsen) *qʷɬá·l* (J. Sam)	Babcock (1967) unpublished notes (camas raw or cooked); Turner and Bell 1971
T'Sou-ke (Sooke)	*qʷɬóʔol* (camas) *qʷɬóʔoləŋ* (harvesting place east of Sooke River)	W. Suttles, pers. comm. 2003
	kʷɬɔʔɔl (? qʷɬáʔal)	Suttles, W. 1982, pers. comm. to N. Turner in Turner and Kuhnlein 1982:204
Clallam	*qʷɬuʔiʔ; qwlhoo'ee* (sing.) or *qwaylhoo'ee'* (plural)	Fleischer 1980:207; Thompson, L. 1974, pers. comm. to N. Turner, both in Turner and Kuhnlein 1982:204
Samish	*qʷɬáʔal* (camas and harvesting place on Fidalgo Bay)	W. Suttles, pers. comm. 2003
Lummi	*qʷɬɔʔɔl*	Suttles interview notes (PV, 1947)
Straits Salish (Northern Straits)	*qʷɬáʔəl*	W. Suttles, pers. comm. 2003
Halkomelem	*spé·nəxʷ* (camas) *xʷpənénəxʷ* (harvesting place)	W. Suttles, pers. comm. 2003
Nooksack	*spæ·lxʷ*	Suttles interview notes (LG, 1950)

spellings of Indigenous words have changed over the years based on the expertise of the transcriber, the intricate variations of each distinct dialect, and subtle changes in pronunciation over time. For example, the "*kɬ*" is often substituted for "*qɬ*" (Table 2.1)

(W. Suttles, pers. comm. 2003). Turner and Kuhnlein (1983) provide a comprehensive list of camas terms for First Peoples of the Pacific Northwest.

2.3.2.2 Camas Harvesting Grounds

Unlike other significant camas harvesting regions (e.g., Washington, Idaho, Montana), relatively little is known about the specific harvesting sites for camas on southern Vancouver Island. Deep-soil camas meadows or prairies in the vicinity of Victoria (e.g., Beacon Hill Park) were not specifically noted in the ethnographic literature, but were probably important resource sites before European contact. Extensive harvesting grounds were likely associated with families of high status. The shallow-soiled resource sites commonly found in inland and upland areas, such as Mill Hill near Victoria, were probably significant refuge sites for woman and children during times of intertribal raiding (C. Bryce, pers. comm. 2002). Suttles (1951a:59) stated that the "Semiahmoo… Songish and probably the Sooke had prairies behind their winter villages where they could get camas and other bulbs." The Songhees (Lekwungen) used to camp near the location of present-day St. Ann's Academy (near downtown Victoria) when harvesting camas at *Meegan*, or Beacon Hill (Bryce 1997). On Salt Spring Island, both the Saanich at Fulford Harbour and the Cowichan at Burgogne Bay maintained the hillsides behind their camps for camas and berries by burning and clearing (B. Akerman, pers. comm. to B. Beckwith and N. Turner 1999). It is probable that all communities of Indigenous peoples of southern Vancouver Island had camas grounds near their homes before European contact. Off-reserve sites and smaller off-shore islands were targeted for harvesting just after the establishment of reserves, when the regional non-Indigenous population was still quite low. As the settler population grew, the use of established camas beds on reserves became even more important (CP to Babcock 1967).

It was commonly recorded that camas bulbs were dug from coastal bluffs, offshore islands, or other habitats with shallow soils (Suttles 1951a; Turner and Bell 1971). Women preferred to dig camas at these sites because the bulbs did "not grow as deep there and [were] easier to get out" (Suttles 1951a:59). Smaller islands (e.g., Mandarte, Sidney, D'Arcy, Discovery) have often been noted as important harvesting locales (Suttles 1951a; EC to Turner 1996, N. Turner, pers. comm. 2003). People would travel to the Gulf Islands "because they felt the camas grew best out [t]here, growing more clustered since they were undisturbed by settlements" (EO to Babcock 1967). Johnny Sam and his wife would travel to Flattop Island (San Juan Islands) to harvest camas (Babcock 1967). T'Sou-ke people harvested camas from sites at Deadman's Island, Otter Point, and Milne's Landing, an inland site east of the Sooke River. The Otter Point harvesting grounds were destroyed by cows and sheep (MG to Suttles, W. Suttles, pers. comm. 2003).

The camas harvesting season extended from the late spring through the summer (Turner and Kuhnlein 1983). Mary George (T'Sou-ke) claimed that: "Women's hands got purple from the flowers" (W. Suttles, pers. comm. 2003), clearly indicating that, at least for some, the bulbs were harvested before the flowers senesced, or dried up. According to the Saanich calendar, the "Moon of Camas Harvest, " called *PENÁW̱EṈ*, appeared to coincide with the month of May (Claxton and Elliott 1993). However, Johnny Sam and Christopher Paul (to Babcock 1967), and Elsie Claxton (to Turner 1996, N. Turner, pers. comm. 2003) all stated that the best indicator for camas harvesting time was when the flowers had died back and the seed capsules were ripening. Furthermore, Babcock explained (1967):

> If camas [was gathered] before the dormancy [period], [C]P thinks it would be similarly [unsatisfactory] as getting it too late – he bases this estimate in his [work] in potatoes. Dormancy [period] could be told by when the leaves & stalk of the camas plant get very dry, turn brown, curl up, & "lay down." The plants start growing again as soon as a good rain comes along in summer & the ground gets damp.

Nancy Turner (pers. comm. 1999) also suggested that the appropriate time to harvest camas would probably have been when the leaves have senesced for the year. At this time, the seeds are mature and the bulbs would have their maximum complement of stored nutrients. On southern Vancouver Island, camas seed production occurs in the late spring for both species of camas, although specific growth patterns are highly dependent on environmental conditions (Chapter 3) (Figure 2.3). In general, *Camassia quamash* (mid-late May) reaches maturation about two weeks before *C. leichtlinii* (late May – early June) in most locations (pers. obs. 1998-2003; Hebda 1992). First Peoples in other regions generally harvested camas bulbs towards the end of the growing season (Balls 1962; Murphey 1987). Gritzner (1994:40) suggested that Native Americans harvested camas "when the flowers on the lower half of the raceme [flowering stalk] began to fade, or just after the plants were past blooming." This generality was probably a common rule of thumb for the Straits Salish as well (e.g., Stern 1934).

Cheryl Bryce (pers. comm. 2002) speculated that the reason why there are variable harvesting times recorded in the ethnographic literature is that Indigenous peoples were harvesting the two different species of camas at slightly different times of maturity. Bryce also suggested that different soils and habitats may have contributed to different harvesting times, and perhaps varying bulb tastes. The Flathead of the Interior Plateau apparently received camas through trade from the Nez Perce because "…they preferred its larger size and superior flavor to their own" (Hart 1976:16). Even though cultural preferences for specific flavours within the *Camassia* genus are not commonly recognized in the ethnographic literature, differences in the taste and palatability of other Indigenous food taxa are widely known (Balls 1962; Heizer and Whipple 1971; Turner and Peacock in press). Differentiation between the two edible camas species is not known to occur in the recent Indigenous nomenclature (Turner and Bell 1971; Turner *et al.* 1983). It is possible that, over time, just as some of the original Indigenous derivations for camas names have been lost (Turner and Kuhnlein 1983), specific designations and distinctions for camas variants have disappeared as well.

Even though the exact scheduling of the harvest was variable by all accounts, the gathering of camas bulbs while flowers or fruiting stalks were visible appears to have been a near-universal practice. This timing served a practical purpose. The toxic look-alike lily, death camas or white camas (*Zigadenus venenosus*; Melanthiaceae), has a morphological structure and ecology similar to that of edible blue camas (Turner and Kuhnlein 1983). However, the flowers of death camas are cream- or white-coloured, and the flowers, and later the seed capsules, are smaller and more crowded along the stalk than those of the *Camassia* species (Figure 2.4). Johnny Sam and Christopher Paul both distinguished between the two types of camas – the poisonous and "useless" one (*Zigadenus*), and the edible and "gathered for food" one (*Camassia*). As noted by Babcock (1967):

J. Sam	…two ways of distinguishing these two types from each other: by flower color and by bulb taste. The plant of the edible camas has blue blossoms, while the poisonous type is white-flowered. The raw camas bulb tastes different (in some fashion) from the poisonous, and once cooked, if the poisonous bulb is eaten, it will swell up the mouth.
C. Paul	…the bulbs of the non-poisonous variety are dark brown and smooth ("like onions") on the exterior, but the poisonous bulbs are pale brown and rough on the outside.

Johnny Sam's wife would taste a questionable bulb to determine the variety when she had doubts (Babcock 1967). Because of the alkaloid content in the poisonous bulbs, it is said to have a bitter taste. In some cases, the flowering stalks of the edible camas were marked while still in bloom (Turner and Bell 1971) to help distinguish between the two types when harvesting later. Although *Zigadenus* and *Camassia* share common habitats throughout most of their range, soil conditions appeared to mitigate the need for distinguishing between edible and poisonous bulbs as harvest criteria in regions east of the Cascades (Thoms 1989). Records of the Indigenous practice of weeding death camas from *Camassia* grounds are rare from other regions.

Death camas bulbs are particularly poisonous to most livestock; sheep seem to be especially susceptible to the toxic alkaloid *zygadenine* (Fernald and Kinsey 1943). Hogs, however, readily consume the bulbs, which were also known as "hog potatoes" (Haskin 1934; Turner and Szczawinski 1991). The seeds and leaves of *Zigadenus venenosus* are also poisonous (Taylor 1974).

Figure 2.3 Seed stalk of *Camassia leichtlinii* showing capsules (fruit) splitting with black seeds inside (indicated by arrows).

Figure 2.4 Poisonous *Zygadenus venenosus* growing with the edible *Camassia quamash*.

2.3.2.3 Camas Bulb Procurement: Harvesting and Resource Management

Families, often consisting of a wife and her husband, their children, and possibly grandparents (Babcock 1967), usually traveled together to a resource harvesting site (Suttles 1951a; Malouf 1979). Before European contact families could have included "followers," most likely slaves, who assisted in food procurement and played an important role in economic systems in general (W. Suttles, pers. comm. 2004). Temporary camp sites were usually established near fresh water, and therefore, were not always immediately adjacent to the camas harvesting grounds (Babcock 1967). According to Jenness (1934-35, ca. 1930s), the Saanich would camp "…near their camass grounds on San Juan Island, using for shelter either a few boards taken from their houses, or rush huts [tent-like structures covered with cattail (*Typha*) or tule (*Schoenoplectus*) mats]." Camas bulbs would be prepared and cooked at these camps, unless the bulbs were harvested from locations close to a permanent village site (Suttles 1951a).

Before European contact the prime camas grounds were most likely family-owned and maintained with tenure rights inherited over generations (Deur 2000). Access to and use of inherited resource sites were controlled and directed by their respective owners or "skilled specialists" within the family (Babcock 1967; Suttles 1987:57; C. Bryce, pers. comm. 2002). Straits Salish bilateral kinship patterns, which incorporated broad intercommunity associations, could have resulted in the camas sites appearing to be communally based. Even though Suttles (1951a) and Turner *et al.* (1983) recorded that some camas sites were open to harvesting by outsiders, it remains uncertain whether these sites were for general community use or only accessible to those who maintained familial or trade relationships. The access, while open, may have been more by custom or convention, as is often the case in common property situations (e.g., Ostraff 2003). Ownership was explained by Mary George (W. Suttles, pers. comm. 2003):

> [T'Sou-ke people] had lots (plots). They didn't dig just anywhere. Stakes marked them. Women owned them, and they would fight for their claims.

> If someone came on to a woman's plot, she would quarrel. If the owner died, a near relative got the plot.

Christopher Paul described the ownership of camas plots (to Babcock 1967):

> Families respected each other's plots, and reserves respected each other's boundaries... Other than restrictions by reserve boundaries and the growing restrictions of white-used land, camas plot establishing was done by the families with considerable freedom... When each family claimed a plot of land, [they were] concerned only with the camas itself, not with any claim on the land itself. The family would keep claim on the plot as long as it yielded bulbs...

Ownership of resource sites was influenced and regulated by active stewardship and consistent resource extraction (Stern 1934: Turner *et al.* in press). It is probable that some of the more productive beds were more closely controlled and protected (Suttles 1951a; Turner and Bell 1971). Strict ownership protocols of camas beds may be linked to changing socio-environmental conditions and an increased risk of resource scarcity (c.f. Gritzner 1994). The tenure responsibilities for harvesting sites were comparable to the ownership of fishing sites, ancestral names, and medicinal knowledge (Jenness 1934-35).

Many camas gathering locales were probably large enough for several families to selectively harvest their respective plots in any one year (Turner and Bell 1971). The more general harvesting locale may have been communally used by a village or an extended network of people, whereas accessibility to a plot, or perhaps a rotation or choice of plots, was maintained and inherited within a family (c.f. Deur 2000). Unfortunately, there is little known about the size of camas harvesting plots (Babcock 1967). Based on limited data on plant harvest sites from this region (Suttles in press) and California (Anderson 1993), resource plots were mostly small in extent.

The camas prairies of the interior were often many hectares in size, and the "classic camas grounds" were thousands of hectares (Thoms 1989:201). Ownership of camas grounds by the Flathead occurred at the band level; there was apparently no family or individual owned harvesting areas (Malouf 1979).

Plot delineation in coastal areas was a common Indigenous practice (Suttles 1951a; Babcock 1967; Deur 2000; Turner *et al.* in press). Straits Salish peoples may have taken advantage of the open bedrock and heterogeneous terrain to use these as plot boundaries for both native and introduced plant resources. For example, Grant (1849) described the T'Sou-ke peoples utilizing the natural contours of the Sooke River to establish their plots of agricultural root crops:

> [The] Natives have several little gardens in which they grow considerable quantities of Potatoes, Carrots & Turnips. These are situated on little nooks of flat Land formed at the bends of the River...

Suttles (in press) recounted the narrative of two members of the North West Boundary Commission who were exploring the San Juan Islands in 1860. On Stuart Island, just north of San Juan Island, they recorded lines of cobbles on shallow-soiled terraces in an area that appeared to have been "dug up a great deal by Indians gathering Kamass roots" (Warren 1860, in Suttles in press). Similar rock barriers were seen earlier by the same explorers on San Juan Island (Suttles in press).

The clearing of the camas grounds was an important part of an overall stewardship strategy (Turner and Bell 1971; Turner and Kuhnlein 1983). This practice not only served to facilitate the harvest of the camas bulbs but also represented responsible ownership of the beds (Babcock 1967; Deur 2000; Turner *et al.* in press). Christopher Paul described the establishment of an "owned" plot (to Babcock 1967):

> Once a family cleared a plot, it would "just naturally" become their plot to use.... The plot...would be cleared of stones, weeds, and brush, but not of trees. The stones would be piled up in a portion of the plot where there were no camas plants growing.... The piles of stones on the plots are the remains or "markers" of the plots.... Many of these stone piles are still left in the lands in this area.

As far as can be determined, archaeological evidence of marked camas plots, such as piled stones, has not been investigated on the Saanich Peninsula. It is possible that the significance of any rock markers was simply dismissed by early settlers and the stones eventually became overgrown or were cleared for agriculture.

Christopher Paul provided the sole account of methods of clearing (to Babcock 1967):

> …the brush would be piled to one side, left to rot or to be burned…; this brush was actually uprooted, not just cut down. The purpose of the clearing… was to make the camas easier to clear – when the camas was gathered extensively, this was important.

He also told Babcock (1967) that the clearing would take place in the fall or spring when "the soil was soft from the heavy rains, but not muddy (or frozen) as in the winter." The manual clearing of camas sites during these seasons was uncommon. Alternatively, the regular use of fire as a potential method of clearing plots would have most likely occurred in the late summer or early fall (discussed later in this section). In all likelihood, clearing of the camas plots replaced burning after fire suppression began to be enforced by settlers, and piles of woody weeds would have been more prevalent in infrequently-used resource sites.

The actual gathering, or digging, of the camas bulbs has been well documented, but the detailed selection criteria for camas plots are less understood. Mary George (W. Suttles, pers. comm. 2003) recalled that a plot would be claimed after the relative density of the camas plants was assessed in the spring. Similarly, Babcock (1967) related:

> [Johnny Sam and his wife] would row from E. Saanich to [Flattop] Island – this would take them about all day. They would get there in the evening and camp there. Early the next morning they would look the island over for camas, so they'd know where they were going to dig. They would dig wherever they found "nice-sized" [mature] plants.
>
> … [they] would sometimes dig up two or three bulbs at a promising-looking clump in a preliminary check to see if the bulbs were big enough. After this survey, they would set out on the real digging.

The digging process consisted of selectively gathering the mature camas bulbs while systematically working the soil. A small section, or subplot, of topsoil would be worked over at a time. If the soil was compacted or with a heavy turf or sod, the bulbs could have simply been removed from the underside of an inverted section (Mary George to Suttles, W. Suttles, pers. comm. 2003). Christopher Paul described the bulb selection process (to Babcock 1967):

> When gathering, the Indians would not collect the immature bulbs;... these small, soft bulbs were "not worth cooking,"... Not all the small bulbs are immature... [I have] eaten some small ones cooked which were satisfactory. When the bulbs are mature, they are harder than the "tender" immature bulbs. The mature bulbs would sometimes get as big as about 2 1/2 inches [~6.5 cm] in diameter. After the bulbs become too old, however, they weren't any good to eat, either...

The largest and the smaller bulbs were generally left in the plot (Turner and Bell 1971; Turner and Kuhnlein 1983). Bulbs which were approximately 3 - 6 cm across were considered to be of harvestable size (Turner and Kuhnlein 1983). The camas bulbs on Mandarte Island, the well known Saanich harvesting site, were characterized as "big as a light bulb" (EC to Turner 1996, N. Turner, pers. comm. 2003) and "big as plums" (LP to Suttles, W. Suttles, pers. comm. 2003) (see photos of *Camassia leichtlinii* bulbs in chapters 1 [Figure 1.2] and 3 [Figure 3.7]).

Once the subplot had been thoroughly manipulated, an adjacent section of soil would be chosen (Underhill 1945; Turner and Bell 1971; Turner and Kuhnlein 1983), and this process continued until the entire marked plot was harvested (Stern 1934). Regular digging of the camas grounds aerated and tilled the soil, creating a more productive bed. Louie Pelkey recalled: "the more you dig, the better it grows" (Suttles 1951a:59, W Suttles, pers. comm. 2003). Rocks and unwanted vegetation (e.g., death camas) may have been removed at this time (Turner and Kuhnlein 1983). Lummi women would sow camas seeds directly into the crushed soil as they harvested the bulbs (Stern 1934). Suttles (pers. comm. 2003) commented that the re-planting of the seed heads was also a practice of the Nooksack and Nuwhaha.

In all likelihood, there was some form of ceremony associated with harvesting; however, information on specific rituals are rare. Cheryl Bryce (pers. comm. 2002) speculated that the singing of hereditary songs would have been a traditional custom associated with the camas harvest. The Nez Perce and other Indigenous peoples in the US interior would assemble annually at major camas grounds (e.g., Weippe Prairie) for root harvesting, as well as to trade, dance, gamble, race horses, feast, and engage in other ceremonies and activities (Gritzner 1994; Driscoll 2003).

A long, pointed digging implement was likely used in all camas harvesting regions (Stern 1934; Suttles 1951a; Turner and Bell 1971; Alcorn and Alcorn 1974; Chestnut 1974; Hart 1976; Malouf 1979; Murphey 1987), and for resource gathering in general (Underhill 1945; Suttles 1951a; Barnett 1955; Peacock and Turner 2000; Turner and Peacock in press). On southern Vancouver Island the digging stick was generally made from the wood of Pacific yew (*Taxus brevifolia*) or another hardwood, such as oceanspray (*Holodiscus discolor*) (Turner and Bell 1971; Turner and Kuhnlein 1983). On the Interior Plateau digging sticks were made from black hawthorn (*Crataegus douglasii*), saskatoon (*Amelanchier alnifolia*), horn, antler, or other hard materials (Hart 1976; also Turner 1995, 1997, 1998). Often the tip of this tool was hardened by fire (Suttles 1951a; Hart 1976; Murphey 1987). After the time of colonization, a *sq̓ɛləx*, or an iron rod, "something like a wrecking bar" (CP, JS), or a potato fork (EO), was used to extract the camas bulbs. Ernie Olsen also said that his wife used only her hands for gathering (Babcock 1967).

Camas was usually harvested in large enough quantities to supply a family with enough bulbs for food and trade until the next harvest season. Jenness (1934-35) suggested that "an energetic family could fill 10 or 12 bags with the roots during [a three week] period." Similarly, when Johnny Sam and his wife went to Flattop Island, they "would gather four or five [potato] sacksfuls [sic]… (each sack carried about 50 lbs. [23 kg] of camas bulbs)" (Babcock 1967). Sam's wife's parents used to collect "six or seven potato sacks full at a time at most; they would stay on the island only two days if the going was good, or three or four if it was slower" (Babcock 1967). Before the use of potato sacks, camas bulbs were collected into woven, tumpline-supported pack-baskets (Underhill 1945; Turner and Bell 1971; MG to W. Suttles, pers. comm. 2003); CP to Babcock 1967). If fish, clams, and other winter provisions were also gathered while at the temporary camp, then a family might stay as long as a month (Babcock 1967).

When calculated, it appears that a family could harvest approximately 92-160 kg (200-350 lbs.) camas bulbs in a two-day period, with a possible maximum harvest for the year of over 230 kg (500 lbs). By estimating volume for an annual harvest using the above ethnographic data, Deur and Turner (in press, 2004b) suggested that a family might procure over 10,000 bulbs in one season, although Turner (pers. comm. 2002) cautioned that the average size of the bulbs used in their calculation (the size of sweet chestnuts) was probably smaller than the figure noted by Babcock (1967).

Although entire families would often participate in the camas harvest (Turner and Bell 1971), the procurement and production of plant foods were generally considered to be the specialty and responsibility of women (C. Bryce, pers. comm. 2002; Turner 1995). Before colonization, dividing the labour was the most likely and efficient way of extracting a diversity of plant and animal resources (c.f. Suttles 1951). Even though women may have gathered other plant foods and materials while at the camas site (Jenness 1934-35), the camas harvest was likely the primary occupation (C. Bryce, pers. comm. 2002). According to Babcock's consultants, however, all members of the family would perform the same tasks, with no division of labour (Babcock 1967). Christopher Paul believed, however, that the gathering "may have been 'bossed' by a family member, although a gender was not specified (Babcock 1967).

There is limited evidence that camas bulbs were extracted from a harvest site and replanted or transplanted into other beds. The Tillamook in Oregon transplanted camas bulbs into village-owned polycultures in wet coastal forest clearings sites (Deur 1999). The Nuu-chah-nulth transplanted *Camassia* bulbs into moist resource sites in the Hesquiat area (Turner and Efrat 1982). Bulbs may have been transplanted into other beds or estuarine "gardens" within Nuu-chah-nulth territory, including a site at the mouth of the Megin River, north of Ahousat (Turner *et al.* 1983; Deur 2000), or possibly Johnstone Island in the Alberni Inlet (B. Beckwith, N. Turner, and D. Deur pers. obs. 1999) (see Chapter 3 [Figure 3.2C]). The Nooksack and Nuwhaha likely transplanted camas bulbs (W. Suttles, pers. comm. 2003), as well. Replanting of camas bulbs, both within established camas harvesting grounds and into other prepared root beds, occurred as well

(Deur 2000). Replanting could have been both purposeful or unintentional: "for dropped, split, or discarded bulbs [would have] spread the plant into new areas" (White 1999:43).

The final activity involved with harvesting was the firing of the camas harvesting grounds. Fire was a widespread management tool for Straits Salish peoples (Turner and Bell 1971; Norton 1979; Turner 1999a; White 1999; W. Suttles, pers. comm. 2003). Burning was employed to maintain openness (Turner and Kuhnlein 1983; Turner and Peacock in press) and to enhance fertility (Suttles 1951a; Turner and Bell 1971) in the harvesting grounds. Mary George explicitly described the harvest sequence (W. Suttles, pers. comm. 2003): "When [the women] finished digging, they leveled the ground, covered it with seaweed, and when it was dry, they burned it over. This made the bulbs bigger the next year." Applying seaweed to harvested camas beds as a fertilizer was evidently an uncommon procedure in this region (c.f. Turner and Peacock in press). Mrs. George also commented that there were fewer trees in the Sooke region in the past as a result of fire (W. Suttles, pers. comm. 2003).

Although fire use was most often recorded for the summer months (see Ethnohistory), Bob Akerman recalled that burning occurred in the spring. He stated (pers. comm. to B. Beckwith and N. Turner 1999), as paraphrased by Turner:

> [Mr. Akerman's] grandmother *Tuwahwiye* told him that people used to burn specific areas in the spring, just before the "*lacamas*" (*Camassia*) was going to be shooting out of the ground. They set fire to the area at the bottom of a hill, after a few days of warm, drier weather in the spring, and if there was a nice breeze blowing up the hill, it would just carry the fire – a hot, quick, "flash" fire – up to the crest of the hill. The fire would burn off all the old, dried grass, but was so quick it didn't burn the organic materials in the soil. ...Right after the fire, the green shoots of the *lacamas* would appear, and they would grow really well.

Alternatively, Bryce (pers. comm. 2002) expressed that burning in the fall fit in well with the natural cycle of the year:

> Burning was preparing [the land] for its rest. That's what winter is for... giving the land a rest. That's when the spirit world is closest; it starts coming closer in the fall. We would burn for our ancestors. Fall would be

> a time when they are drawing closer, so burning is a way of honouring both the ancestors and the land.

With the exceptions of recognized site locations and seasonality of the burns, noted above, there is very little known regarding the methodology used by Indigenous peoples (c.f. Turner 1999a; Peacock and Turner 2000). It is highly probable that Straits Salish women played a key role in fire management (C. Bryce, pers. comm. 2002;), as they did in other camas harvesting activities (W. Suttles, pers. comm. 2003).

2.3.2.4 Camas Bulb Production: Making and Sharing of Camas Products

Camas bulbs were cooked soon after harvesting, before they became soft and unpalatable. Raw bulbs were sometimes stored for short periods of time (Suttles 1951a), although preservation techniques varied from group to group (W. Suttles, pers. comm. 2003). Uncooked bulbs were rarely eaten (Turner and Kuhnlein 1983; Gritzner 1994). The bulbs were traditionally cooked by steaming in covered depressions in the ground, a method commonly referred to as pit-cooking. It is commonly believed that men helped by collecting firewood, but women were in charge of the pit-cook (JS and CP to Babcock 1967; MG to W. Suttles, pers. comm. 2003). A family usually steamed their own camas, although, at times, many families would contribute to a large pit, and subsequently, divide up the cooked bulbs (Suttles 1951a). Others might also donate bulbs to a family who were cooking camas for a feast or potlatch. Forty-five kilograms (100 lbs) or more of camas bulbs was a common quantity for cooking (Turner and Bell 1971; JS to Babcock 1967).

The cooking pits on the coast were relatively small in comparison to the mounded pits in central Washington and Idaho where between 500 and 700 kg of camas bulbs would be often be cooked at one time (Thoms 1989). Unfortunately, there is limited physical evidence of former pit-cooking depressions or plant food production in western Canada in general (e.g., Peacock 1998), and on southern Vancouver Island, specifically (e.g., Eldridge 2000; Owens *et al.* 2001; see Chapter 1). It is much more likely that archaeological remains of pit-cooking occur in other less-populated or less-developed coastal regions (Reagan 1934). As well, depressions are not often excavated, and when they are, the appropriate palaeoethnobotanical analyses are rarely performed (D. Lepofsky, pers. comm. 2003; see Lepofsky *et al.* in press).

Louie Pelkey described the pit-cooking process (Suttles 1951a:61-62):

> You dig a hole about two feet deep and about four feet across. In this you lay fine dry wood, then heavy sticks parallel across it, then rocks across the heavy sticks. Now light the fire. When the rocks get red hot this means get ready. When the rocks drop down, take the ashes out and level off the ground with a good hard stick. Then lay on kelp blades [probably the blades of bull kelp, which are easy to gather in quantity – *Nereocystis luetkeana*], salal [*Gaultheria shallon*] branches, sword ferns [*Polystichum munitum* (Kaulf.) K.B. Presl],... and the camas. ..You must fix it so that no dirt gets in and yet leave it all full of holes [air spaces]. Leave a hole at the top and when it is covered pour in more than a bucket of fresh water. When the water seeps through to the rocks, it steams up. Put grass on top, then about four inches of dirt, then build a fire on top of that. Leave it all night until the next afternoon.

Johnny Sam learned how to pit-cook from watching his late wife. Babcock (1967) wrote:

> The whole thing would be begun in the morning; at this time, a pit would be dug (about 4 ft. by 3 ft. by 2 ft. deep) and lined with rocks on the sides and bottom. A fire would be built on these rocks, and when the rocks became very hot – which would take about a half a day, until noon – the wood would be taken off and the rocks would be covered with kelp and... with balsam branches [*Abies grandis*]. The camas bulbs would then be put on top of that, and covered in turn with... balsam branches and kelp. All of this is covered with sacks, and maybe then with sand, so that no air or steam escapes from the pile and it keeps quite warm. The camas bulbs would be taken out, cooked, the next morning.

Straits Salish cooking pits were modified to accommodate the number of ingredients needed to meet specified culinary goals (Turner and Kuhnlein 1983). Other foods were also steamed in pits with the camas bulbs, including clams, deer or other meats (Turner and Bell 1971), and varieties of "root" vegetables (Suttles 1951a), particularly springbank clover (*Trifolium wormskjoldii*) rhizomes and common silverweed (*Potentilla anserina*) roots (Turner and Kuhnlein 1982; Turner *et al.* 1983).

Tree bark, from arbutus (*Arbutus menziesii*) and red alder (*Alnus rubra*) (Suttles 1951a; Turner and Kuhnlein 1983), was occasionally added to the pit to colour the camas bulbs. Other plants were also purposely added to the cooking pit to add flavour to the cooked bulbs, including seaweed and salal (Babcock 1967), or other "sweet bushes" (Suttles 1951a:61). In the British Columbia Interior, the Okanagan-Colville peoples often cooked their camas bulbs with other plants, such as black tree lichen (*Bryoria fremontii*) and dry ponderosa pine (*Pinus ponderosa*) needles (Turner *et al.* 1980).

Even though the basic pit-cooking procedure described above was common throughout the range of camas use (Reagan 1934; Spinden 1964; Chestnut 1974; Hart 1976; Malouf 1979; Turner and Efrat 1982; Turner *et al.* 1983; Thoms 1989), there is relatively little known about the beliefs or customs associated with cooking camas bulbs. Christopher Paul and Johnny Sam both recalled prohibitions associated with pit-cooking camas (to Babcock 1967):

> [JS] is also familiar with the precaution observed by the Indians during cooking [and described by CP as well]; he learned this from his wife, who learned it from the Discovery Island people. First, the man and wife couldn't have sexual relations ["you couldn't touch your wife"]..., if they were engaged in cooking camas, during the night... The other precaution was that the person doing the cooking (just that person) had to be very "quiet" when sleeping that night – that is, was supposed to stay in one position as much as possible all night long. Moving would cause the sand to fall through the top of the pile onto the camas & ruin it.... If these [precautions] were not observed, the camas would not cook properly, and would become sticky and unfit to eat ("rubbery"). ...these are old practices, dating from well before the arrival of the whites.

In the Interior Plateau, it was believed that Ktunaxa [Kutenai] men must not go near the roasting pits for the bulbs to be properly cooked by the women. Hart (1976:16) speculated: "This taboo held with most tribes and was probably just a means to keep men out of the way." Although not always associated with cooking, taboos regarding sexual relations and immobility were common in First Nations cultures, especially in association with hunting and fishing success (Lantis 1938).

According to Bryce (pers. comm. 2000): "Camas was a delicacy. ...Camas and other products (most often food) were given in the Big House Ceremony as gifts or payment for being a witness [of a wedding or other significant event]." Celebrations and dances associated with the camas harvest and feasts were more common in other regions (Malouf 1979; Gritzner 1994).

The role of camas in folklore remains uncertain. Reagan (1934) reported that the Hohs and Quileutes have many stories regarding camas. For this review, camas was found to be included in three west coast First Nations stories. The first was an Indigenous "Jack and the Bean Stalk" (Hayman 1989), which is a Cowichan version of the "Star Husband Tale," a common narrative among many Indigenous groups, including those of southern Vancouver Island. The Central Nuu-chah-nulth of the Alberni Inlet also have a story called "Swan Women Give Place Names to the *Ho:pach'as?ath* Country" (Arima *et al.* 1991). (These two stories are reproduced in Appendix 1.) Bryce (pers. comm. 2002) explained that the "Legend of Camosun" is a very long story which depicts the origin of the food species found in Songhees (Lekwungen) territory. Below is an greatly abbreviated version, which was adapted from a Songhees Nation brochure (Bryce 1997):

Legend of Camosun

After the flood, the Transformer *Haylas* was traveling with Raven and Mink teaching the people how things were to be done.

They found a young girl and her grandfather. She was crying, so *Haylas* asked her why. She answered, "My Father is angry with me, and will not give me anything to eat."

Haylas asked her if she liked sturgeon, and when she answered, "No," he threw the sturgeon to the Fraser River. That is why there are sturgeon there and not here. He asked her if she liked cranberries and when she answered, "No," he threw them into the Shawnigan Lake. That is why there are cranberries there now.

She refused many things, but duck, herring, coho, [oyster, camas, and many other resources] she accepted and that is why these were plentiful on the Gorge waterway [Victoria]. Because she was greedy, *Haylas* told her she would look after the food resources for her people and turned her into stone. He also turned her grandfather into stone.

Camas bulbs were often cooked for an extended period of up to 36 hours (Jenness 1934-35; Spinden 1964; Babcock 1967; Turner and Bell 1971; Murphey 1987). The main carbohydrate present in camas is in the form of inulin, a polysaccharide which is tasteless and largely indigestible to human beings (Turner and Kuhnlein 1983). Inulin-containing root foods needed prolonged cooking to facilitate the breakdown, or hydrolysis, of the carbohydrate into a high concentration of reducing sugars, or fructans (including fructose). As a result, the cooked bulbs are very sweet and digestible (Turner *et al.* 1980; Turner and Kuhnlein 1983; Thoms 1989; Kuhnlein and Turner 1991).

The sweetness of cooked camas bulbs was well-recognized by many, if not all, Indigenous groups, and in several accounts, the bulbs were used as a sweetening agent for other foods (Turner and Bell 1971; Turner *et al.* 1980; Turner and Kuhnlein 1983; Kuhnlein and Turner 1991). According to Suttles (1951a:62): "Informants have compared [the bulbs] with sugar because they were added to other foods for sweetening. As the only sweetening in the economy, they were no doubt greatly valued." A favourite dessert was made from whipped soopolallie (*Shepherdia canadensis*) and camas bulbs (Jenness 1934-35; Suttles 1951a). Murphey (1987:15) commented that the cooked camas had a "fragrance…like vanilla cake," and tasted "like brown or maple sugar." After prolonged boiling, a sweet hot beverage, "drunk much like coffee" (Hart 1976:17), or a type of molasses or syrup could be produced (Spinden 1964; Gorsline 1992a).

Prolonged cooking also caused a dramatic change in the appearance and texture of the camas bulbs. The crisp, whitish raw bulbs, after steaming, would usually retain the shape of a precooked camas bulb, but become soft and turn deep brown (Balls 1962; Turner and Bell 1971). The bulb could also become very dark to black with extended cooking (Sweet 1962; Hart 1976; Malouf 1979; Murphey 1987); the Okanagan-Colville English name for camas is "black camas" (Turner *et al.* 1980). Ernie Olsen stated that cooking the bulbs would convert the outer membranes of the bulb into "a hard, protective covering" (to Babcock 1967). Camas bulbs which have been pit-cooked for about four hours retain their original shape and outside appearance, and are soft, mildly sweet-tasting, and have the consistency of uncooked bread dough.

The raw bulbs have a relatively high moisture content (Turner and Kuhnlein 1983) and, therefore, do not store well for a long period of time. Christopher Paul speculated that raw bulbs would keep for a short time, but "probably no longer than until the first heavy rainy weather after the gathering, which would dampen the stored bulbs badly and cause them to lose their proper taste" (to Babcock 1967). Camas bulbs that were to be eventually stored or traded were dried after pit-cooking, a process that could take up to a week on the Interior Plateau (Hart 1976), and possibly longer on the coast, unless it was in the hottest part of the summer. Among Straits Salish groups, cattail bags were commonly used to store dried camas bulbs (Suttles 1951a), although bentwood cedar boxes, which would have deterred insect pests, could have also been used for storage (C. Bryce, pers. comm. 2002). Wooden apple boxes or other containers have been used in more recent history (Babcock 1967). Dried bulbs were reconstituted by soaking overnight in water (Turner and Kuhnlein 1983; Turner *et al.* 1983) or by boiling (Turner *et al.* 1980).

Camas bulbs were commonly eaten whole as a vegetable with other foods, such as salmon (Turner and Bell 1971; Turner and Kuhnlein 1983; JT in Turner *et al.* 1983), or mixed with other foods (Turner *et al.* 1980). Although the cooked bulbs were often dipped in an oil (e.g., dogfish, whale, seal) (Turner and Efrat 1982; Turner and Kuhnlein 1983), some Straits peoples preferred to eat them plain (CP to Babcock 1967; IJ in Turner *et al.* 1983). The bulbs were a frequent food at large feasts and potlatches and often three to five cooked bulbs, depending on the size, were considered a proper serving (Babcock 1967; Turner and Kuhnlein 1983; Turner *et al.* 1983; C. Bryce, pers. comm. 2002). Cooked camas was also added to cooking pits to flavour salmon and deer, and was ground into a flour for making bread (C. Bryce, pers. comm. 2002). Dried camas bulbs were important provisions while traveling (Boas 1890).

In other regions, the Ditidaht of western Vancouver Island stored their flattened and dried camas bulbs in cedar-bark baskets, layered with grass (Turner *et al.* 1983). The Okanagan-Colville made a "gravy" with cooked camas bulbs, which were dried and ground, or boiled them with dried bitter-root (*Lewisia*) (NF in Turner *et al.* 1980). The Nez Perce, Flathead, Chehalis, Quinault, Lummi, and probably many others stored their cooked camas bulbs as dried pressed cakes or loaves (Stern 1934; Olsen 1936; Spinden 1964; Gunther 1973; Hart 1976; Malouf 1979; Turner and Kuhnlein 1983). The Nisqually cached the dried bulbs in lined baskets placed in trees which could then be accessed while traveling (Gunther 1973).

The sharing of camas bulbs among different groups of Indigenous peoples is well-documented. All of Babcock's Saanich consultants (1967), for example, discussed the importance of "giving away" cooked camas bulbs, either at ceremonial dances and feasts or in an exchange of some kind, although none of them could recall the bulbs specifically being traded or sold. Camas bulbs were often given away by women (JS in Babcock 1967). Although the term "trade" was not used by Suttles' (1951a) consultants, Cheryl Bryce (pers. comm. 2002) emphasized that trade was an important part of their culture. Camas bulbs were even cited as a component of a ransom offering (Jenness 1934-35).

Specific references to "trading" of camas bulbs were more common for Indigenous groups who lived in areas outside the natural range of camas (Turner and Bell 1971; Gunther 1973; Turner *et al.* 1980; Turner and Efrat 1982; Turner *et al.* 1983; Turner *et al.* 1990; Turner and Loewen 1998), and some outside groups would travel great distances for the resource (Sweet 1962; Turner *et al.* 1980; Turner and Efrat 1982; Gritzner 1994; MG to W. Suttles, pers. comm. 2003). Camas was such a renowned food throughout western Washington that: "Except for choice varieties of dried salmon there was no article of food that was more widely traded than camas" (Gunther 1973:24). Johnny Sam's parents-in-law would take their camas to the west coast of Vancouver Island where they would receive blankets and baskets in exchange (in Babcock 1967). Elsie Claxton recollected that the Saanich would sell cooked camas bulbs to the Nuu-chan-nulth for "$5.00 or $10.00 a [50-pound potato] sack, a long time ago" (to Turner 1996, N. Turner, pers. comm. 2003).

2.3.2.5 Summary of Ethnographic and Ethnobotanical Evidence

The available ethnographic and ethnobotanical sources clearly revealed the high cultural importance of *Camassia*. Camas bulbs were a well recognized root food for many First Nations groups in the Pacific Northwest. Information gaps regarding camas use and management lead to speculation that much valuable data have been lost. Camas may have played an even more significant role in Straits Salish culture than has been previously recognized (Chapter 4).

The harvest of camas bulbs generally occurred in the spring and possibly early summer and consisted of a patterned series of activities which included digging and tilling the soil, selective removal of the bulbs, replanting and transplanting, and clearing and regular burning of the harvesting grounds. Some plots were owned and regulated; strict family-based tenure protocols and stewardship customs could have been in place for generations. Productive plots were likely delineated in some way. Camas harvest was a social event with the possibility of whole families, including some from different villages or perhaps nations, participating and sharing in the tasks and ceremony.

Once procured from the soil, camas bulbs were then processed into a edible product - a palatable and sweet food. The most detailed accounts from the literature describe the pit-cooking process. Besides camas bulbs, other traditional foods which endured longer after European colonization (e.g., clams, venison), as well as introduced foods, could have been cooked by this method. Pit-cooking was also a widespread cooking strategy in other parts of the Pacific Northwest (Turner 1995, 1997).

Although much of the available information appeared to describe camas use and management in a post-colonization cultural context (discussed in greater detail in the next section and in Chapter 4), the role of camas, as a resource, was firmly established in the social foundation of Straits Salish societies. There was explicit selection criteria for the harvesting of camas bulbs and methodologies for managing its productivity, oral history and ceremony regarding camas use and its place in cultural identity, and strategies for resource exchange and redistribution which maintained crucial networks among the Indigenous communities. Camas bulbs were not just a dietary component but figured prominently in the subsistence patterns and social structure of the culture. Regardless of the degree of use of *Camassia* in the diet over time, this root vegetable remains an important part of cultural identity today.

2.4 SYNTHESIS OF QUALITATIVE RESOURCES

Based on this qualitative review, the role of camas bulbs in Straits Salish cultures could be considered as significant as that of cedar or salmon. In comparison to these other key Indigenous resources of the Pacific Northwest Coast, however, camas remains notably underrepresented and consistently overlooked in much of the academic literature. Why has this discrepancy occurred and what can be revealed about the representation of camas in the historic and anthropogenic references?

Most descriptions of Indigenous peoples have been from the post-colonial era when they were struggling to live in less favourable environmental conditions than before. The lands had been appropriated by a dominant society; alterations to the terrestrial landscape (notably the oak-camas parklands) occurred rapidly, and thus affected the maintenance of traditional subsistence systems and land management practices. In this historical context, therefore, First Nations have been perceived as constantly struggling to maintain their traditional economic livelihood and cultural sustainability. As Indigenous societies transformed under shifting economic pressures and increased acculturation, anthropological reconstructions of traditional subsistence patterns were, more and more, based on cultural memory and the early experiences of Indigenous peoples in a time since the creation of reserves (Chapter 1). Ecologically sustainable Indigenous subsistence practices were believed to only exist "under conditions of low population density, abundant land, and limited involvement with a market economy (see Redford 1990:29). By definition, therefore, the social mechanisms and resource management systems of sustainable Indigenous economies have been difficult to interpret.

These unavoidable circumstances have affected the conception and perpetuation of the hunter-gatherer stereotype (Lee and Devore 1968), and influenced the tone, objectivity, and subjects of writers over the years. In the next sections, the shortcomings and challenges of using of qualitative references will be assessed, followed by an evaluation of the scale of historical corroboration between ethnohistoric and ethnographic references and assessment of the interpretive clues of cultural landscape change and the adaptive nature of Indigenous and environmental knowledge and economic choices.

2.4.1 Evaluation of the Use of Qualitative References

Qualitative resources are inherently biased by the personal or professional objectives and values of the authors (Kennedy 1995). Writers vary in their capacity for objectivity. For example, Grant's frustration with the Straits Salish "abominable custom of burning the woods" (Hendrickson 1975:11), and Brown's (1868:379) appreciation of the Indigenous womens' "aptitude" for digging camas bulbs shed light on the subjective nature of these historic references. There is also a noticeable gender bias present in both the ethnohistory and ethnography disciplines (e.g., Kramer 2000; Howard 2003). Most if not all the early writers were male explorers, colonists, and settlers. Their accounts, as well as the published works of principally male ethnographers, tend to be weighted toward male-dominated Indigenous activities, such as fishing, hunting, and technological activities (e.g. canoe making, house construction), rather than plant procurement and production (but see Anderson 1993; Peacock 1998; Deur and Turner in press, 2004b).

The use of plant resources by Indigenous peoples has also been misjudged or simplified in ethnographic research. Norton (1980) describes this narrow focus as a lack of basic botanical understanding, ignorance of Indigenous patterns of nomenclature and applications of environmental knowledge, and the underestimation of the role of women's work in First Nations' economies and land use patterns. The important role of plant foods in Indigenous culture has also been frequently overlooked because of the rapid acculturation during the early colonial period and the subsequent losses of managed harvesting sites, anthropogenic landscapes, environmental knowledge, and language (c.f. Norton 1980; Turner 2003).

Descriptions of the observations and experiences by early writers were also influenced by personal agendas and professional mandates. Many of the authors of the late 1700s and early 1800s, for example, were explorers and fur traders who had limited vested interest in long-term settlement, and as a consequence, freely commented on the landscape and people around them. Furthermore, these accounts were shaped by the author's level of knowledge and familiar points of reference. Many explorers commented on the resemblance of camas bulbs to the onion, presumably the cultivated varieties. Because camas is botanically and nutritionally related to the onion, these comparisons are reasonable.

Alternatively, the written accounts of the colonists in the 1830s and 1840s focused more on the conditions and extent of available arable land. Many authors also likened the landscape of southern Vancouver Island, and adjacent areas as well, to the culturally modified landscapes of Britain, yet generally disregarded the possibility that the New World versions were in any way influenced by human efforts. George Vancouver (1798, in Lutz 1995:11), for instance, "had no reason to imagine this country had ever been indebted for its decoration to the hand of man." In all likelihood, too, the purposeful dismissal of a human presence on the landscape made the land easier to occupy and elevated the value of the land to all newcomers. Landscape descriptions, especially the formal letters of correspondence sent back to Old World authorities, were no doubt embellished to promote the colonization of the new country and to secure on-going support (c.f. Nash 1973).

Moreover, early colonial descriptions of the landscape or of the role of Indigenous peoples within it should not be accepted as factual examples of pristine conditions. The boundary between unaltered and disturbed landscapes is not distinct (MacDougall *et al.* 2004). Detailed information about the efficacy of agricultural pursuits and colonizing potential, for instance, were not written until about 1850. By the time the writers were providing in-depth accounts of the physical environment, the Indigenous peoples, and the native landscape had already been greatly altered. In a letter dated 16 November 1850, James Douglas wrote:

> We are using every exertion to raise grain and other farm produce for the supply of this establishment and the posts dependent of it – but it will take some years and large means to accomplish that object. …Time and industry will accomplish much and I shall do everything in my power to make the most of the means at my disposal (Bowfield 1979:133).

Similarly, the depictions of Indigenous resource procurement in the mid-1800s do not represent pre-contact cultural circumstances, although the practices and ceremonies employed were based on traditional subsistence objectives and governing codes of behaviour and ritual. The romanticized accounts of eighteenth century camas harvesting, for example, reduced this economic imperative to a quaint activity which added to the charm of the surrounding landscape, and in fact, probably reinforced the perception of a natural, and not cultural, origin of the parklands. By 1864, there had already been nearly a century of European impacts and it is possible that camas harvesting at this time had become a more integrated Indigenous enterprise with participants from different Indigenous nations. Hazlitt's (1858:180) description of the harvest as a "great season of 'reunion' for the women of the various tribes" may be indicative of this cultural change. Brown (1868:379) expressed the harvest as " the time when, away from the filth of villages, Indian life appears in its most picturesque aspect." The "filth of villages" could have been a comment on the substandard living conditions in the Lekwungen village near the Fort. In light of the debauchery known to colonial living, it is easy to see how the camas camps must have appeared altogether wholesome and quaint.

2.4.2 Corroborative Clues regarding Changes in Indigenous Use of Camas

Continuity and corroboration among the qualitative references helped to establish the historic context for environmental and cultural change. When assessed together, the references strongly suggest that Straits Salish people exploited a range of habitats for camas harvesting and the selection and utilization of these sites changed over time. For instance, camas grounds with deep soils - characterized as meadow, plains, or parkland - may have been prevalent prior to European colonization. Many authors from the historic record used similar terms to describe the landscape, including "natural park," "succession of plains," and "English park scenery." The landscape was often depicted as "diversified," "fertile," and "luxuriant." These images are consistent with the Indigenous stated objectives of camas management (e.g., enhancement of ecological productivity and soil fertility). The widespread historic descriptions of the parkland setting also supported

Christopher Paul's account of the clearing "of stones, weeds, and brush, but not of trees" within the camas bed (in Babcock 1967). Saplings and tree seedlings were likely removed from each plot by clearing or weeding. Larger trees would remain unaffected by these horticultural practices, as well as by the low-intensity flash fires.

There are other historic descriptions that add credence to this conception of anthropogenic parkland landscape. The soils were consistently described as black in colour with a texture of a loam or vegetable mould (e.g., Grant 1849; Hazlitt 1858; MacFie 1865), the type of soils commonly associated with open cultivated land (Maas n.d.). Hazlitt (1858:215) described the height of the native legumes as "up to my horse's belly." James Douglas claimed that the clover was "knee-deep" and the ferns, most likely bracken (*Pteridium aquilinum*), grew to the height of his shoulder (in Bowsfield 1979:xviii-xix). Incidentally, native legumes, especially springbank clover (*Trifolium wormskjoldii*), and bracken fern were valued Straits Salish plants and would have been widespread within the open habitats of southern Vancouver Island (Kuhnlein *et al.* 1982; Kuhnlein and Turner 1991; Turner 1995). Furthermore, both clovers and bracken fern would have been familiar plants to British colonists; legumes have long been widely cultivated and associated with good soils and agricultural potential (c.f. Turner 1999b), because of their nitrogen-fixing capability, and bracken fern is a highly successful circumpolar species which has been the bane of British agriculturalists for many centuries (Page 1986).

Descriptions of landscape burning practices by Indigenous peoples were most often reported near settlements. This was undoubtedly due to the perceived threat of the fires to personal property and safety. However, there is also a possible correlation between the locations of the Indigenous management sites and the homestead sites chosen by the colonists. It appears that the oak-camas parklands on southern Vancouver Island were the targeted landscapes. In fact, four major posts of the Hudson's Bay Company – Vancouver, Nisqually, Victoria, and Cowlitz Farm – "were constructed on or near extensive camas plains" (Mackie 1997:290). Indigenous residents of this region, with their permanent settlements along the coastline, were not putting their habitations in jeopardy when burning inland resource sites. Furthermore, Grant's (1849) suggestion that First Peoples burned resource habitats to "clear away the thick fern and underwood," probably implied that these fires occurred in the deeper soils of oak-camas or Douglas-fir ecosystems. Harvesting grounds in shallow soils would have been less likely to be encroached upon by invading native plant species than those located in the deep-soiled meadows and parkland.

Camas grounds in more remote places, such as the less populated or uninhabited smaller islands, likely became the preferred harvesting locales after the camas grounds of southern Vancouver Island were converted to agriculture. Many clues in the ethnographic record supported the notion that Straits Salish peoples adapted to a more efficient and structured harvesting regime in the post-colonization landscape. For example, the preference for harvesting in shallow soils for the easier extraction of the bulbs and targeting sites with a certain population structure (i.e. clumped) implied that labour and time coasts may have been important criteria for camas harvesting (Chapter 4). For Indigenous families who were adapting to a very different social environment, traditional economic pursuits probably changed dramatically, then eventually died out altogether, making way for new traditions.

2.5 CHAPTER CONCLUSIONS

Camassia was clearly a highly significant resource for the livelihood of Straits Salish peoples on southern Vancouver Island, as well as in adjacent regions. The extended families of the Lekwungen, Saanich, and T'Sou-ke maintained accessible and tended harvesting sites in many locations, and these sites likely included, or were principally, deep-soiled meadows or parklands. The activities associated with camas food production were part of a complex, coordinated system which enabled people to maintain access to and sufficient yields of their valued resources in a spatially and temporally variable landscape. Camas bulbs were used as both a principal carbohydrate, filling an essential dietary niche, and as a tasty and nutritional culinary ingredient for sweetening other foods or for producing desserts. As well, camas was a staple for winter consumption, trade and offerings, feasts and potlatches, and traveling rations.

As time passed, shallow-soil and more remote habitats became the only sites available for camas harvesting. Straits Salish peoples maintained the environmental knowledge necessary to adapt their economic decisions and traditional food needs to fit within a rapidly changing world (see Deur 2000; Turner *et al.* 2000; Deur and Turner in press, 2004b). Even though the use of camas bulbs diminished greatly within the first decades after European colonization of southern Vancouver Island, and eventually passed from regular use altogether, *Camassia* is still generally regarded as an important symbol of cultural identity.

3.0 EXPERIMENTAL ANALYSIS OF *CAMASSIA* ECOLOGY AND MANAGEMENT: QUANTITATIVE RESEARCH

Never trust a plant [to do what you think it should do].

Dr. Marda West,
Botany Professor,
California State University, Sacramento.

3.1 LITERATURE REVIEW

Formerly, the parkland *Camassia* ecosystems of western Canada occurred in a more contiguous landscape across southern Vancouver Island, the Gulf Islands, and many smaller islands (Figure 3.1), as well as in other localities of southern British Columbia and adjacent Alberta. Since the time of the earliest written accounts the parkland mosaic was a predominant landscape cited throughout this region. Seemingly, there was an interdependent relationship between Indigenous use of resource plants and the distribution and structure of these parklands. Management practices, especially landscape-scale burning, employed by First Peoples in a variety of habitats could have been crucial in maintaining the ecological gaps and open parkland where camas appears to thrive (Deur 2000).

With the advent of the colonial era, agricultural expansion, followed by urban and exurban development, has significantly reduced and restricted camas habitats and populations largely to shallow-soiled coastal bluffs, rocky outcrops, and hilltops (Figure 3.2A). The extensive deep soils of the camas meadows in Beacon Hill Park in Victoria are one notable exception in the region (Figure 3.2B). The contemporary fragmented distribution, compiled with limited information about the ecology of oak-camas parklands and about the environmental and social changes in this region (see MacDougall *et al.* 2004; Appendix 5), has greatly constrained our perceptions and understanding of camas communities. Moreover, there has been relatively little scientific research on the growth, development, and ecology of the region's two principal camas species, *Camassia leichtlinii* and *C. quamash*.

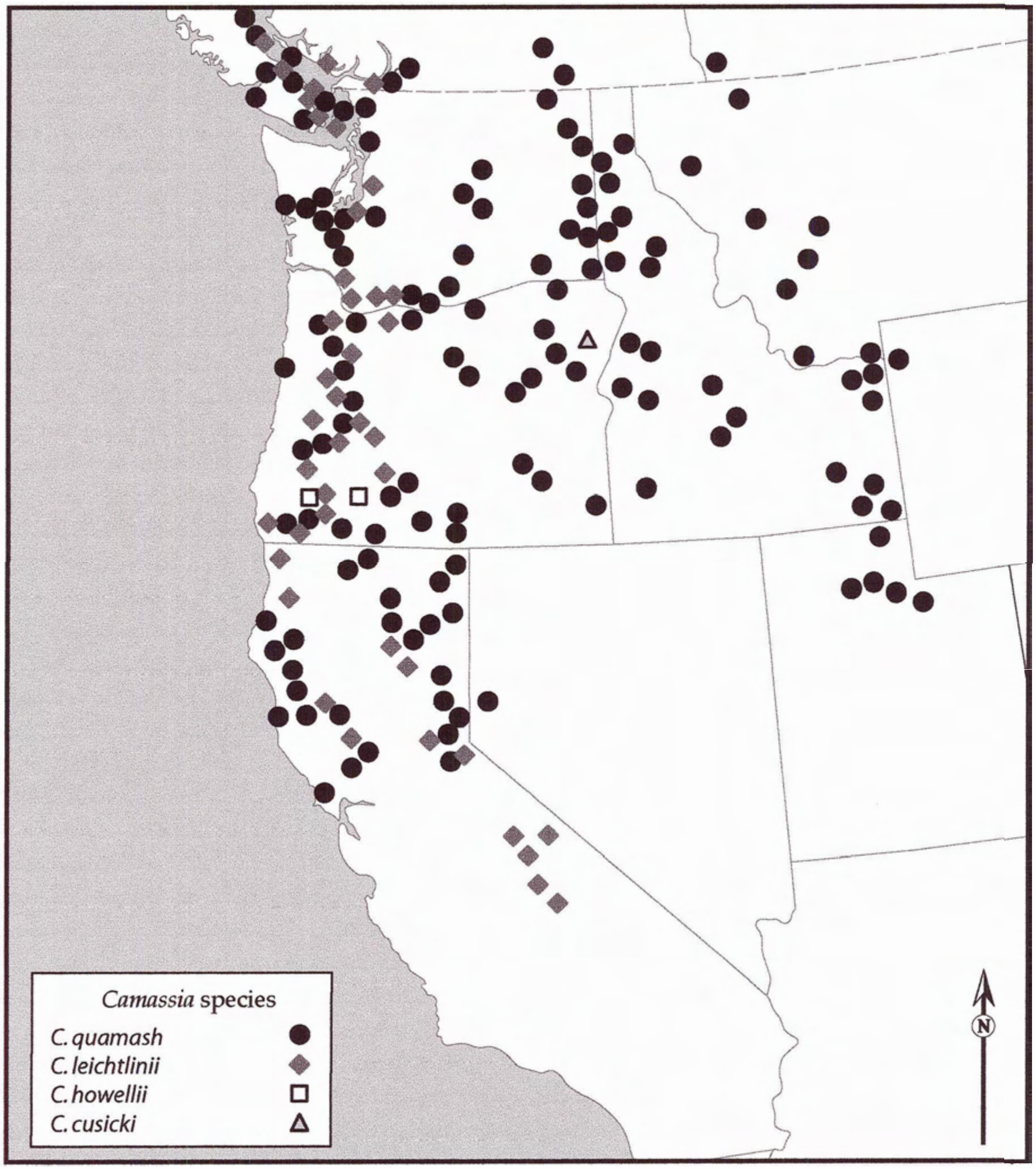

Figure 3.1 Distribution of *Camassia* species in western North America (adapted from Gould 1942). Map does not include outlying occurrences to the north, see text for specific information on the camas locations in British Columbia and Alberta.

Even though *Camassia* is a distinguishing component of today's Garry oak ecosystems, camas is not restricted to ecosystems on Vancouver Island with Garry oaks (*Quercus garryana*), and can also be found throughout the moister communities of the Coastal Douglas-fir Biogeoclimatic zone (R. Hebda, pers. comm. 1998), including estuarine meadows and bogs (Figure 3.2C). Judging from widely dispersed remnant populations, camas evidently had a much continuous natural distribution over the entire region prior to European contact. According to Charles Pemberton, son of J. D. Pemberton, Engineer and Surveyor of the Hudson's Bay Company (Bowfield 1979), the largest contiguous oak habitat (~3,000 ha) was formerly on the southern part of the Saanich Peninsula, where the oaks were once "very plentiful," and "an outstanding feature of the landscape" (circa late 1800s, in Erickson 1996:19).

Today, *Camassia* is a widespread wildflower on southern Vancouver Island and the role of the bulbs in the diets of Indigenous peoples of the past is occasionally described in general publications (e.g., Eltringam 1979; Hebda 1988.). Even though some contemporary Straits Salish peoples (e.g., Songhees) are now developing restoration projects which include the use and management of camas, the limited distribution and remote locations of harvesting sites have restricted access to camas bulbs. Hence, camas use and management are, at present, mostly ceremonial and educational in practice.

To begin addressing gaps in the ecological knowledge of *Camassia*, this chapter includes a thorough review of the research on camas, including compiled information from the fields of biosystematics and taxonomy, horticulture and ecology. Two experiments on camas are also presented in this chapter. A nursery study was conducted to describe the growth and development of *C. leichtlinii* in a specific setting. This research was largely exploratory in nature and provides new information on the growth patterns of camas, such as dormancy and flowering rates, bulb development, and vegetative reproduction. A field study was also conducted to document scientifically the effects of simulated Indigenous management practices on *Camassia* (both species) populations in "wild" settings (i.e. local parks). The systematic harvesting of camas

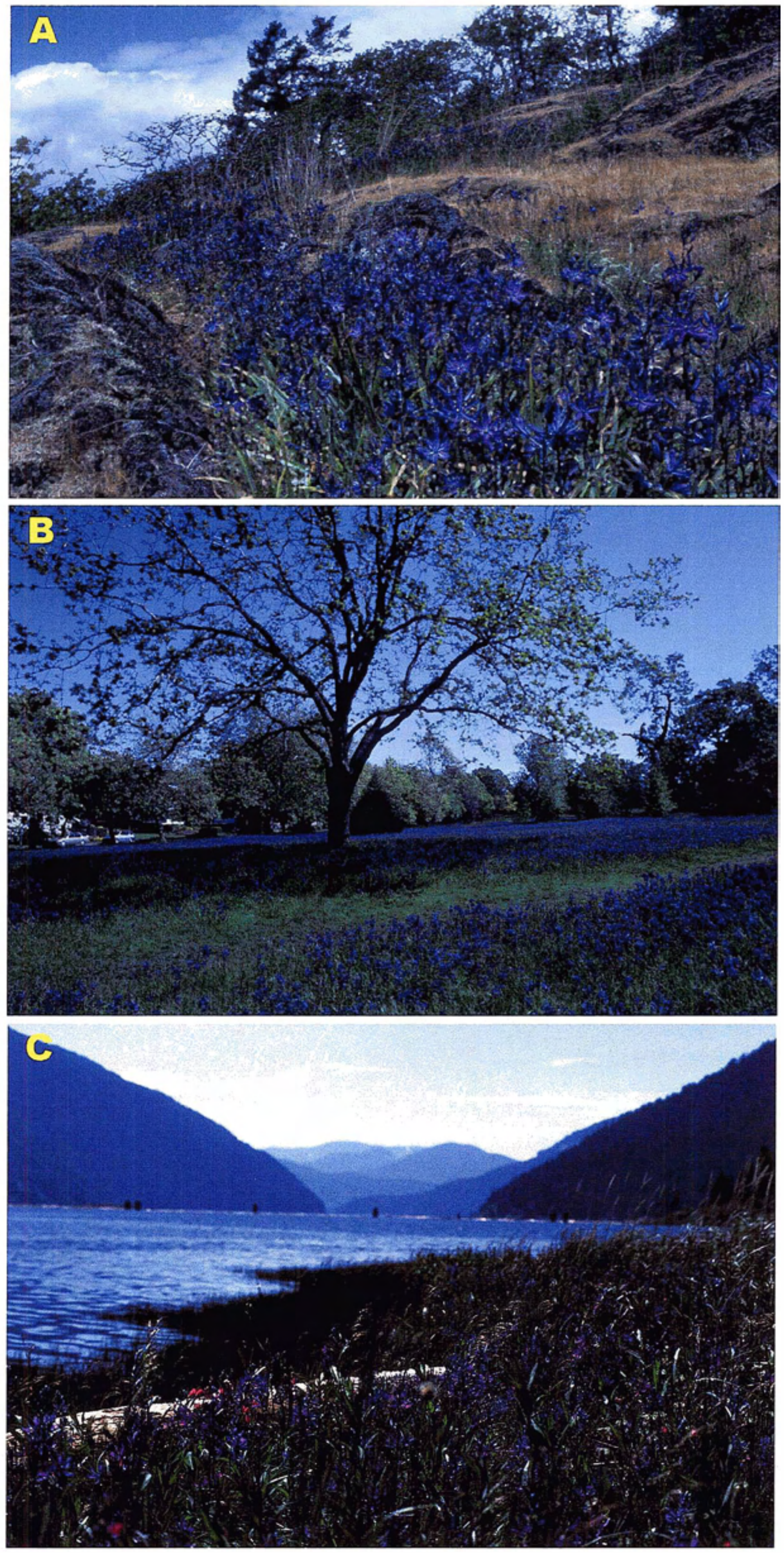

Figure 3.2 Three examples of *Camassia quamash* habitats: (A) shallow-soil rock outcrop at Government House; (B) deep-soil meadow in Beacon Hill Park (both A and B in Victoria); and (C) estuarine meadow on Johnstone Island in the Alberni Inlet.

bulbs and prescribed burning were treatments employed in this applied research.

Both the nursery and field studies advance the current understanding of *Camassia* ecology and ethnoecology. How can applied ecological experimentation contribute to the general knowledge of past Indigenous management? For example, Indigenous consultants described the selection of bulbs based on the characteristics of specific above-ground plant attributes (e.g., plants that were flowering or large, populations that were dense or clustered). It has been reported in the ethnographic literature that management activities, such as digging and burning, enhance camas productivity. The experiments described in this chapter represent a first step in the development of an ethnoecological framework for Straits Salish management of camas on southern Vancouver Island (Chapter 4). Moreover, these data can also be applied to the development of more detailed ecological studies and more informed management recommendations for today's degraded camas habitats (Chapter 5).

3.1.1. Taxonomy and Nomenclatural Review

There are four western *Camassia* species: *C. cusickii* S. Watson (Cusick camas), *C. howellii* S. Watson (Howell camas), *C. leichtlinii* (Baker) S. Watson (Leichtlin or great camas) and *C. quamash* (Pursh) Greene (common camas) (Gould 1941, 1942; Ranker and Hogan 2002) (Figure 3.3). The two eastern species of *Camassia* include *C. scillioides* (Rafinesque) Cory (eastern camas, wild hyacinth) and *C. angusta* (Engelmann & A. Grey) Blankinship (prairie camas). *Camassia scilloides* ranges from Pennsylvania to Texas, whereas the distribution of *C. angusta* is restricted within the western part of the same range (Ranker and Schnabel 1986; Ranker and Hogan 2002; USDA 2002). A small population of *C. scilloides* has also been found in Ontario, Canada, near the US border (Gould 1942; Scoggan 1978; Ranker and Hogan 2002). *Camassia* was thought to be an exclusively North American genus, chiefly restricted to the Pacific Northwest (Evinger 1928; Gould 1941, 1942). In 1969, *C. biflora* (Ruiz & Pavon) Cocucci was described from South America (Cocucci 1969, in Ranker and Schnabel 1986).

Ranker and Hogan (2002) recognize two subspecies of *C. leichtlinii* and eight of *C. quamash*. The subspecies of *C. leichtlinii* are distinguished by perianth colour. *C. leichtlinii* subsp. *leichtlinii* has creamy white flowers and is endemic to the Umpqua Valley, Oregon. Covering the remaining range of the species, *C. leichtlinii* subsp. *suksdorfii* (Greenman) Gould has flowers that are blue to bluish violet, and occasionally white. These two subspecies are said to be interfertile, and a complete range of perianth colour can exist where their ranges overlap (Gould 1942).

Ranker and Hogan (2002) retain the taxonomic sub-classification of *Camassia quamash* from Gould (1942) to emphasize the high morphological and geographical variability of the species (Figure 3.3). The eight subspecies of *C. quamash* in western North America are *C. quamash* subsp. *quamash*, *C. quamash* subsp. *azurea* (A. Heller) Gould, *C. quamash* subsp. *maxima* Gould, *C. quamash* subsp. *walpolei* (Piper) Gould, *C. quamash* subsp. *intermedia* Gould, *C. quamash* subsp. *linearis* Gould, *C. quamash* subsp. *breviflora* Gould, and *C. quamash* subsp. *utahensis* Gould.

Camassia has a long-standing cultural nomenclature. The common name "camas," for example, has been a widely recorded word for place names and geographic features (Malouf 1979; Statham 1982). Toponyms in the US come from Washington (*Camas, Camas Creek, Camas Prairie, Camas Valley*), Oregon (*Camas, Camas Creek, Camas Mountain, Camas Prairie, Camas Valley*), Idaho (*Camas, Camas Creek, Camas Prairie*), Montana (*Camas, Camas Creek, Camas Prairie*), and Utah (*Kamas*), just to name a few (Gritzner 1994:35-36). Many of these names were in common usage well before the mid-nineteenth century (Thoms 1989).

Captains Meriwether Lewis and William Clark are credited with the type specimen for the genus (*C. quamash*, originally described as *Phalangium Quamash* by Frederick Pursh in 1814 [Gould 1942; Jewell 1978]). They collected it at Weippe Prairie, Idaho, on their return trip from the Pacific Coast in 1806. *Camassia* was first presented to the famished members of the Lewis and Clark expedition by the Nez Perce the previous fall.

John Lindley first applied *Camassia* as the genus name in 1832. *C. scilloides* became the name for the eastern species, and *C. quamash* was retained for the western

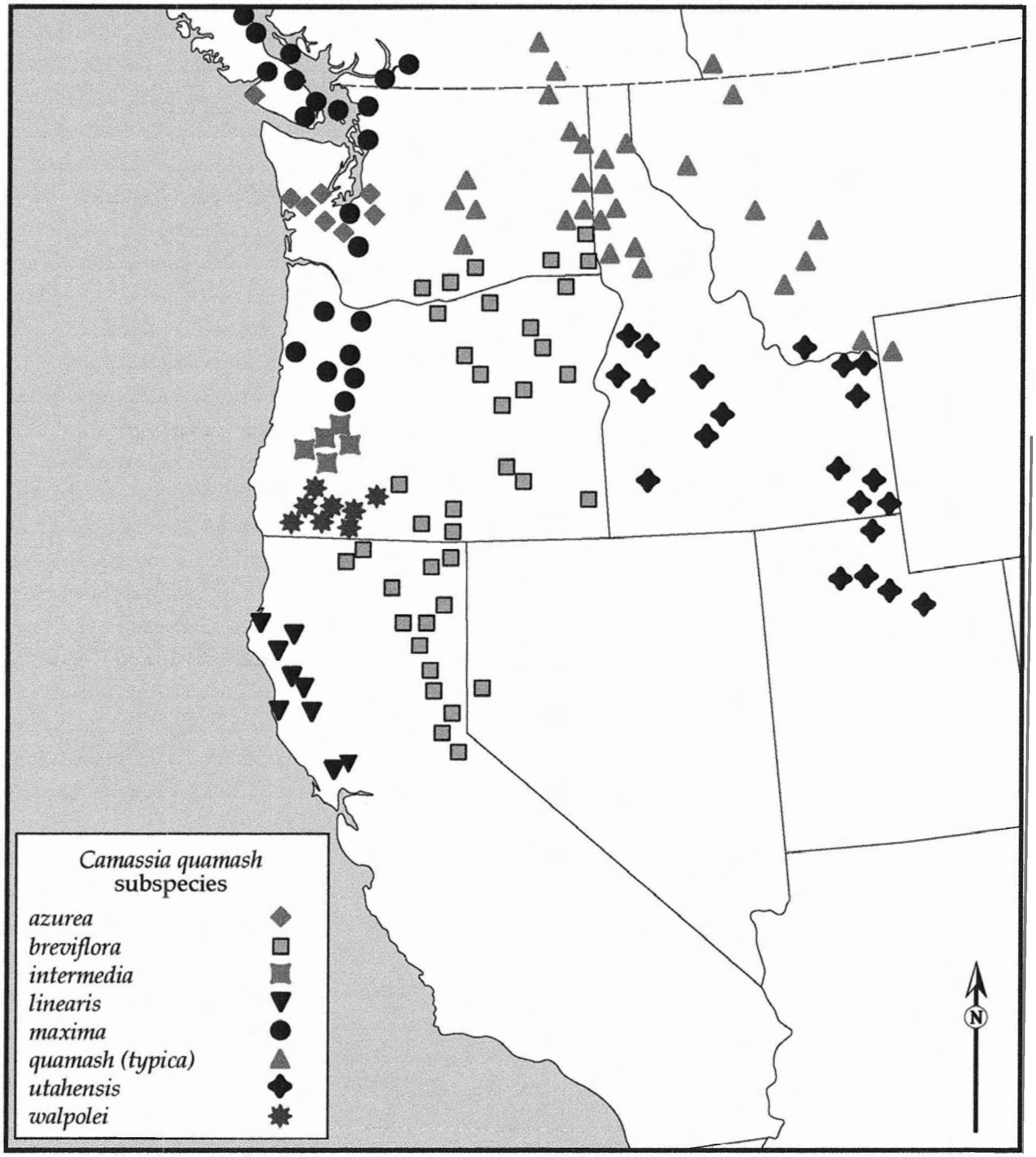

Figure 3.3 Distribution of *Camassia quamash* subspecies in western North America (adapted from Gould 1942). Map does not include outlying occurrences to the north, see text for specific information on the camas locations in British Columbia and Alberta.

one. *C. leichtlinii* was first described from white-flowered specimens collected by John Jeffery in 1853 in the Umpqua Valley, Oregon (Evinger 1928; Gould 1942). It has been widely believed that *Camassia* is closely associated with the North American genera *Chlorogalum* and *Schoenolirion* (Gould 1942; Pfosser and Speta 1999). However, recent molecular evidence suggests that *Camassia* is more closely related to the Agavaceae (Ranker and Hogan 2002).

Camassia is an old genus in western North America, and some authors suggest it dates to the early Cretaceous (Thoms 1989; Pfosser and Speta 1999). The centre of dispersal, and apparently the centre of diversity, for *Camassia* is likely southwestern Oregon, where the largest pool of species and subspecies occurs. *C. leichtlinii* represents an early genotype which then increased its range and evidently gave rise to *C. quamash* at some point north of the Columbia River (Gould 1942). *C. quamash* increased its range, and number of subspecies, significantly. *C. cusickii* is thought to have been derived from *C. quamash*, and *C. howellii*, which is another early genotype, remained endemic to southwestern Oregon (Gould 1942; Jewell 1978). Lastly, *C. scilloides*, the principal eastern species, probably represents the final major leg of camas's easterly migration (Gould 1942). Based on geographical and molecular data, Ranker and Schnabel (1986) suggest that *C. angusta* may be a more recent derivation of *C. scilloides*. About *Camassia*, Grey (1938:150) wrote: "I do not know any small genus in which nomenclature is so confused…" and this certainly appears to be the case for this genus.

Camassia is found in 31 states in the continental US (USDA 2002) and three Canadian provinces (Gould 1942). *C. scilloides* represents the widest ranging species, occurring in 23 states and one province (Gould 1942; Scoggan 1978). The four western species of the genus are restricted to the eight states of the Pacific Northwest. Two species -- *C. quamash*, and to a lesser degree *C. leichtlinii* -- achieve a greater range into British Columbia and Alberta, Canada (Gould 1942; Thoms 1989; USDA 2002).

Botanists, in addition to anthropologists, have studied the edibility of *Camassia* species in Indigenous diets. The bulbs of *C. quamash*, *C. leichtlinii*, and *C. howellii* are widely recognized as an Indigenous food. *C. cusickii* was initially believed by early botanists to be unpalatable or inedible because the outer scales decompose and allegedly become ill-smelling. Jewell (1978), however, found the bulbs of *C. cusickii* to be as tasty, after the removal of these scales, as *C. quamash*. He also commented that this large camas species was apparently not only harvested, but favoured, by the local Indigenous peoples (Jewell 1978). Although Fernald and Kinsey (1943) found no evidence of the edibility of the eastern *C. scilloides*, this species was apparently "much eaten" according to Medsger (1939, in Kuhnlein and Turner 1991:87).

3.1.2 *Camassia* Characteristics from British Columbia

Camassia quamash and *C. leichtlinii* are the two principal Canadian camas species (Figure 3.1). The specific ranges of these two species in western Canada are described from herbaria specimens from UVIC (University of Victoria), UBC (University of British Columbia), V (Royal British Columbia Museum), and DAO (Agriculture and Agri-Food Canada).

The three subspecies of *Camassia quamash* currently recognized in BC include ssp. *maxima* and ssp. *quamash*, after Hitchcock and Cronquist (1976), and also *C. quamash* ssp. *azurea*, a western Vancouver Island camas (Hebda 1992; Douglas *et al.* 2001). The latter subspecies occurs in peatlands, and is undoubtedly the west coast subspecies found growing in sedge bog habitat at Bamfield (K. Golinski, pers. comm. 2003), and possibly the subspecies found on the Brooks Peninsula. The camas subspecies on the Brooks Peninsula is thought to be a remnant population held over from the warm and dry Xerothermic period of the early to mid-Holocene (Ogilvie 1997). *C. quamash* ssp. *maxima* is found in southwestern British Columbia, whereas *C. quamash* ssp. *quamash* is generally restricted to east of the Cascade Mountains (Hitchcock and Cronquist 1976).

Camassia quamash ssp. *maxima* is known from Mitlenatch Island and Campbell River to Victoria, and has been found growing on the Gulf Islands, including Denman and Hornby islands, as well as Lasqueti Island. *C. quamash,* likely of the subspecies *maxima* (Gould 1942), is found in estuary meadows on Vancouver Island including Macktush Creek estuary on the Alberni Inlet, Somass Delta in Port Alberni (pers. obs.), and the Courtenay River estuary in Comox (pers. obs.). *C. quamash* is also known from wet sites in other coastal regions of Washington and Oregon (Deur 2000). *C. quamash* ssp. *maxima* has been recorded from the BC mainland at Chilliwack (Gould 1942).

It should be emphasized that the occurrence of coastal *Camassia* populations in seasonally wet habitats, including estuaries and bogs, is more similar to the reported ecological conditions of the genus in other regions of the Pacific Northwest (Gould 1942). In Washington, Idaho, and Montana, for instance, camas habitats are most widely described as wet meadow or wet prairie. Camas distribution and growth are reported to be correlated with habitats with abundant moisture (Jewell 1978; Statham 1982; Turner and Peacock in press). The unique westcoast Vancouver Island populations could represent a more hygric end of the habitat gradient for *Camassia*, and, in some cases, may possibly be the remnant populations of past Indigenous transplanting or tended resource sites (Deur 2000). For example, the *C. quamash* population located on Jonestone Island near Port Alberni (Figure 3.2C) was seen growing with *Conioselinum gmelinii*, *Fritillaria camschatcensis*, *Potentilla anserina*, and *Trifolium wormskjoldii*, four additional significant Indigenous root vegetables (B. Beckwith, N. Turner, and D. Deur pers. obs. 1999). This species, and perhaps subspecies, is also common in surrounding dry sites of the Port Alberni valley, similar to conditions more commonly seen on southern Vancouver Island (Figure 3.2A, B). No research has been done to date on a possible correlation between past Indigenous manipulation and transplantation of camas bulbs and the current taxonomic divisions and geographical distributions of the *Camassia* subspecies.

In the BC Interior, *C. quamash* ssp. *quamash* is known at Lower Arrow Lake and in the Trail and Robson regions near the southern edge of the province. This subspecies is also found in the general vicinity of Pincher Creek, Alberta (Gould 1942). Some interesting outlying specimens come from Sorrento on Shuswap Lake and Haines, Alaska. These populations may have been planted and should be verified (Taylor 1974). The herbarium at the Royal British Columbia Museum has several *C. quamash* specimens with a variety designation of *quamash* from Vancouver Island, but these too should be investigated, as this subspecies is not generally recognized west of the Cascade Mountains (Hitchcock and Cronquist 1976; Douglas *et al.* 2001).

C. leichtlinii ssp. *suksdorfii* is primarily restricted to southeastern Vancouver Island, from Nanoose Hill to Victoria, and the southern Gulf Islands. Outlying populations on Vancouver Island have been recorded from two localities west of Duncan. Isolated occurrences of this species have also been found on or near the BC mainland on the Sechelt Peninsula (Douglas *et al.* 2001), on Bowen Island, and in Chilliwack (Gould 1942). Despite its apparent limited distribution today, Burbank (1914) reported an abundance of *C. leichtlinii* on Vancouver Island in 1914.

Although *C. quamash* ssp. *maxima* and *Camassia leichtlinii* ssp. *suksdorfii* are recognized as the camas taxa of the study region, for simplicity, each will be referred to by their respective species determinations only (i.e., *C. leichtlinii* and *C. quamash*).

The key taxonomic characteristics that set *C. leichtlinii* and *C. quamash* apart in this region are flower morphology and development (Table 3.1). Generally, both species have leaves that are basal, grasslike with a thick midvein, and shiny green in colour; a terminal raceme composed of showy flowers which are usually blue to violet; and bulbs with brown or black tunics which most often appear solitary (Gould 1942; Jewell 1978). *C. leichtlinii* generally has radially symmetric flowers with tepals that twist together over the developing fruit as the flowers fade (see Figure 3.4). *C. quamash* typically has weakly bilaterally symmetric flowers with five upward curving tepals and one downward pointed one. These tepals wither separately after pollination and spread away from the ovary rather than enclosing it (Figure 3.4). The fruiting pedicels tend to be longer than the bracts in *C. leichtlinii,* but shorter than the bracts in *C. quamash* (Douglas *et al.* 2001).

The size of the bulbs varies depending on growing conditions and location. Mature bulbs in natural settings are generally smaller than those growing in gardens: *C. quamash* has been recorded from 1.1 to 4.0 cm in diameter in Idaho, and 1.4 to 3.0 cm diameter on Vancouver Island (Beckwith, unpubl. field notes; Hebda 1992). The recorded diameter of *C. leichtlinii* bulbs taken from wild populations on Vancouver Island ranges from 1.5 to 3.9 cm (Beckwith unpubl. field notes; Hebda 1992).

Table 3.1 Characteristics of *Camassia* species in the general Victoria region. Adapted from Douglas *et al.* (2001:282); Hitchcock and Cronquist (1976:688-89); Hebda (1992:56-62).

Characteristic	***C. leichtlinii***	***C. quamash***
Bulbs	About 3 cm in diameter, but can become large, usually solitary, more ovoid, with black tunic	About 2 cm in diameter, usually solitary, with black tunic
Mature bulb depth	About 20 cm	About 10-12 cm
Leaves	3-7; 40-60 cm length/ generally wider than *quamash*	3-5; 15-50 cm length/0.5-3 cm width
Flowering stem height	20-100 cm	10-70 cm
Flowers (perianth)	Variable from 4-80, regular; tepals twisting together at maturity; pedicels 1.0-4.0 cm long	Variable from 2-30; slightly irregular; tepals withering separately; pedicels 1.0-2.0 cm long
Blooming time	Late April through late May	Early April through mid-May
Seed set and dispersal	July through summer	May through summer
Habitat	Open, moister sites, generally with deeper soils (meadows, forest clearings), also coastal bluffs and rocky knolls	Open dry sites, usually with shallow soils (rocky knolls/bedrock hollows), also deeper soils (sloping or south-facing meadows)

A wide variation of colour exists within the genus and sometimes a paler blue- or white-flowered individual or cluster of individuals of either species can be seen growing on southern Vancouver Island. The herbarium at the Royal British Columbia Museum has several specimens of white-flowered *C. quamash* with a "form *albiflora*" designation; however, this description was not used after 1933 at this herbarium and has not been seen elsewhere. White-flowered individuals of both species are the result of a genetic mutation and can be seen frequently over their respective ranges (Griffiths and Ganders 1982).

3.1.3 Ecology of *Camassia*

Geophytes, or plants with underground perennial structures (Chapter 1), are a class of Indigenous resource plants associated with a significant degree of tending and stewardship (Thoms 1989; Anderson 1993, 1997, 1999). Much of what is known about camas ecology comes from the fields of horticulture, geography, and anthropology (e.g., Thoms 1989). Ecological research involving camas is limited. Published records of local camas biology and ecology are primarily confined to informal surveys and observations (e.g., Eltringham 1979; Turner and Kuhnlein 1983; Hebda 1988). *Camassia* has been described in more detail in the local academic works of Roemer (1972) and Erickson (1996). The most detailed account of local camas populations to date is Hebda's (1992) treatise on *Camassia.*

3.1.3.1 Camas Growth and Development in Controlled Settings

Camassia, a bulbous perennial species, has been cultivated as a garden plant for over 170 years (Leffingwell 1930). According to Ranker and Hogan (2002:303), the genus "...represents a major horticultural contribution from the native flora." Horticultural cultivars of camas are primarily differentiated by morphological characteristics associated with flowering, including flower number, colour, width, and the height of the flower scape (Doerflinger 1973; Genders 1973; Williamson 1987; USDA 2000).

Camas has a long maturation period, taking four or more years for seeds to become mature, flowering individuals with large bulbs (Genders 1973; Thoms 1989). Like other geophytes, camas apparently needs to reach a critical size (Thoms 1989; Harper 1977), and a specific soil depth (c.f. Pütz 1993), before flowering. Hence, maturity is correlated with soil depth (Thoms 1989; Hebda 1992), with the exception of plants growing in shallow soils over bedrock. Juvenile camas bulbs exhibit substantial morphological changes before reaching maturity; the variety of shapes, including an elongated "pencil-like" form, likely facilitates downward repositioning of the bulb as it increases in age (Figure 3.5).

Most of the known information on camas bulb development comes from Anne Maclay's (1928) work on *Camassia quamash* [and her subsequent work published under her married name, Leffingwell (1930)], and from the interdisciplinary research of Alston Thoms (1989). In general, the bulb develops new scales each year from a terminal bud (Leffingwell 1930). The bulb is composed of two developmental sections at any one time: the mature bulb (mother) and the developing bulb (daughter). For instance, the bulb in the early spring is covered with the older, compressed scales of the mother bulb which envelope the developing scales of the daughter bulb (Maclay 1928).

Annual growth begins with the development of new leaves from the terminal bud (Maclay 1928; Thoms 1989). As the growing season progresses, the daughter bulb utilizes the carbohydrates stored in the mother bulb and increases in size. Consequently, the mother bulb decreases in size and begins to shrivel. Maximum bulb size of a new mother bulb will be attained just before the seed pods are fully developed. The terminal bud continues to grow, and subsequently, the development of an immature daughter bulb commences in the weeks after seed set (Thoms 1989). This new bulb will become the next year's mother bulb, and, if flowering, will begin the production of an immature flower stem in the fall prior to the next growing season (Leffingwell 1930).

There was little information on the mode of bulb division in *Camassia* (e.g. Genders 1973). Asexual reproduction may arise from lateral bud development, similar to that reported for *Allium tricoccum* (Nault and Gagnon 1993). *C. quamash* readily reproduces asexually in garden settings (USDA 2000). It may be possible to force vegetative division by cutting or injuring the regenerative basal plate of the bulb (Rix 1983; Hebda 1992). Only mature bulbs reproduce by bulb division (Genders 1973), and bulbs, bulblets (immature bulbs), and offsets can all be successfully transplanted (USDA 2000).

Although camas grows well from seed, camas seeds will not germinate immediately after maturing (Leffingwell 1930). For maximum germination (90-100%), *Camassia quamash* seeds need 42-100 days of cold temperatures (about 1-5°C) under

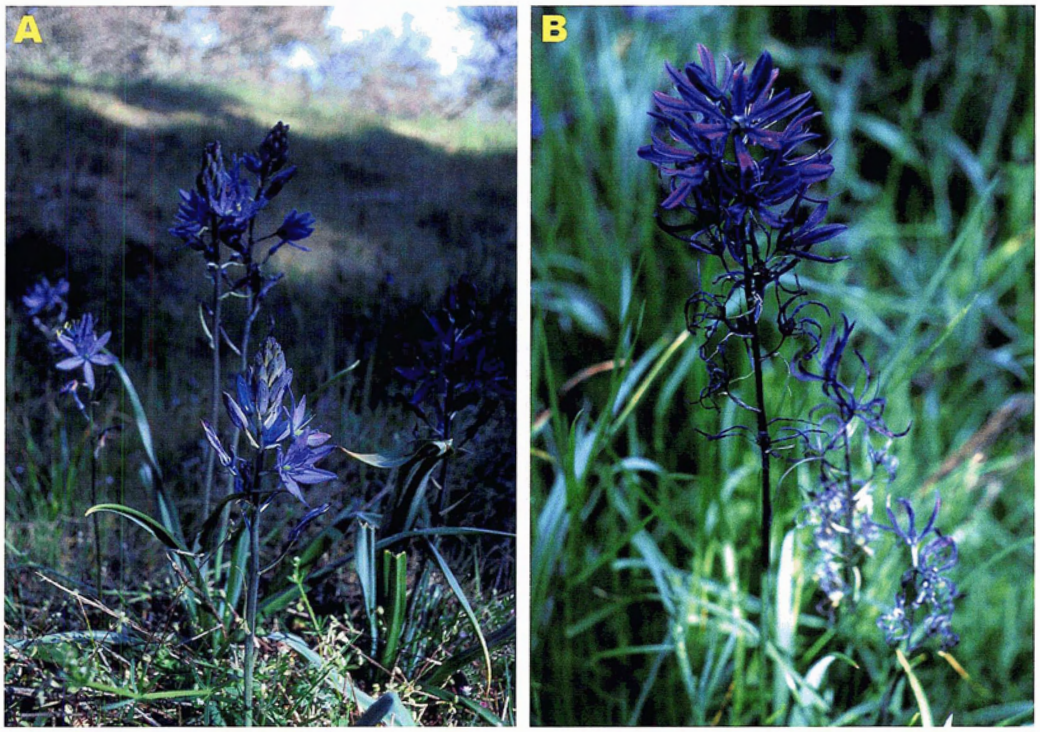

Figure 3.4 The two *Camassia* species on southern Vancouver Island. Note the different patterns of post-pollination flower development between the two species: tepals on *C. leichtlinii* (A) twist around ovary, whereas those of *C. quamash* (B) wither separately.

Size Class	Very Small	Small	Pencil-like	Medium	Large	Very Large
Width (cm)	<0.5	0.5-1.0	0.5-1.0	1.0-1.5	1.5-2.0	2.0-3.5
Length (cm)	<1.0	1.0-2.0	1.0-5.0	1.0-5.0	4.0-6.0	5.0-6.0

Figure 3.5 Approximate size distribution of *Camassia leichtlinii* bulbs. Photograph of bulbs taken as part of field study at Devonian Regional Park on 1 July 1999.

moist stratification. Seeds also do well the following spring if planted out in the fall and will emerge, in regions with relatively mild winters, in February or March. Seedlings and bulbs need adequate moisture through their growing season to survive (USDA 2000).

For the promotion of *Camassia quamash* growth and regeneration, the USDA (2000) recommends minor soil disturbance in areas adjacent to established plants and maintenance of soil nutrient levels (i.e. fertilizer). Late summer broadscale burning to promote the overall vigour of the population and reduce interspecific competition is also suggested. Soil compaction, caused by mowing and grazing, for example, should be avoided if possible at all times for optimal bulb development. Planting and management recommendations are similar for *C. leichtlinii* (USDA 1999).

All species have been found to have a diploid chromosome complement of 15 pairs (Gould 1942; Ranker and Hogan 2002).

3.1.3.2 Camas Growth and Development in Natural Settings

Although *Camassia* can grow in many different habitats, the species have specific ecological requirements for optimum growth. An "annual dry period," characterized by wet conditions through the growing season followed by summer aridity (Grey 1938; Genders 1973; Statham 1982:44), is an important requirement for *Camassia* development. Both substantial soil moisture and unrestrained drainage are necessary for optimal camas growth (Statham 1982; Plew 1992). Very dry habitats will not support *Camassia quamash* (Statham 1975, 1982). Extreme heat can result in decreased *C. quamash* productivity (e.g., reduced bulb yields) as a consequence of early senescence (Thoms 1989), and can restrict seedling establishment of this species (USDA 2000), as well as of *Erythronium grandiflorum* (Loewen *et al.* 2001). Alternatively, excessive soil moisture for too long into the summer dry period can delay flowering and restrict seed dispersal of *C. quamash* (Statham 1975, 1982), as well as potentially cause *Camassia* bulbs to rot (Genders 1973; Hebda 1992). Variability of soil moisture on a microhabitat scale can affect *C. quamash* density (Thoms 1989). Overall, camas is a very hardy species (i.e. can tolerate cold temperatures) (Burbank 1914; Grey 1938; Genders 1973; Hebda 1992).

Camassia development is strongly regulated by soil type and soil conditions. Soils of camas (*C. quamash*) prairies or meadows in the US interior vary depending on location, but are generally basaltic in origin; they are wet and soft in the winter, and hard and dry in the summer (Leffingwell 1930). Camas soils in southern Idaho are in the range of mollisols, and have a pH range of acidic to slightly alkaline (Statham 1982; Plew 1992). Mollisols are commonly associated with prairie vegetation (Statham 1982), and are "characterized as sandy/silt with notable levels of clay" (Plew 1992:219). Camas (both species) soils on southern Vancouver Island are of the Brunisolic Order with parent materials of glacial or marine origin (Roemer 1972; Jungen and Lewis 1978). Soil pH of camas habitats on Vancouver Island is acidic (rocky outcrop) to slightly acidic ("meadowlands") (Douglas *et al.* 2001). Although it remains uncertain whether soil conditions contribute to the morphological variations that differentiate the *Camassia* species (Jewell 1978), Statham (1975, 1982) suggests that significant correlations between soil pH and the attributes of flower colour and bulb size exist (Chapter 4).

Camassia is often characterized as a spring ephemeral genus (Tompsett 1985:41). Early spring growth of plants is common in regions with a short growing season (Dafni *et al.* 1981; Nault and Gagnon 1993). Maturity (i.e., flowering) in *C. quamash* can take longer in natural settings than in artificial locations (Thoms 1989), although maturation and flowering potential could be enhanced with disturbances which aid in the accessibility of soil moisture, nutrients, and light (see Tompsett 1985; Thoms 1989; Hebda 1992; Huffman and Werner 2000). Asexual reproduction, although uncommonly observed in wild camas populations (pers. ob.; Thoms 1989), may be a reserved survival strategy to be used when favourable conditions for growth are present (Tompsett 1985), or when the bulbs are damaged.

Camas bulbs can remain dormant through the growing season, or can abort growth if conditions are suboptimal (see Tompsett 1985; Loewen *et al.* 2001). The seasonal dormancy of camas during summer drought is well documented (e.g., Statham 1982; Thoms 1989; Hebda 1992; USDA 2000), but "opportunistic," or prolonged, dormancy, or the opting-out of above-ground development during the growing season, is not widely understood (e.g., Schuller 1997). The latter form of dormancy can possibly last for several years and is moderated by the rates of bulb decomposition and depletion of stored food reserves (Harper 1977).

Competition of vegetation for nutrients, moisture, and space all affect camas growth patterns and phenology. Seedling establishment is hindered by competition from other vegetation, but also from untimely disturbances, temperature extremes, and erosion, among other factors (USDA 2000). Seedlings can also be adversely affected by high litter cover (USDA 2000; Loewen *et al.* 2001), although some surface organic matter is necessary for lateral root growth (Hebda 1992). Intraspecific competition is also a factor affecting growth and reduced flowering can result from overcrowding within a population (Hebda 1992).

Ungulates, such as elk and deer, and gophers readily eat camas; the latter apparently transport viable *C. quamash* bulbs into new areas (Watson 1988, in USDA 2000). Although some herbivorous insects will eat camas, there are no serious insects pests recorded. Disease, nematodes, and mosaic virus could also cause damage (USDA 2000). On southern Vancouver Island, camas leaves can be heavily grazed by the introduced eastern cottontail rabbit (*Sylvilagus floridanus mearnsi*) and native Columbian blacktail deer (*Odocoileus hemionus columbianus*).

3.1.3.3 Ecological Research on Camas

No previous ecological studies focusing solely on *Camassia*, and no ethnoecological research on the effects of soil disturbance (i.e., digging or harvesting) on camas were found in the literature. Ethnoecological theses on other geophytes, however, are becoming common (Chapter 4). These studies have concentrated on the effects of harvesting or mechanical manipulation on vegetative reproduction (e.g., Anderson 1993; Loewen 1998), and harvesting and nitrogen enhancement on growth and reproduction (e.g., Stevens 1999). Both Kat Anderson (1993) and Sandra Peacock (1998) modeled the ecological effects of Indigenous management on root plants at different environmental scales (Chapters 4, 5).

Vegetation studies which include *Camassia* largely concentrate on the role of fire within *Quercus garryana* savanna (e.g., Tveten and Fonda 1999; MacDougall 2002) or *Festuca*-dominated prairie (e.g., Tveten 1997; Schuller 1997; Dunwiddie 2002). The responses of *Camassia* to prescribed fire treatments have been variable. In the Puget Sound region, Tveten and Fonda (1999) found that neither fall nor spring burns affect *C. quamash* frequency or cover, whereas Schuller (1997) reported that frequency of this species increases after fall burning. On Vancouver Island, MacDougall (2002) found a general increase in *C. quamash* cover after both one and two burn cycles. Dunwiddie (2002) recorded an increase in *C. leichtlinii* cover after one burn, but variable responses to subsequent prescribed fire treatments in the San Juan Islands. Furthermore, he suspects that flowering was also enhanced by fire, although this conclusion was not tested Dunwiddie (2002).

Plant species of fire-adapted ecosystems tend to be generalists with a wide range of reproductive strategies and growth forms (e.g., Antos *et al.* 1983; Dunn and Ewing 1997). As with *Camassia*, variable responses of perennial forbs to fire occur in the ecological literature (e.g., Schuller 1997; Tveten 1997). Both flowering (e.g., Wrobleski and Kauffman 2003) and cover (Kost and De Steven 2000; Dunwiddie 2002) of perennial forbs respond favourably to fire. Positive responses are specifically noted for spring ephemeral species with below-ground perennial structures (Antos *et al.* 1983; MacDougall 2002). Wrobleski and Kauffman (2003) reported an induced lengthening of the growing season for forbs as a result of prescribed fire in big sagebrush ecosystems in Oregon.

Often immediate structural changes within the vegetation community occur after fire. Bare ground increases and litter cover deceases after prescribed burning (Dunwiddie 2002; MacDougall 2002). Additionally, increased charcoal fragments and blackened soil increase soil temperature (Harper 1977: Antos *et al.* 1983; Agee 1993), and could result in long term enhancement of vegetation regrowth (Iverson and Hutchinson 2002). Although soil texture is often unaffected by fire (Agee 1993), soil moisture decreases immediately after fire, especially in xeric sites (Iverson and Hutchinson 2002). Moisture availability in the soil likely plays a major role in the vegetation recovery (Wrobleski and Kauffman 2003). Repeated fires may increase soil pH (Agee 1993).

Chemical pathways are affected by burning. A decrease in biomass with frequent burning could limit nitrogen availability in grassland ecosystems (Blair 1997; Turner *et al.* 1997). Even with low intensity fires, high losses of nitrogen result because of volatilization (Boerner *et al.* 1988; Turner *et al.* 1997). Burning can also potentially increase plant productivity by releasing potassium in the form of potash into the soil (Thoms 1989). Although fire will release some nutrients locked up in plant tissues and carbon cycling pathways (Wright and Heinselman 1973), whether or not these nutrients are available to surviving or colonizing plants depends on the intensity of the burn (Agee 1993).

There has been limited research on the effects of other experimental treatments or on the cumulative effects of multiple treatments. Huffman and Werner (2000) found that fire combined with roller-chopping (i.e. multi-blade cutting tool pulled behind a tractor) significantly enhances flowering of *Lilium catesbaei* in pine savanna. The removal of woody species by cutting is often reported to lead to increased graminoid (i.e., grasses, sedges, and rushes) cover (Bowles *et al.* 1996).

Research on the effects of soil disturbance on geophytes has generally come from studies on disturbance by animals. Hartway and Steinberg (1997) found a positive correlation between pocket gopher (*Thomomys mazama*) mounds and species diversity in western Washington prairies. Herbivory patterns can affect the geophyte distribution (Thomson *et al.* 1996). Populations of the geophyte *Erythronium grandiflorum*, may be enhanced by "microdisturbances" caused by the digging of mammals, including grizzly bears and pocket gophers (Loewen 1998:169). Roemer (1972) reported that *C. quamash* is strongly impacted by heavy grazing, but whether the effects result solely from herbivory or from trampling is not clear. Both the feeding strategies and physical disturbance patterns of animals could greatly affect geophyte populations (e.g., Huntly and Inouye 1988; Naiman 1988).

3.2 NURSERY STUDY: DEMOGRAPHIC INVESTIGATIONS OF *CAMASSIA LEICHTLINII*

Although the horticultural merits of *Camassia* are widely recorded from First Peoples and non-Indigenous gardeners and growers, relatively little is known about naturally occurring camas populations in general, and even less is known about *Camassia* growth and development on Vancouver Island specifically. The majority of commercially sold varieties of camas on southern Vancouver Island are not from native stock and are mostly imported from nurseries in Holland.

As mentioned previously, research touching on the ethnoecological relationships between Indigenous resource management and camas bulbs is generally lacking. To begin addressing the specific questions of how people affected camas populations through their management practices, more information regarding camas growth and development was needed. A transplant study was carried out to address the following questions: How does transplantation affect camas? Do camas plants reproduce both sexually (i.e. seed) and asexually (i.e. bulb division)? How accurately can the size of the bulb be estimated from above-ground plant attributes (i.e. leaves, flowering stalks, etc.)? A five-year nursery-based monitoring study was conducted to describe camas demography. Specifically, this study focused on three principal information gaps in the current understanding of camas populations in this region: dormancy, asexual reproduction, and bulb growth. Comparisons between below- and above-ground attributes were also investigated.

3.2.1 Methodology used in Nursery Study

3.2.1.1 Experimental Design

Growth and development of *Camassia leichtlinii* (referred hereafter in this section as simply camas) were monitored in open cold frames for five years (Figure 3.6). The individuals for this nursery study were originally excavated from a natural habitat as part of a native plant rescue operation at an urban development site near Mill Hill Regional

1998

1999

2000

2001

2002

Figure 3.6 Nursery study cold frames, 1999-2002.

Park in Langford. The salvage site was an inland mixed *Pseudotsuga menziesii* and *Quercus garryana* woodland. The camas plants were salvaged in March 1998.

Two hundred and seventy individuals (i.e., bulbs with emerging green leaves) were randomly selected from several hundred salvaged camas plants. All the bulbs appeared to be solitary at the time of salvaging. All the plants had emerging leaves but no visible flower stalks at the time of transplant. Some individuals had limited leaf damage as a result of a high incidence of herbivory of camas plants at the collection site and injury during transplantation. The bulbs were cleaned of excess soil with a dry cloth before planting.

On 21 March 1998, the 270 camas plants were planted in cold frames located in the plant nursery at Government House in Victoria. The cold frames used in this study were filled with sand and topsoil mixed together in equal amounts, and divided into nine equal sections. Thirty camas bulbs were randomly selected and systematically planted in each cold frame section at intervals of 10-15 cm and a depth of 10 cm. The cold frames were not sprayed with a herbicide prior to planting and no other site preparation occurred. From 1998-2000, a small sumac tree partially shaded the three-sectioned cold frame on the eastern side.

Regular weeding occurred approximately every four months for the duration of the nursery study. The camas received periodic water in their first summer. Watering was discontinued after the first year.

3.2.1.2 Monitoring Methods

Demographic data were gathered on the camas plants for five growing seasons, 1998-2002. The nursery population was monitored once a year: approximately two months following transplanting (19 May 1998) in the first year, and in early June in subsequent years. In all cases, the camas plants were in flower and/or fruit. In order to track the development of each camas plant over time, I recorded presence/absence in each year. In 1998, I recorded data on the number of leaves, number of flowers per stalk, and flower stalk height on each reproductive camas plant. Starting in 1999, leaf number was also collected on all camas, and flowering data (number of flowers per stalk, flower stalk height) were collected on reproductive camas. Data were gathered on offsets, or individuals arising from bulb division and growing adjacent to planted camas.

Fruit and seed production was not monitored in this study. Data on seedling establishment and growth were also not studied.

All bulbs were weighed to the nearest 0.1 g, using a laboratory balance, and measured (length and width) at the Royal British Columbia Museum before planting (20 March 1998). At the end of the study, the bulbs were extracted from the cold frames and again weighed and measured (15 August 2002). Detailed notes on asexual reproduction were also taken at this time. Most of the bulbs were immediately replanted in the "Garry Oak Woodlands" area just below Government House by The Friends of Government House Gardens volunteers. Selected bulbs were given to the Songhees (Lekwungen) Nation.

The camas plants used in this study were collected from a natural habitat in the early spring (1998), or in other words, before they fully developed for the year. As the species of each camas can only be accurately determined from flowering characteristics, the species was established once the plants flowered in the cold frames. By the end of the study period (2002), 79% of camas in the cold frames flowered, and hence were all determined to be *Camassia leichtlinii*. The non-flowering individuals either died (16%) or remained vegetative (5%) for the duration of the study. Although the remaining camas were probably *C. leichtlinii* because they all originated from the same salvage site, the possibility that *C. quamash* was collected as well cannot be overlooked because the two species can share the same habitats (see Field Study section for more on the relative distribution of the two camas species).

3.2.1.3 Analytical Methods

I analyzed trends in vegetative (leaf number), reproductive (flower number per stalk, stalk height), and bulb (fresh weight, size) attributes over time. For bulb size, longitudinal sectional area (area $= \pi r_1 r_2$) was used to account for variability in bulb length and width. Correlation analysis was used to determine if significant relationships existed among these plant attributes.

Resighting histories for individual plants were determined by tracking growth patterns (e.g., presence/absence, vegetative growth only, sexually reproductive) annually. The presentation of the data in a summary resighting table (Table 3.2), is an effective way to assess the rates of mortality, prolonged dormancy (i.e. "opting out" of the growth season), offsetting (i.e. bulb division), and sexual reproduction. This table also provides the number of plants exhibiting each growth pattern, thereby clearing showing the variability of year to year growth by individual camas plants. Offset plants were monitored after first appearing with above-ground growth. Bulb division was indicated by the observation of two or more individuals, clearly distinguished by above-ground structures, arising from one location (Figure 3.7).

Rates of mortality, dormancy, and offsetting were confirmed retroactively upon excavation of the cold frames in 2002. In other words, the difference between a dead bulb and a dormant one was determined by the re-appearance of above-ground structures or by digging up the bulb. Mortality occurred if plants failed to produce above-ground structures and no bulb was recovered at the end of the study. Dormancy was assumed for those plants which lacked above-ground structures in at least one or more years of the study, and, for which a living bulb was recovered in 2002. Dormancy rates were calculated for the total number of individuals dormant in any one year of the study, and for the number years that each plant was dormant.

3.2.2 Results and Discussion of Nursery Study

3.2.2.1 General Demographic Trends

Mortality was highest in the first year after transplantation (Table 3.3). Forty-one (15.2%) of the original planted 270 camas plants died in the first year after transplanting. Only one additional plant died in the subsequent four years.

Table 3.2 Summary resighting table tracking growth patterns for *Camassia leichtinii* over time and the number of plants exhibiting each growth pattern. Plants above dashed line are the original cohort of planted bulbs, and those below originated from bulb division (offset bulbs). Bulbs that died in the first two years of study are not included in this table. Growth pattern codes: 0 = dormant, 1 = vegetative, 2 = flowering.

Number	Number of Plants Exhibiting Growth Pattern	Year				
		1998	1999	2000	2001	2002
1	7	1	0	0	0	1
2	1	1	0	0	0	2
3	2	1	0	0	1	0
4	2	1	0	0	1	1
5	1	1	0	0	1	2
6	3	1	0	0	2	2
7	1	1	0	1	0	2
8	1	1	0	1	1	1
9	2	1	0	1	1	2
10	1	1	0	2	0	0
11	1	1	0	2	0	1
12	1	1	0	2	0	2
13	1	1	1	0	1	1
14	2	1	1	0	1	2
15	1	1	1	0	2	2
16	2	1	1	1	1	1
17	5	1	1	1	1	2
18	18	1	1	1	2	2
19	3	1	1	2	0	0
20	2	1	1	2	1	2
21	2	1	1	2	2	0
22	106	1	1	2	2	2
23	1	1	2	2	0	0
24	54	1	2	2	2	2
25	2	2	1	2	2	2
26	6	2	2	2	2	2
27	1		1	1	2	2
28	1		2	2	2	2
29	1			1	0	0
30	1			1	0	1
31	1			1	1	1
32	1			1	1	2

Table 3.2 cont.

33	2			1	2	1
34	1			1	2	2
35	2			2	1	2
36	1			2	2	2
37	6				1	1
38	4				1	2
39	1				1	0
40	3				2	1
41	10				2	2
42	1				2	0
43	21					1
44	18					2
Total Plants	304	228	230	240	265	304

Prolonged dormancy was also highest in the first year after transplantation (Table 3.3). Twenty-three (10.0%) plants were dormant in 1999. Dormancy decreased in subsequent years -- 20 (8.3%) in 2000, 16 (6.8%) in 2001, 9 (3.9%) in 2002 -- as more plants broke dormancy than entered dormancy at any one time. Of all plants in the cold frames over the study period, 13 (4.3%) individuals were dormant for only one year, 24 (7.9%) were dormant for two or more consecutive years.

The offsetting rate increased steadily over time (0.9% - 25.0%) even though the total proportion of original plants reproducing through bulb division was low (14.8%) (Table 3.3). Overall, 76 offset camas plants developed from 40 individuals. For all camas plants, 28 (10.4%) divided only once over the study period, and 12 (4.4%) produced more than one offset. The highest number of offsets produced in the five-year period by an individual camas plant was 12.

Of the original cohort of plants, the rate of flowering increased to 90% in 2002 (Table 3.3), indicating a relatively mature population by this time. A largest annual increase in the number of mature plants occurred between 1999 (61) and 2000 (179). Of all offset individuals, approximately 50% flowered in three of the four years in which bulb division occurred. Unlike the original cohort of bulbs, a steady increase in the flowering rate for offset individuals was not recorded. Both the original and offset

Figure 3.7 Examples of asexual reproduction showing: (A) two flowering stalks (arrows) arising from one site, and; (B) at least two offsets (arrows) arising from the basal plate of mother bulb.

bulbs added to the sexual reproduction potential of the population. Thirty-nine camas plants, or 97.5% of individuals that produced offsets, exhibited both asexual and sexual reproduction.

In reference to specific growth trends, camas plants tend to become bigger or more developed over time, although the exact strategies for growth are not straightforward. Many plants (40.8%) increased their number of leaves every year (Table 3.4). An additional 31.4% of the total number of plants increased their leaf number annually until 2002. Those plants that showed an increase in leaf number over time tended to have fewer leaves in 1999, as determined by a calculation of mean leaf number for each growth pattern (Figure 3.4). Overall, the number of leaves for *Camassia leichtlinii* ranged from 3 – 17 on mature camas.

Growth patterns for flower number per stalk (Table 3.5) and flowering stalk height (Table 3.6) were more variable than those for leaf number, although similar trends occur. The largest camas plants had between 50 and 100 flowers born on a 90-cm or taller flower stalk.

On average, camas bulbs increased in size and weight over time. In 1998, for example, the weights of the bulbs ranged from 0.6 g - 40.3 g (mean 9.8 g), whereas the bulbs in 2002 ranged from 0.2 g to >102 g (mean 31.1 g). Specifically, the bulbs appeared to become broader but not longer over time, a growth trend similar to that seen for *Camassia leichtlinii* in natural settings (see Figure 3.5). In spite of this, camas bulbs did not increase in size or weight at a steady rate, nor did all bulbs get bigger or heavier over time ($r = 0.130$, $p = 0.07$) (Figure 3.8). This analysis was performed for all bulbs from the original cohort, regardless if they were solitary or if they divided. Analyzing separately the bulbs that remained solitary and bulbs that split yielded similar statistical results. Hence, bulb weight cannot be predicted from a plant's capability for asexual reproduction.

There was a strong positive correlation between weight and longitudinal sectional area of *Camassia leichtlinii* bulbs ($r = 0.883$, $p = <0.01$). In other words, as bulbs become bigger, they also predictively become heavier. Because of this relationship

Table 3.3 Development stages of *Camassia leichtlinii* in each year of nursery study, including rates of mortality, dormancy, and reproduction (offsetting and flowering).

Developmental Status	**1998**	**1999**	**2000**	**2001**	**2002**
Original Plants	270	229	228	228	228
Vegetative	262	144	29	20	14
Flowering	8	61	179	192	205
Dormant	0	23	20	16	9
Dead	0	41	1	0	0
Mortality Rate	0.0%	15.2%	0.4%	0.0%	0.0%
Offset Plants	0	2	12	37	76
Vegetative	0	1	8	15	34
Flowering	0	1	4	20	39
Dormant	--	0	0	2	3
Offsetting Rate	0.0%	0.9%	5.0%	14.0%	25.0%
Total Flowering Rate	3.0%	26.9%	76.2%	80.0%	80.3%
Total Dormancy Rate	0.0%	10.0%	8.3%	6.8%	3.9%
Total Number of Plants	270	230	240	265	304

Table 3.4 Trends in *Camassia leichtlinii* leaf number (n = 191). Growth codes: "+" = increase, "-" = decrease, "0" = no change.

Number of Plants Exhibiting Trend	**Leaf No. in 1999 (mean ± sd)**	**2000**	**2001**	**2002**	**Proportion of Total**
78	2.86 ± 1.34	+	+	+	40.84%
32	3.31 ± 0.93	+	+	-	16.75%
28	3.57 ± 1.17	+	+	0	14.66%
19	3.42 ± 1.54	+	0	+	9.95%
8	4.00 ± 1.31	+	-	+	4.19%
6	3.33 ± 1.97	0	+	+	3.14%
5	5.00 ± 1.00	+	0	-	2.62%
4	4.75 ± 1.71	+	-	-	2.09%
3	5.00 ± 0.00	+	-	0	1.57%
3	3.00 ± 1.00	-	+	+	1.57%
1	4	+	0	0	0.52%
1	3	0	+	-	0.52%
1	5	0	+	0	0.52%
1	4	0	-	+	0.52%
1	1	0	0	+	0.52%

Table 3.5 Trends in *Camassia leichtlinii* flower number per stalk (n = 55). Growth codes: "+" = increase, "-" = decrease, "0" = no change.

Number of Plants Exhibiting Trend	Flower No. in 1999 (mean ± sd)	2000	2001	2002	Proportion of Total
15	17.40 ± 11.67	+	+	+	27.27%
12	23.42 ± 8.35	+	+	-	21.82%
10	22.70 ± 16.83	+	-	-	18.18%
8	27.12 ± 17.46	+	-	+	14.55%
4	43.75 ± 1.71	-	+	+	7.27%
1	32	0	+	+	1.82%
1	11	+	0	+	1.82%
1	11	+	+	0	1.82%
1	12	+	-	0	1.82%
1	76	-	+	-	1.82%
1	42	-	-	+	1.82%

Table 3.6 Trends in *Camassia leichtlinii* flowering stalk height (n = 56). Growth codes: "+" = increase, "-" = decrease, "0" = no change.

Number of Plants Exhibiting Trend	Stalk Height (cm) in 1999 (mean ± sd)	2000	2001	2002	Proportion of Total
16	58.25 ± 11.33	+	+	-	28.57%
12	56.75 ± 18.56	+	+	+	21.43%
10	66.20 ± 18.24	+	-	+	17.86%
8	66.62 ± 15.80	+	-	-	14.29%
5	78.20 ± 9.01	-	+	+	8.93%
3	76.00 ± 9.54	-	+	-	5.36%
1	66	+	-	0	1.79%
1	70	+	0	-	1.79%

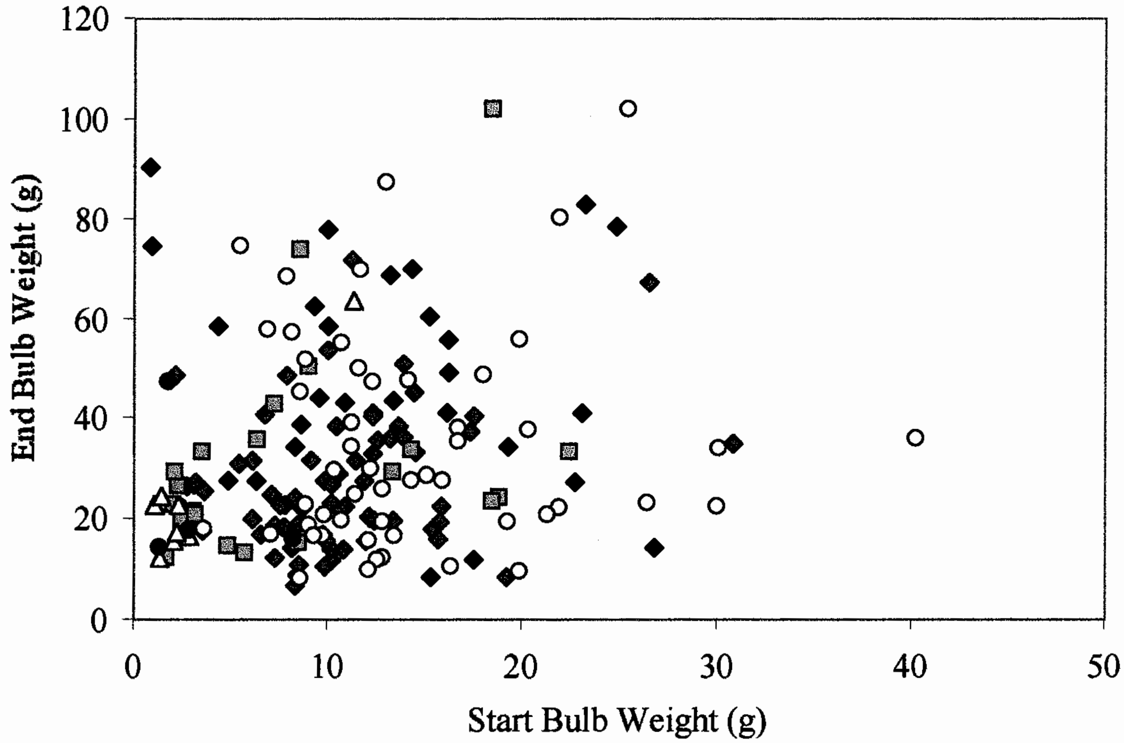

Figure 3.8 Comparison of *Camassia leichtlinii* bulb weights measured at the beginning (1998) and end (2002) of study period. Different symbols represent the number of years each bulb flowered, beginning in 1999: ● = 0 years; △ = 1 year; ■ = 2 years; ○ = 3 years; ◆ = 4 years.

between bulb weight and longitudinal sectional area, therefore, bulb weight alone was used in subsequent analyses.

3.2.2.2 Relationships among Plant Attributes

Relationships between select plant attributes – bulb weight, leaf number, flower number, flowering stalk height – were investigated. Significant relationships existed between the below-ground attribute of bulb weight and the above-ground plant attributes of leaf number, flower number, and flowering stalk ($r = 0.466$, $r = 0.381$, $r = 0.431$, respectively; $p = <0.01$ in all cases) (Figure 3.9a-c). Stronger associational trends occurred when above-ground factors were compared to each other: flower number and leaf number ($r = 0.569$, $p = <0.01$); and flower number and stalk height ($r = 0.557$, $p = <0.01$). The relationship between leaf number and stalk height was not as strong ($r = 0.348$, $p = <0.01$) (Figure 3.9d-f).

Weak relationships were also found between reproductive output and bulb weight. Reproductive output in these analyses was measured either by the number of offsets produced by a plant or by the number of years a plant flowered. Bulb weight does not appear to relate strongly to a plant's capability to either flower regularly ($r = 0.294$, $p = <0.01$) (Figure 3.10a) or produce multiple offsets ($r = 0.231$, $p = <0.01$), although the majority of the bulbs that flowered regularly were over 10 g. The dotted line on Figure 3.10a indicates a bulb weight of 10 g, or the minimum weight estimated for a harvestable bulb as described by Indigenous consultants (= "3-6 cm across" in Turner and Kuhnlein 1983:211) (discussed in detail in Chapter 4). There is also no clear relationship between a plant's capability to flower regularly and its ability to increase in bulb weight (Figure 3.8). However, the camas individuals that did not flower or only flowered once had the lowest bulb weight on the whole.

Furthermore, some camas plants flower regularly and produce multiple offsets ($r = 0.254$, $p = <0.01$). Generally, the individuals with three or more offsets were also the plants which flowered at least three of the five years of the study period (Figure 3.10b).

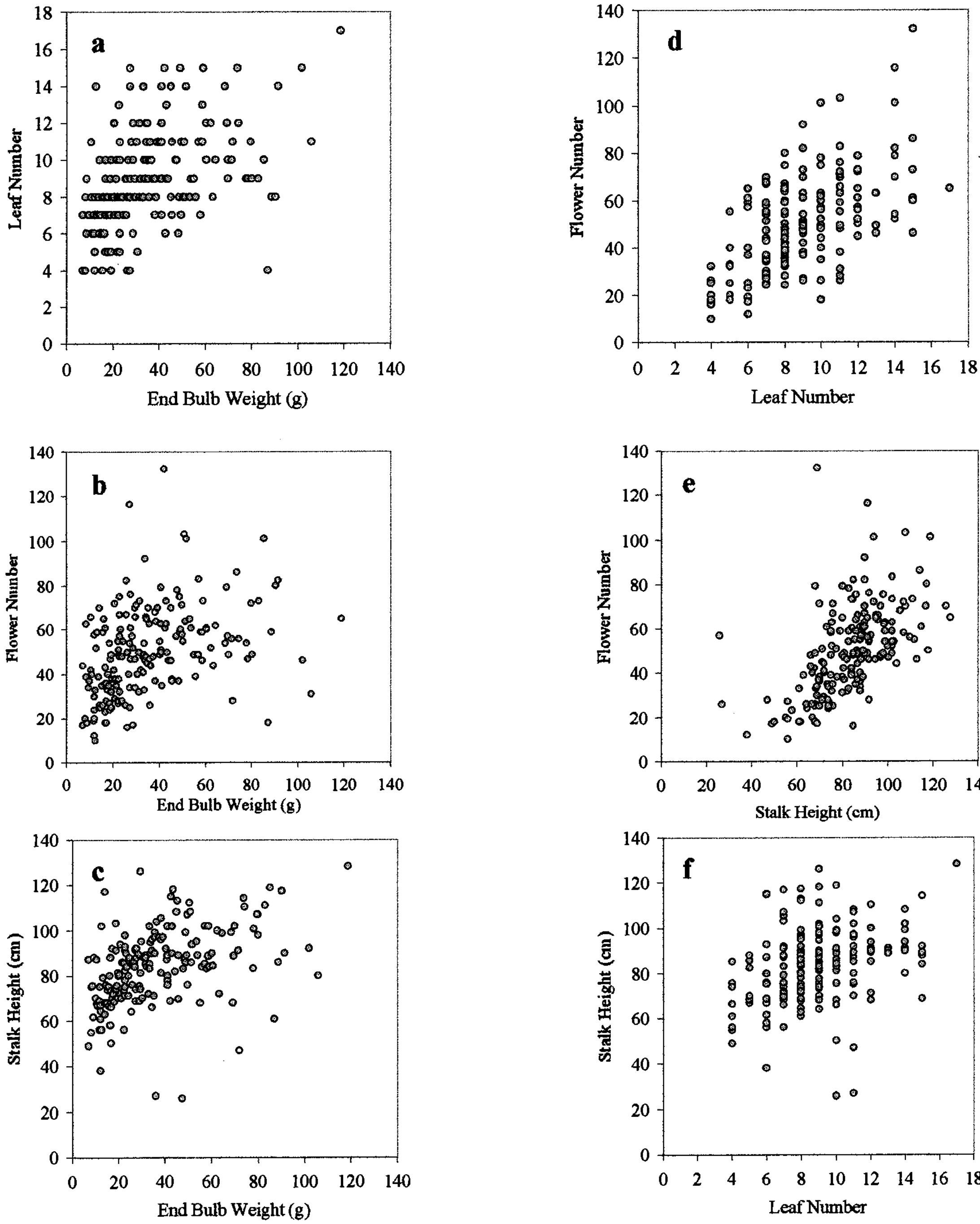

Figure 3.9 Relationships between different below- and above-ground variables for *Camassia leichtlinii*: (a) bulb weight (2002) and leaf number, (b) bulb weight (2002) and number of flowers, (c) bulb weight (2002) and flowering stalk height, (d) number of leaves and flower number, (e) flowering stalk height and flower number, and (f) number of leaves and flowering stalk height.

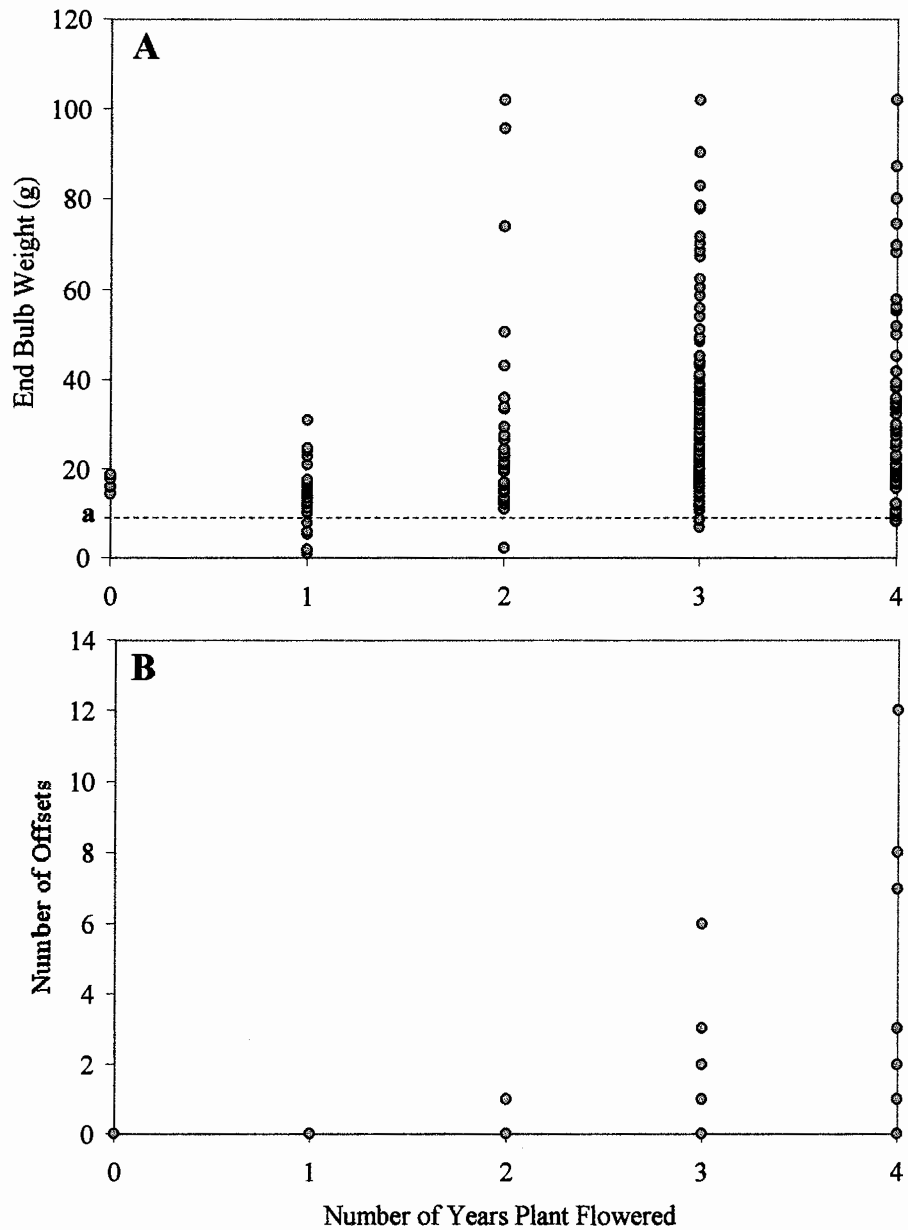

Figure 3.10 Relationships between the number of years a *Camassia leichtlinii* plant flowered and (A) its bulb weight (2002) and (B) the number of offsets it produced. The dotted line (a) on plot A represents the 10 g minimum bulb weight for harvesting according to Indigenous consultants (see text for details).

3.2.3 Conclusions from Nursery Study

Overall, the number of camas individuals increased during the five-year study (Table 3.3). After an initial decrease in visible camas (i.e. those producing above-ground structures) due to mortality and dormancy in 1999, the total number of individuals continued to increase through bulb division. Hence, mortality, dormancy, and asexual reproduction all affected population size of *Camassia leichtlinii* in cold frames.

Camassia leichtlinii appeared to rebound well from a springtime planting, with limited mortality and dormancy. The high percentages of mortality and dormancy in the first year were likely related to transplant shock (e.g., Jewell 1978). The 15% mortality in 1999 compared well with the observations of Jewell (1978), who lost 14% of transplanted *C. quamash* even with intact soil around the bulbs. Overall, dormancy rates decreased over time, although a limited number of camas plants remained dormant for up to three years. Prolonged dormancy occurred in all years of the study, as some plants remained or became dormant, while others broke dormancy and produced above-ground structures. Of the plants that experienced dormancy, most were dormant for more than one year. It is probable that the rates of mortality and dormancy would have been lessened if the camas plants were transplanted during the summer quiescent period (USDA 2000), and if the bulbs and roots remained protected within their original soil (Jewell 1978).

Clearly, the growth patterns of *Camassia leichtlinii* in the nursery setting varied. Camas plants increased in size and developed more leaves and flowers over time, but these relationships between these demographic attributes were weakly correlated. No strong relationships were found between above-ground characteristics (e.g., leaf number, flower number, stalk height) and bulb weight, or when above-ground characteristics were compared.

Camassia had the capability to reproduce both sexually (i.e. seed production) and asexually (i.e. bulb division). Moreover, it was found that half of all offset bulbs also produced flower stalks. The best indicator of larger bulbs, or those over 10 g, appeared to be regular flowering frequency.

3.3 FIELD STUDY: ETHNOECOLOGICAL INVESTIGATIONS OF *CAMASSIA LEICHTLINII* AND *C. QUAMASH*

A better understanding of camas growth and development emerged through the nursery study. Yet, how does camas growth compare in natural settings? How does camas, at both population and community levels, respond to the localized disturbance patterns of simulated management activities, in modern-day camas habitats?

To address these questions, a four-year ecological study was conducted in natural parks in the greater Victoria region. According to the qualitative literature (Chapter 2), the traditional harvesting of camas bulbs by Straits Salish peoples included the systematic digging of harvest plots and the removal of a larger cohort of bulbs within the plot. During the harvesting process, weeds and rocks were also removed from the plots. After the harvest was complete, the plot was burned over. To investigate the ecological effects of these Indigenous methods, experimental treatments of selective harvesting of camas bulbs and burning were selected for this field study. Percent cover and population characteristics (e.g., vegetative/reproductive, flower number) were monitored to determine how *Camassia* responds to experimental treatments. As with the nursery study, results from this applied work can be applied to both ethnoecological reconstruction research (Chapter 4) and in restoration and management prescriptions for degraded camas habitats (Chapter 5).

3.3.1 Field Study Methodology

3.3.1.1 General Setting and Site Descriptions

During reconnaissance for suitable plot locations in several Capital Regional Parks (CRD) Parks in the spring of 1999, I found the camas ecosystems to be highly fragmented and degraded. These shallow-soiled habitats had a high abundance of the invasive exotic *Cytisus scoparius* (scotch broom) and many introduced grasses (e.g., *Anthoxanthum odoratum*, *Bromus* spp., *Aira* spp.). Criteria for plot selection included predominantly herbaceous vegetation with camas present, open exposure, comparable soil depth, and no established scotch broom.

The four sites chosen for this study were located in three CRD Parks – Mill Hill, Witty's Lagoon, and Devonian (Figure 3.12; corresponding location data are found in Appendix 2). Mill Hill is situated within the inland Municipality of Langford, just northwest of Victoria. Witty's Lagoon and Devonian, both coastal parks, are in Metchosin, located southwest of Victoria (Figure 1.1, Chapter 1). Witty's Lagoon Regional Park includes a small peninsula, Tower Point, which is connected to the rest of the park by the lagoon and an extensive tidal flat. Because the Tower Point habitat is geographically isolated from the habitat at Witty's Lagoon Regional Park, and each site has a unique history and environment, the two sites were treated separately.

3.3.1.1.1 Mill Hill Regional Park

Mill Hill, a 60.8 hectare regional park, was established in 1981 as a regional conservation area (CRD Parks 2001). All the study plots were located between approximately 150 and 200 m in elevation. This park is primarily composed of Sprucebark type soils which are characterized as rapidly drained Orthic Dystric Brunisols with high fragment content and bedrock within 10 cm of the soil surface (Jungen 1985). This park has been inventoried and mapped as part of the Sensitive Ecosystems Inventory (SEI) and includes the *Quercus garryana*/*Bromus carinatus* (Garry oak/California brome) and *Quercus garryana*/*Holodiscus discolor* (Garry oak/oceanspray) plant communities, both red-listed (S1, critically-imperiled) according to the BC Conservation Data Centre (CRD Parks 2001). *Aster curtus* (white-top aster), *Balsamorhiza deltoidea* (deltoid balsamroot), *Sanicula bipinnatifida* (purple sanicle), and *Trifolium depauperatum* var. *depauperatum* (poverty clover) are examples of the rare plant species in this park. Native vertebrates include *Odocoileus hemionus columbianus* (Columbian blacktail deer), *Microtus townsendi* (Townsend's vole), *Tamiasciurus hudsonicus* (red

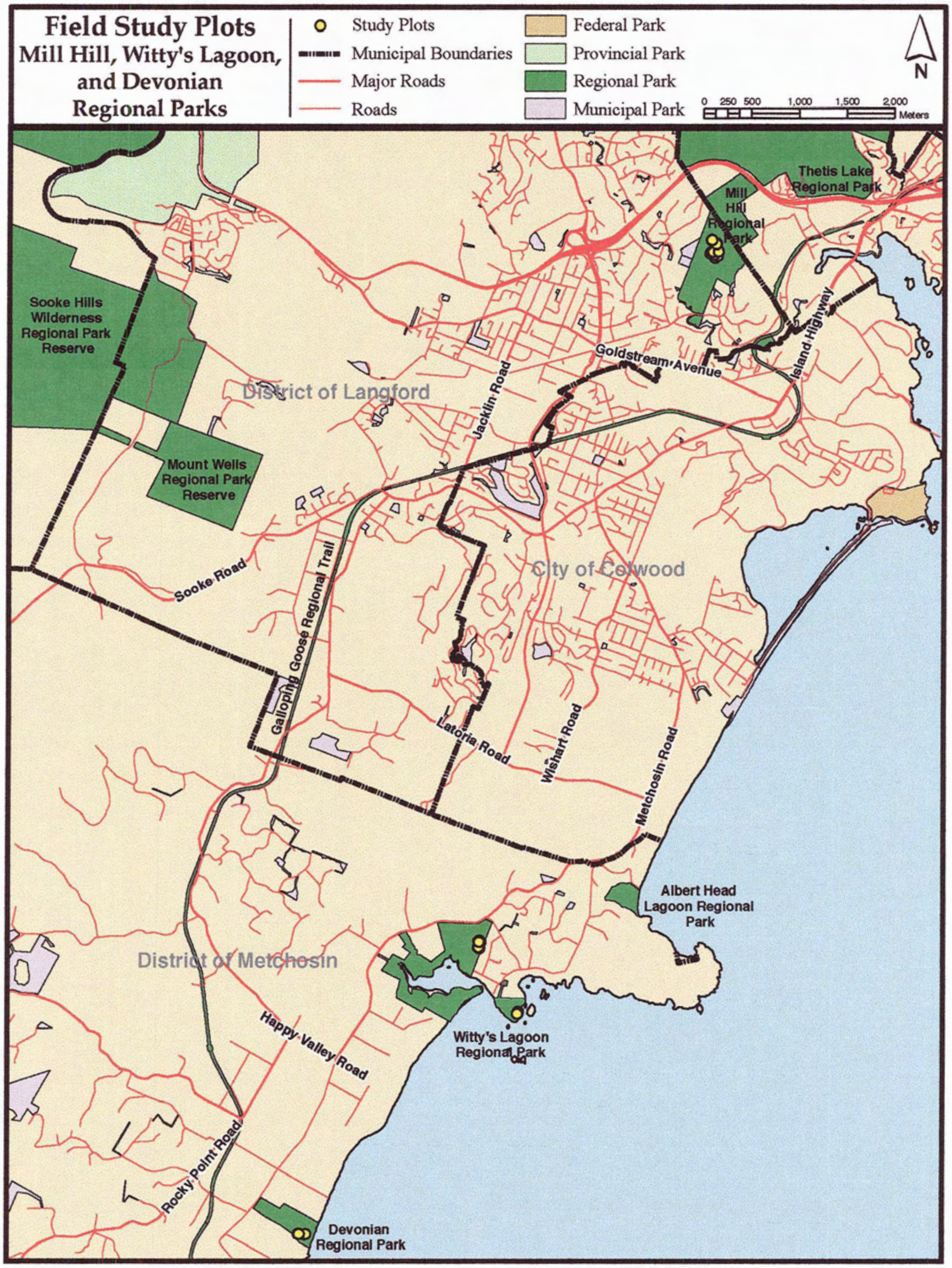

Figure 3.11 Field study plot locations (yellow circles) in three Capital Regional District (CRD) Parks: Mill Hill, Witty's Lagoon, and Devonian. Map provided by CRD Engineering and Parks departments.

squirrel), and *Sorex vagrans* (wandering shrew). Introduced mammals include *Sciurus carolinensis* (eastern gray squirrel) and *Sylvilagus floridanus mearnsi* (eastern cottontail rabbit). Both *Thamnophis* spp. (garter snakes) and *Elgaria coerulea* (alligator lizard) are also present at Mill Hill (CRD Parks 2001).

Mill Hill is within the traditional territory of the Whyomilth Peoples, a family group of the Songhees (Lekwungen) Nation. Cheryl Bryce (Songhees Nation, pers. comm. 2000) suspects that Mill Hill was likely used as a refuge for women and children during times of intercommunity warfare, and a possible year-round lookout for Indigenous sentries. It has been long believed by local archaeologists that the park had only one shell midden site near the base of the hill. This midden (Site DcRu 70), first recorded in 1967, was never excavated, and is estimated to be 70% intact (Beram 1988). It is now thought that there is more than one shell midden at Mill Hill and that these cultural sites are extensive. The sites may "contain cultural material as old as 3,000 years" (Crocker n.d.:9). Many artifacts have been found on-site by past caretakers and pocket middens are common along Millstream, a creek which flows along the southern boundary of the park.

Mill Hill remained a lookout well into the twentieth century, and could have been used for that purpose during both World Wars. From 1949 until the 1970s, there was a BC Forest Service fire suppression camp at the base of Mill Hill. A road linked the ranger station with a lookout tower at the summit. The Forest Service buildings became the headquarters for CRD Parks in 1980. Remnants from the old lookout tower still remain at the summit (Crocker n.d.).

3.3.1.1.2 Witty's Lagoon and Tower Point (Witty's Lagoon Regional Park)

The site at Witty's Lagoon is comprised of 56 hectares of predominantly Douglas-fir forest surrounding a lagoon. This park was established in 1966 as a regional conservation area. All the study plots were located between approximately 40 and 60 m in elevation. The soils of Witty's Lagoon are mainly of the Ragbark association. Similar to the soils of Mill Hill, the soils are characterized as rapidly drained, shallow Orthic

Dystric Brunisols with high coarse fragment content (Jungen 1985). Witty's Lagoon is floristically diverse with seven recognized plant communities.

The plots at Tower Point were approximately 10 m above sea level. The soils differ from those of the study site in the main part of Witty's Lagoon Regional Park. Marine in origin, Saanichton type soils are well drained Orthic Sombric Brunisols which have low coarse fragment concentration (Jungen 1985). Rare plant species at Tower Point include *Triteleia howellii* (Howell's triteleia), *Allium geyerii* var. *tenerum* (Geyer's onion), and poverty clover. Vertebrates include the native *Peromyscus maniculatus* (white-footed mouse), Columbian blacktail deer, Townsend's vole, and wandering shrew, and the introduced eastern gray squirrel.

The Kakyaakan peoples (Lekwungen family group) were the traditional occupants of this locality (Searle and Associates 1990). In terms of archaeological heritage, Witty's Lagoon is one of the most culturally rich parks; there are five known archaeological sites, three shell middens, and two fortification sites located within the park (Beram 1988). In 1971, an archaeological site (Site DcRv 2) on the spit was excavated uncovering many artifacts and house remains, likely of the post-contact period. A shell midden site (Site DcRv 81) located on the shore of the lagoon was excavated in 1987 (Searle and Associates 1990). One of two fortification sites (Site DcRv 58) is located at Tower Point. Originally created to act as a defensible embankment or place of refuge, this site also has an extensive shell midden and two burial cairns. The age of the fortification site is unknown (Beram 1988). The remnant trench and mound topography is still easily observable at Tower Point, and occurs to the immediate south of the study plots.

There are also widespread remains associated with European settlement at Witty's Lagoon. Although the land apparently changed owners numerous times, the primary land disturbance was the partial clearing of the forest for the creation of pastures. Metchosin Creek, which flows into the lagoon, was used for irrigation in the past (Searle and Associates 1990).

3.3.1.1.3 Devonian Regional Park

Established in 1980, Devonian Regional Park is comprised of 14.4 hectares and is classified as a regional natural area. All the study plots were located between approximately 20 and 40 m in elevation. The main soils of this park are classified as Ragbark, but rock outcrop is common. The soils are rapidly drained and shallow Orthic Dystric Brunisols (Jungen 1985). The park includes the forested area around Sherwood Creek and Sherwood Pond, as well as a large rocky hill and sandy beach. Before the region was settled by the Hudson's Bay Company colonists in 1850, Devonian was the traditional territory of the Kakyaakan peoples. For most of the time since European colonization, the park was known as Sherwood Farm (CRD Parks 2003). Even though there are no recorded cultural areas within the park, there are archaeological sites nearby. Sherwood Pond is actually a lagoon, affected by changing tides and shore accretion. Human occupation sites are generally associated with lagoons along the southern Vancouver Island coastline (Beram 1988).

3.3.1.2 Experimental Design

Sites for 40 1 m x 1 m permanent plots were selected within each of the parks. Each plot was marked with an 8-inch galvanized nail and flagging tape in the northeast corner. The nails were inserted fully, with nail heads at ground level. Four treatments based on traditional Indigenous camas management were tested in these plots: harvest (simulated methods), burn, harvest and burn, and no treatment (control) plots. Hence, there were ten blocks of experimental plots tested. All treatments were randomly assigned within each block. There were four blocks at Mill Hill (16 plots), three blocks at Witty's Lagoon (12 plots), two blocks at Devonian (8 plots), and one block at Tower Point (4 plots).

The harvest treatment, occurring in both harvest and combined treatment plots (20 plots total), was applied once, from 30 June to 3 July 1999 (Table 3.7). For this

Table 3.7 Field study schedule for data collected for *Camassia* spp. at sites in CRD Parks. Community data = percent cover, population data = demographic variables (life stage, total density, density of seedlings, density of flowering plants, leaf number).

Study Year	Data Collected/Treatment	Date
1999	Community data	2-8 June
	Harvest treatment	28 June – 3 July
	Burn treatment	13, 17 September
2000	Community and population data	24 April – 2 June
	Burn treatment	11,12 September
2001	Community and population data	25 April – 21 June
2002	Community and population data	24 April – 26 June

treatment, each plot was systematically dug (Figure 3.12). Starting on one side of the plot, a strip of sod, approximately 20 cm x 1 m, was cut out and inverted. Weeding, clearing, and bulb harvesting was then completed using bare hands and wooden digging sticks. Because of a high abundance of matted perennial grasses in many sites, shovels were used for the initial ground breaking. Bulb harvesting involved the methodical removal of the largest bulbs in the plot. Because very few bulbs of either species reached the large "harvestable" size reported in the ethnographic literature (Chapter 2), bulbs sizes were assessed after the first strip of sod was inverted and the soil thoroughly worked through. The minimum harvestable size for a camas bulb differed from plot to plot, therefore, a variable proportion of large bulbs were removed from each plot after the initial plot assessment. Parallel strips of roughly equal size were then processed until the far edge of the plot was reached. The above-ground vegetation was kept intact as much as possible so as not to greatly affect fire behaviour in plots that were to be burned. As an additional investigation, I used a single plot at Devonian to ascertain the size classes of camas bulbs within a given population. Length and width were measured for all harvested bulbs.

Figure 3.12 Experimental treatments that simulate Indigneous management practices: (A) harvesting at the Devonian study site and, (B) burning at the Mill Hill study site.

Plots used for the burn and for the combined treatments were burned twice, once in September 1999, and again in September 2000 (Table 3.7). Equipment required for these burns included four backpack water sprayers, shovels and other tools, wetted towels, and a small propane torch. Saturated towels were laid out to frame each plot, allowing for an extra 30-cm buffer around the perimeter of each plot (Figure 3.12). As an extra precaution, the ground outside the wet towels was also sprayed with water. Each plot was initially fired along the downwind side. If the vegetation was sparse or the fire was not covering the plot adequately, the other edges were also lit and the fire allowed to creep across the plot. A complete "mop-up" (thorough wetting) was carried out after each plot was burned.

A supplementary investigation was also conducted in conjunction with the burn treatment. For the burns in 2000, thermologgers were used to record the fire intensity (temperature in degrees Celsius over time) in each burned plot. These computerized sensors begin recording when the temperature of the fire reaches 60°C. In general, sustained temperatures higher than about 60°C are needed to affect biological structure (Iverson and Hutchinson 2002). One sensor was placed at ground level in the center of each burn plot.

3.3.1.3 Sampling Methods

Plots were relocated each year using a compass and, often, a metal detector. Community data (i.e. cover) were collected using a semi-random pin-drop monitoring procedure. Modified pin-drop techniques have been successfully used by the California Native Plant Society (1993; e.g., Beckwith 1995) and by The Nature Conservancy of Washington (e.g., Dunwiddie 2002) because it is an efficient and easily repeatable methodology. The "pin" was a metal rod 60 cm long and approximately 5 mm in diameter. For a set of 25 data points, the one-square-meter plot was visually divided into four quadrants. The pin was then dropped from approximately 30 centimeters above each quadrant six times without looking at the plot. After all four quadrants were completed, or after 24 pin drops, the pin was dropped once more in the centre of the plot for a total of

25 drops. For each pin drop, the species touching the pin was recorded as a tick mark, or as a "hit" for each species. Hits were recorded for all species that touched the pin. If two plants of the same species touched the pin, or if the same plant touched the pin twice, during one pin drop, the species was recorded as only one hit. Hits were accumulated for all 25 pin drops. Cover values for the entire plot (100% coverage) were expressed as percentages (e.g., 16 hits / 25 pin drops = 64% cover). Additional species present in the plot but not hit during the pin-drop procedure were also recorded and given a cover value of 1%.

Cover data were collected in May for all years, 1999-2002. Cover values collected in 1999 represented pre-treatment data. Twenty-five pin-drops per plot were used in 1999, but 50 pin-drops were used in each of the subsequent years (2000-02). The increase in the number of pin drops was done to increase accuracy of cover estimates.

Detailed population data on *Camassia* were collected during the growing seasons from 2000-02 (Table 3.7). A 20 x 20 cm plot was established within each of the one-square-meter plots. These small plots were placed along the perimeter of the larger plots for easier relocation in subsequent years. The population data that were measured included characteristics of the plots (total density, density of seedlings, density of flowering plants) and characteristics of individual camas plants (life stage [i.e. seedlings/vegetative/flowering], leaf number). For this study, seedlings were defined as small, grass-like camas plants with only one leaf not more than 1.0 mm wide. Leaf data were not taken on seedlings. Individuals were considered "flowering" if a flowering stalk was present, even if the stalk was reduced in growth or aborted. All camas plants were measured in each sub-plot. The plots were monitored twice in 2000 (late April and mid May), and three times each in 2001 and 2002 (late April, mid May, and early June in each year). In plots containing both *Camassia* species, only flowering individuals were identified to species.

3.3.1.4 *Analytical Methods*

In each plot, community (percent cover) data were collected on all vascular plant species and total mosses and lichens, and on various environmental variables, Including litter, bare ground, and charcoal. However, in-depth analyses of these data are beyond the scope of the dissertation, and additional plant species and environmental variables are mentioned only to illustrate the environmental heterogeneity of the study sites. To demonstrate this variation among study plots, untransformed cover data for all vascular plant species were subjected to detrended correspondence analysis (DCA) (PC-ORD for Windows, Version 3.09 [McCune and Mefford 1997]). Ordination plots were used to investigate: (1) pre-treatment variation among all plots and sites (1999 data); (2) differences between plots with *Camassia leichtlinii* and with *C. quamash* (1999 pre-treatment data); and (3) variation over time (control plots for all four years, 1999-2002).

Community and population data from experimental *Camassia* plots were analyzed using a repeated measures analysis of variance model with Proc Mixed in SAS Version 8 (SAS Institute Inc. 1999). This allowed testing of the fixed effects of site, treatment, and time, as well as interactions between these factors. Blocks within each site were modeled as a random effect to ensure the correct error terms were used in the testing of the fixed effects. The repeated measures allowed correlation between observations over time to be modeled. A sample SAS program is given in Appendix 3.

Residuals were tested for normality before fixed effects were analyzed. If a variable was found non-normal, a transformation was performed. Square root, log, and inverse transformations were tried, in this order, because each represents a more severe measure. If none of these transformations could achieve normality, the variable was analyzed descriptively. Typically this result occurred only when most of the data were zero.

Percent cover, as well as four population-scale characteristics –density, leaf number, seedling number, flowering plant number – were examined in each of three plot groups: *Camassia* spp. (all plots), and *C. leichtlinii* and *C. quamash* (species level). These different categories were analyzed to assess treatment effects on the *Camassia* species separately and together. Only plots with a single identifiable camas species were used for species-level analyses because of the uncertainty in identifying immature camas plants. Hence, analyses for *C. leichtlinii* included three complete blocks (12 plots), and those for *C. quamash* included three complete blocks (12 plots) plus three incomplete blocks (6 plots).

Treatments began in 2000, and therefore, a covariate factor was included into the model to account for variability in the camas population in the pre-treatment year (1999). Cover of total *Camassia* spp., *C. leichtlinii*, or *C. quamash* was used as the covariate for each respective analysis (e.g., 1999 *C. leichtlinii* cover was the covariate for 2000-2002 *C. leichtlinii* density data). All figures show untransformed means and standard error. Statistical results were significant if $p<0.05$.

3.3.2 Observations Resulting from Harvest and Burn Treatments

In the summer of 1999, one half (20) of the plots were excavated as part of the harvesting treatment. As much as possible, the harvesting of camas bulbs was done in accordance with information from ethnographic and ethnobotanical literature (e.g., Stern 1934; Suttles 1951a; Turner and Bell 1971; Turner and Kuhnlein 1983). An average of 18 bulbs was removed from each plot. To understand the size distribution and quantity of bulbs in a natural setting, all the bulbs in one plot at Devonian Regional Park were dug, sorted into size classes, and counted (see Figure 3.5). Seventy percent of the bulbs in the plot were small or very small (1 cm diameter or less), and only 4.5% were considered to be very large (> 2.5 cm diameter). Each size class likely corresponded to consecutive annual growth; very small bulbs were about one year old and very large bulbs were six or more years old. When the lengths and widths of all harvested bulbs were compared, the dimensions of the *Camassia quamash* bulbs were found to be approximately 70% of the dimensions of *C. leichtlinii* bulbs (Table 3.8). Only *C. leichtlinii* bulbs were consistently recorded to be of the 3-6 cm harvestable size described by Straits Salish peoples (Turner and Kuhnlein 1983). (See Chapter 4 for more discussion on bulb sizes of the two camas species.)

Table 3.8 Average dimensions of harvested *Camassia* bulbs in wild settings.

Species	Length (cm)	Width (cm)
C. quamash (n = 238)	1.92 ± 0.28	2.78 ± 0.43
C leichtlinii (n = 97)	2.64 ± 0.48	4.23 ± 0.66

Camassia quamash plots tended to burn longer and hotter than the *C. leichtlinii* plots. This fire behaviour was most likely due to the dryness of the fuels located at the sites. The vegetation in *C. quamash* plots were generally shorter and less dense than *C. leichtlinii* plots. The *C. leichtlinii* plots were often associated with deeper soils and tended to support dense perennial grasses and forbs which remained at least partially green throughout the summer. The plots with the densest vegetation were not the plots that burned the hottest or for the longest period of time. The burns in two adjacent plots at Witty's Lagoon, for example, recorded very different fire intensities, even though both plots were similar in plant composition. The first plot exhibited the highest fire intensity of all burned plots; this plot sustained temperatures over 60°C for 150 seconds and reached a maximum temperature of >300°C. In comparison, the temperature in the adjacent plot barely exceeded 100°C and sustained biological killing temperatures for only 80 seconds. The differences in fire behaviour between the two plots likely indicated variation in plant abundance or in environmental conditions on a microsite scale.

3.3.3 Field Experimental Results

The rocky outcrop habitats used in this study showed considerable heterogeneity; each site had unique vegetation assemblages. The recorded flora for all study sites was comprised of 88 plant taxa (53 native, 35 exotic) (Appendix 4). Of these, 57 plant taxa were found at more than one site, and 22 were found in study plots at all sites in at least one year of the study. Exotic species were nearly twice as common as native species, a distribution comparable to the vegetation composition on Yellow Island in the neighbouring San Juan Islands, Washington (Dunwiddie 1997). Thirty species (20 native, 10 exotic) were recorded from plots at only a single site, most of those (70%) occurring at Mill Hill.

Both *Camassia* species occurred in plots at Mill Hill and Witty's Lagoon but only *C. leichtlinii* was recorded at the Devonian and Tower Point sites. There may have been *C. quamash* growing on or near these latter sites, but this species was not evident over the course of the study period. In most locations, it is difficult, if not impossible, to separate the two *Camassia* species based solely on vegetative characteristics, and positive identification requires flowering or fruiting individuals (see also Nursery section). Plots where only one camas species was initially recognized in 1999, for example, were identified as containing both species only after the second species flowered, often following treatments. It is likely that the two species have occurred together more often than previously realized in this region.

3.3.3.1 Site Descriptions

The plots at Mill Hill, all located in the upper elevations of the hill, were associated with soil pockets within exposed rocky outcrops. These pockets had variable soil depths and xeric summer conditions. In each plot, there was little or no exposed bedrock or bare soil, and no oak leaves or charcoal present. High moss cover (66%), and low litter (fine fuels) cover (39%) were present before experimental treatments. Mill Hill supports high plant diversity (73% of total number of taxa recorded) overall, but the plots generally contained species of smaller stature and localized abundance (e.g., *Carex inops* Bailey, *Galium triflorum*, *Lupinus bicolor* ssp. *bicolor*, *Olsynium [Sisyrinchium] douglasii*, *Arctostaphylos uva-ursi*). The distribution of species was related to elevation. *Danthonia californica*, for example, occurred within the lower plots, but was gradually replaced by *Festuca idahoensis* in plots closer to the summit. Cover of annual exotic grasses tended to decrease with elevation, and few exotic species were found in the plots near the hilltop. The study site was characterized as a "mixed-camas" ecosystem; both *Camassia* species were present in three of 16 total plots (19%). All other experimental plots contained only *Camassia quamash*. Cover of *Camassia* ranged from 24% to 80% in 1999.

Witty's Lagoon consists of a large contiguous rocky outcrop community surrounded by *Pseudotsuga menziesii* forest. This site was less xeric and more isolated than Mill Hill. Initially, there was little to no exposed bedrock or soil, and no oak leaves or charcoal present on the surface. Moss and litter averaged 34% and 83%, respectively. There was a relatively high species diversity (63% of the total species) which included tall herbaceous species (e.g., *Bromus carinatus, Elymus glauca, Dactylis glomerata*) Both species of *Camassia* grew at the Witty's Lagoon site. Of the total 12 plots at Witty's Lagoon, half were shared by the two camas species and one had *C. leichtlinii* as the sole camas species. The initial cover of *Camassia* was higher than at Mill Hill, ranging from 32% to 92%.

The Tower Point site is surrounded by *P. menziesii* forest except for open shoreline to the southeast. In 1999, the plots had approximately 22% moss and 85% litter. There was no exposed soil, no oak leaves or woody debris, and little exposed rock. The site supported 37% of the total recorded species, and was noticeably lush with abundant *C. leichtlinii*. Camas cover ranged from 48% to 92% in plots before treatment. Species composition was similar to that of Witty's Lagoon with *Elymus glaucus* as the primary native grass, and a high diversity of native and exotic forbs. Tower Point had little *Cytisus scoparius* cover.

The study plots at the Devonian site were located in coastal bluff habitat, separated from the ocean to the south by *Pseudotsuga menziesii* forest. A large wildfire, fueled primarily by mature *Cytisus scoparius*, occurred in 1998. Because finding suitable sites for study plots proved to be challenging in 1999, a block of treatment plots was established within this previously burned area. This block (Block 1) was in a swale in an exposed, xeric rocky outcrop. The other block at this site (Block 2) was located about 30 m inland on a rocky knoll. Block 2 was more moist and sheltered than Block 1. In 1999, moss cover averaged 22% in Block 1 and 4% in Block 2. Litter was similarly distributed, averaging 51% and 10% cover, respectively, with the difference likely due to the fire in the previous year. There was more exposed soil and rock, woody debris, and charcoal in

Block 1 than in Block 2 as well. Fifty-three percent of the total plant taxa in this study was present at the Devonian site. The only camas species recorded at Devonian was *C. leichtlinii*, and its cover ranged from 16% to 80%.

3.3.3.2 Environmental Variation

The study sites varied on regional (i.e. among sites) and local (i.e. among plots) scales. DCA ordination plots of plant cover provided a sense of how the sites, and the study plots, related to one another based on species composition and abundance (Figure 3.13a). The plots at Mill Hill, for example, showed greater variability than that at the other three study sites. Witty's Lagoon appeared to be more similar to the sites of Devonian and Tower Point than to Mill Hill. Despite the localized variation undoubtedly caused by the 1998 wildfire, plant cover at Devonian did not vary as much as the cover at either Mill Hill or at Witty's Lagoon. This observation suggests that environmental factors, such as exposure and elevation, may influence plant species cover as much or more than disturbance events. When the field plots were labeled by their respective *Camassia* species, environmental distinctions were shown to exist between the two species (Figure 3.13b). Plots with only *Camassia leichtlinii* did not overlap with *C. quamash* only plots when graphed spatially. Plots with both camas species did overlap with single-species plots. They seemed to be more strongly correlated with *C. leichtlinii* plots than with those of *C. quamash*. Hence, it can be reasoned that *C. leichtlinii* is more restrictive in its environmental requirements than *C. quamash*.

Plant cover showed considerable variation from year to year. An ordination of the control plots from all four years of the study illustrated that cover changed throughout the duration of the study (Figure 3.14). The least amount of change occurred at Witty's Lagoon, probably because this site was secluded and received the least amount of local, regular disturbance, such as off-trail hikers and introduced animals including dogs, squirrels and rabbits. Some of the greatest temporal variation occurred within the Mill Hill control plots, and in the Devonian control plot which was burned in 1998 (marked with an asterisk on Figure 3.14). Control plots with both species present also showed variability over time.

In almost all cases, the greatest year-to-year temporal variation occurred between 1999 and 2000. Why would control plots in four different sites exhibit such annual variability? Weather data of daily mean temperature and precipitation provided the likely answer to this question (Environment Canada 2003). A graph of the daily mean temperature for the years of 1998-2002 as deviations from normal (calculated from recorded data at the Victoria International Airport, 1940-1990) showed higher than normal temperatures for the month of April in all years considered (Figure 3.15a). Moreover, and possibly more importantly, the graph of precipitation deviations from normal illustrated significantly low rainfall in April for the years of 1998-2000 (Figure 3.15b). The month of April is a crucial period of above-ground growth for both species of camas. Drought conditions during this time and for multiple years could have severely impacted *Camassia* annual growth patterns and affected subsequent development and productivity (c.f. Statham 1982; Thoms 1989; Plew 1992; USDA 2000) (see next sections).

3.3.3.3 Camas Analyses: Site Effects

Community and population data for *Camassia* were analyzed using repeated measures ANOVA which allowed for the testing of fixed effects, including site, treatment, and time, as well as the interactions between these factors. As expected based on the above DCA ordinations, site differences were significant for pooled *Camassia* spp. cover, leaf number, and flowering plant density data (Table 3.9). *Camassia* spp. cover ($p<0.001$) significantly varied among sites over time. *Camassia* cover at Devonian increased from 1999 to 2002 (Figure 3.16). Devonian was the only site to show a noticeable increase in cover. With the lowest recorded percent cover on average (35%) among all study sites, this site had the greatest potential for increasing cover. The other *C. leichtlinii* site, Tower Point, maintained almost twice the mean percent cover (67%) as Devonian. The overall changes in *Camassia* cover at the Witty's Lagoon and Tower

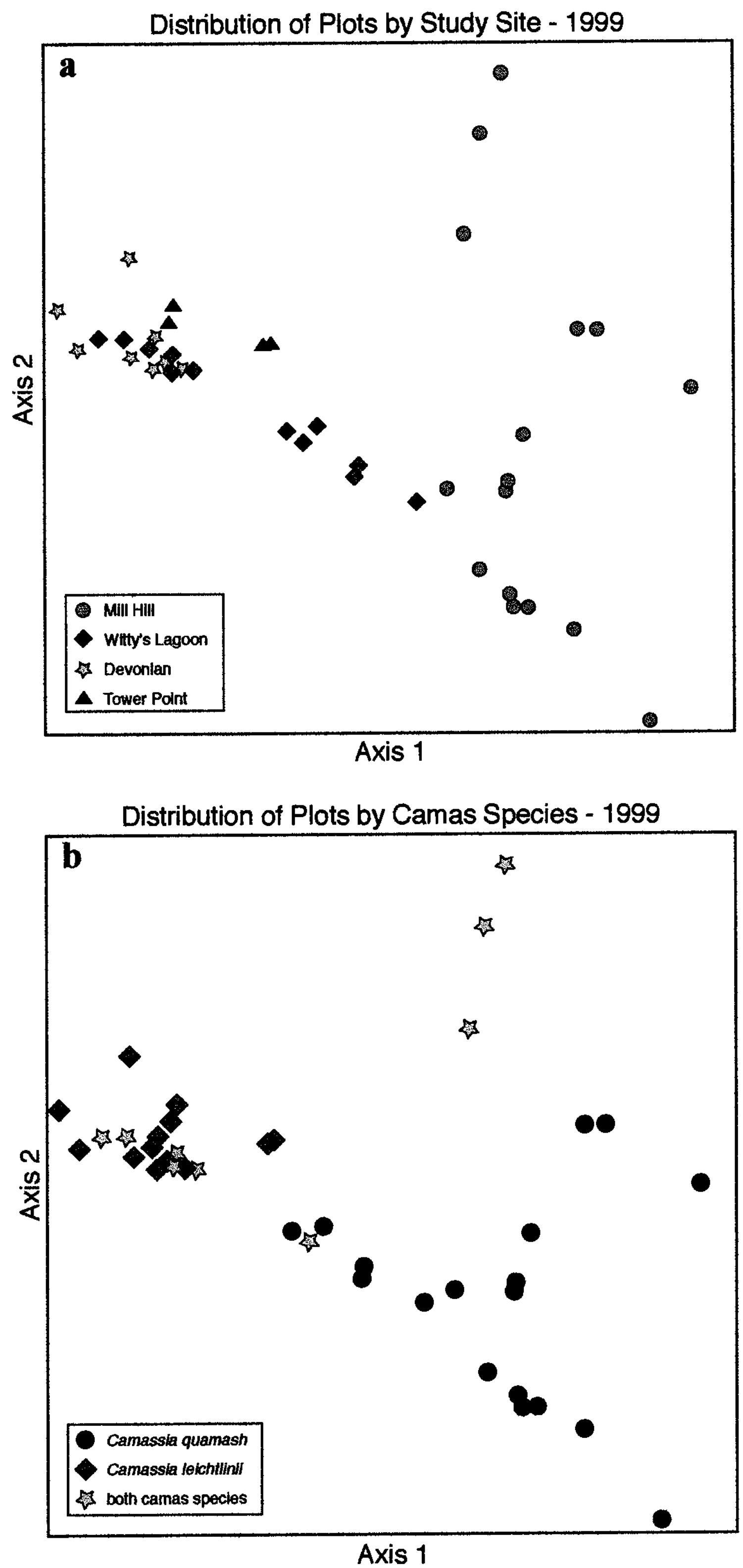

Figure 3.13 DCA ordination plots of all experimental plots as designated by (a) study site and, (b) camas species. Graphs generated from vegetation cover data for all vascular plant species in 1999 (pre-treatment).

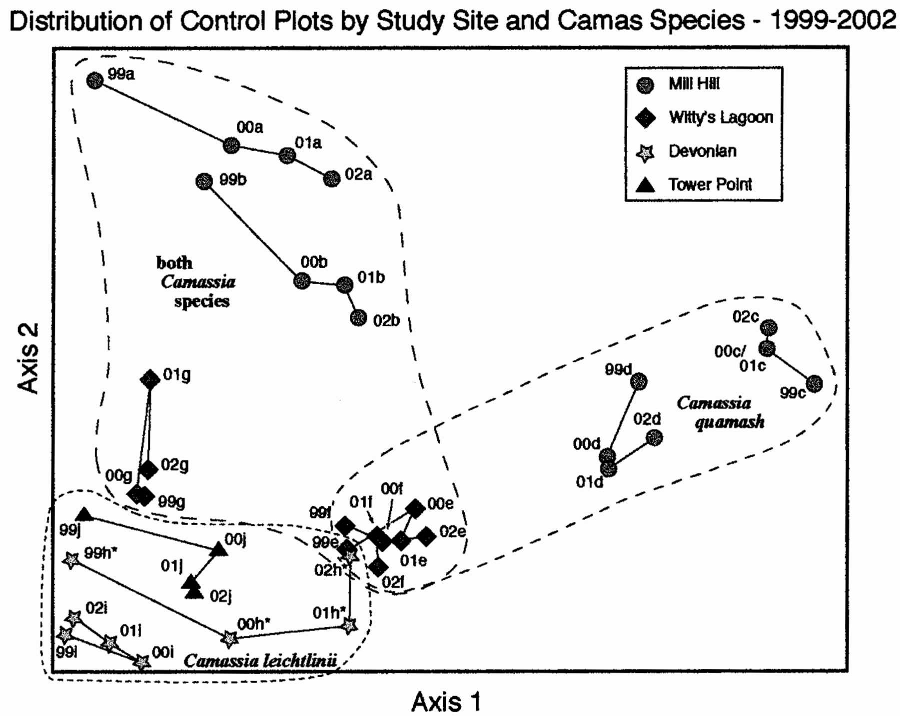

Figure 3.14 DCA ordination plot of annual variation in control plots (joined by lines), as designated by both study site (symbols) and camas species (dashed lines). Graphs generated from vegetation cover data for all vascular plant species, 1999 - 2002.

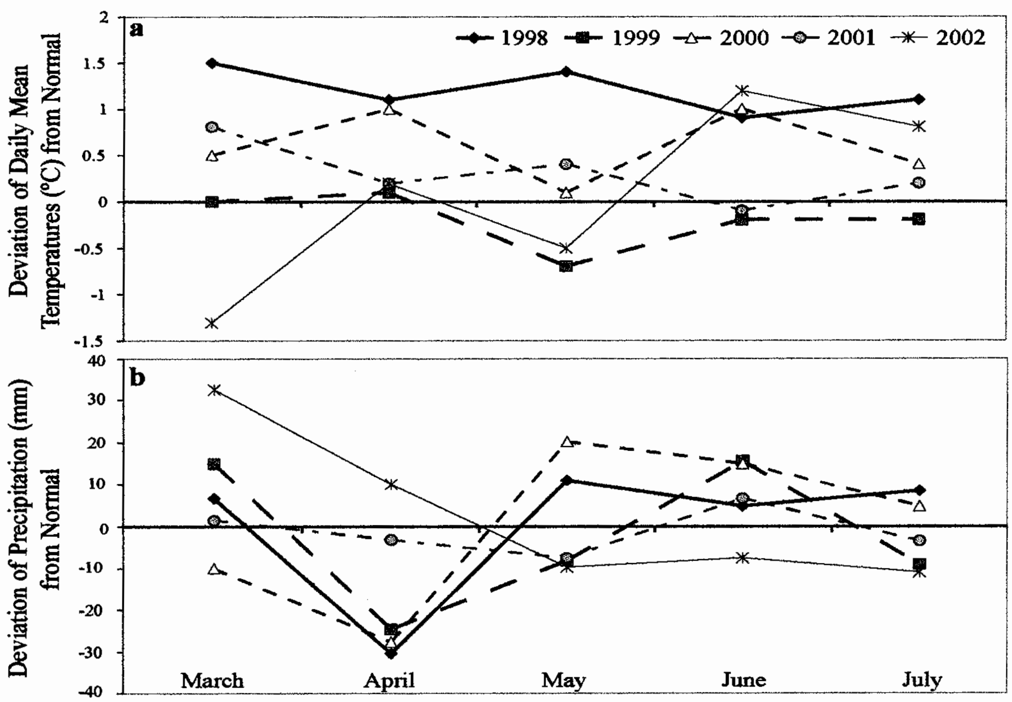

Figure 3.15 Weather data showing deviations from normal as reported at Victoria International Airport for the main growing period for *Camassia* (March - July) from 1998-2002.

Table 3.9 Repeated measures ANOVAs of the effects of site (SITE), treatment (TREAT), time, interactions between factors, and covariate (COVAR; pre-treatment data) on all *Camassia* variables. Significant results in bold (p<0.05). Transformations noted.

Camassia spp. Variables	Effect	Num DF	Den DF	F	P
Cover	SITE	3	6	0.94	0.477
	TREAT	3	83	0.37	0.775
	SITE*TREAT	9	83	1.83	0.076
	time	2	83	2.52	0.087
	SITE*time	6	83	5.11	**<0.001**
	TREAT*time	6	83	0.65	0.686
	COVAR	1	83	18.24	**<<0.001**
Density (*Square root transformed*)	SITE	3	6	0.67	0.599
	TREAT	3	83	1.01	0.394
	SITE*TREAT	9	83	0.85	0.574
	time	2	83	1.97	0.145
	SITE*time	6	83	0.99	0.439
	TREAT*time	6	83	1.03	0.415
	COVAR	1	83	4.61	**0.035**
Leaf Number	SITE	3	6	7.92	**0.016**
	TREAT	3	83	3.16	**0.029**
	SITE*TREAT	9	83	1.27	0.267
	time	2	83	6.04	**0.003**
	SITE*time	6	83	1.39	0.227
	TREAT*time	6	83	0.76	0.607
	COVAR	1	83	5.71	**0.019**
Seedlings (*Square root transformed*)	SITE	3	6	1.26	0.370
	TREAT	3	83	0.93	0.432
	SITE*TREAT	9	83	0.65	0.751
	time	2	83	10.64	**<<0.001**
	SITE*time	6	83	1.52	0.182
	TREAT*time	6	83	1.47	0.197
	COVAR	1	83	6.00	**0.016**
Flowering Plants (*Square root transformed*)	SITE	3	6	6.55	**0.025**
	TREAT	3	83	2.20	0.095
	SITE*TREAT	9	83	2.71	**0.008**
	time	2	83	0.32	0.729
	SITE*time	6	83	2.75	**0.017**
	TREAT*time	6	83	1.20	0.314
	COVAR	1	83	0.86	0.357

Table 3.9 cont. *Camassia leichtlinii* data.

C. leichtlinii Variables	Effect	Num DF	Den DF	F	P
Cover	SITE	1	1	3.30	0.320
	TREAT	3	16	2.14	0.136
	SITE*TREAT	3	16	0.74	0.543
	time	2	16	5.07	**0.020**
	SITE*time	2	16	0.50	0.616
	TREAT*time	6	16	0.72	0.643
	COVAR	1	16	2.36	0.144
Density (*Inverse transformed*)	SITE	1	1	1.56	0.430
	TREAT	3	16	1.15	0.358
	SITE*TREAT	3	16	0.71	0.562
	time	2	16	4.81	**0.023**
	SITE*time	2	16	0.33	0.722
	TREAT*time	6	16	1.81	0.160
	COVAR	1	16	4.24	0.056
Leaf Number	SITE	1	1	15.56	0.158
	TREAT	3	16	6.74	**0.004**
	SITE*TREAT	3	16	3.35	**0.045**
	time	2	16	3.51	0.054
	SITE*time	2	16	1.52	0.248
	TREAT*time	6	16	2.11	0.110
	COVAR	1	16	13.93	**0.002**
Seedlings	SITE	1	1	1.91	0.398
	TREAT	3	16	0.36	0.781
	SITE*TREAT	3	16	0.06	0.978
	time	2	16	1.28	0.304
	SITE*time	2	16	1.59	0.235
	TREAT*time	6	16	0.75	0.621
	COVAR	1	16	1.13	0.304
Flowering Plants	SITE	1	1	7.24	0.227
	TREAT	3	16	3.60	**0.037**
	SITE*TREAT	3	16	1.60	0.229
	time	2	16	1.29	0.303
	SITE*time	2	16	0.24	0.789
	TREAT*time	6	16	1.03	0.444
	COVAR	1	16	0.06	0.812

Table 3.9 cont. *Camassia quamash* data.

C. quamash Variables	Effect	Num DF	Den DF	F	P
Cover	SITE	1	4	1.29	0.320
	TREAT	3	31	1.31	0.290
	SITE*TREAT	3	31	0.31	0.821
	time	2	31	9.17	**<0.001**
	SITE*time	2	31	0.14	0.871
	TREAT*time	6	31	3.27	**0.013**
	COVAR	1	31	5.92	**0.021**
Density	SITE	1	4	1.64	0.269
	TREAT	3	31	0.00	1.000
	SITE*TREAT	3	31	0.40	0.755
	time	2	31	0.91	0.414
	SITE*time	2	31	1.82	0.179
	TREAT*time	6	31	1.58	0.187
	COVAR	1	31	2.22	0.146
Leaf Number	SITE	1	4	2.70	0.224
	TREAT	3	31	1.36	0.274
	SITE*TREAT	3	31	0.15	0.928
	time	2	31	7.85	**0.002**
	SITE*time	2	31	0.59	0.558
	TREAT*time	6	31	1.14	0.364
	COVAR	1	31	0.47	0.498
Seedlings	SITE	1	4	0.57	0.491
(*Square root*	TREAT	3	31	0.18	0.910
transformed)	SITE*TREAT	3	31	0.65	0.588
	time	2	31	9.88	**<0.001**
	SITE*time	2	31	0.74	0.485
	TREAT*time	6	31	0.74	0.619
	COVAR	1	31	0.53	0.473

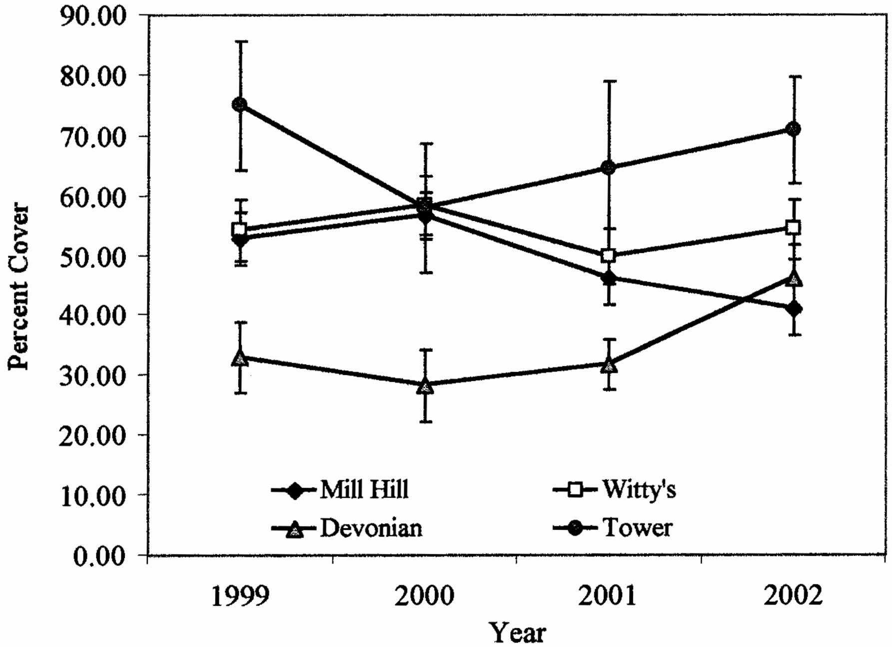

Figure 3.16 Variation in *Camassia* spp. cover by study site over a four year period. Data show means ± 1 SE.

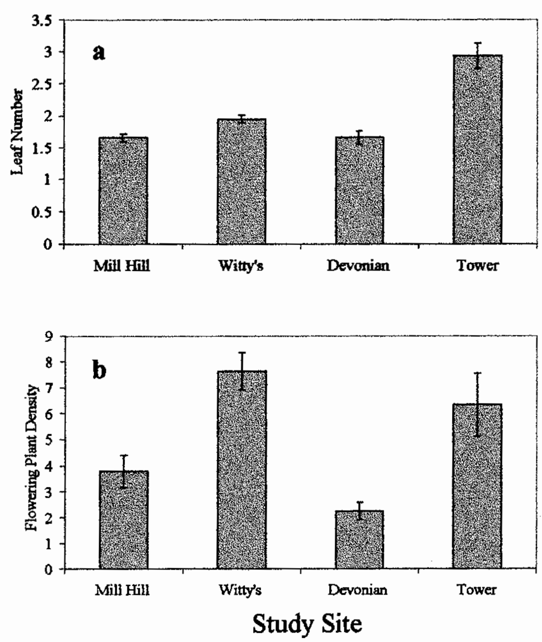

Figure 3.17 *Camassia* spp. leaf number (a) and flowering plant density (b) by study site. Data show untransformed means ± 1 SE for all years.

Point sites were negligible. *Camassia* cover at Mill Hill decreased between 1998 and 2002.

Two *Camassia* spp. population variables - number of leaves per plant ($p=0.016$) and flowering plant density ($p=0.025$) - were significantly related to site. Of all sites, the *C. leichtlinii* plants at Tower Point had the largest mean number of leaves (2.8 leaves/plant) (Figure 3.17a). Although this number seems low, all camas plants, including juvenile plants except seedlings, were considered when calculating this value. The mean for mature (i.e. flowering) camas density was 6.3 flowering plants/400 cm^2, or 157.5 flowering plants per square meter, at Tower Point (Figure 3.17b). This flowering plant density represents 18% of the total mean camas density at this site: the highest proportion of flowering plants recorded for all four sites (See Chapter 4, Table 4.1, for more discussion on the number of mature camas plants among the study sites). Alternatively, Tower Point had only 14% of the total number of seedlings and 66% of the total plant density when compared to the other study sites, although these analyses were not statistically significant. When these population results were compared to the high plant cover at this site, it reasoned, therefore, that a high percentage of *C. leichtlinii* plants at Tower Point were large, immature and mature plants, with few smaller, juvenile individuals.

The Devonian site recorded the lowest means for both *Camassia* leaf number (1.6 leaves/plant) and flowering plant density (2.2 flowering plants/400 cm^2). This site, however, had a high total plant density (52.1 plants/400 cm^2) of which many were seedlings (8.3 seedlings/400 cm^2), though these values too were not statistically significant for *Camassia* spp. at this site. Nevertheless, these high densities, when compared to the low mean plant cover, leaf number, and flowering plant density, suggested that many of the *C. leichtlinii* plants in the Devonian plots were smaller, immature individuals. As there were only two blocks of study plots at Devonian, as mentioned previously, the block burned in 1998 was likely contributing to these analytical results.

In all cases except flowering plant density, significant covariate effects were recorded indicating that the initial variability of the camas plants affected subsequent growth and development.

3.3.3.4 Camas Analyses: Treatment Effects

Time and treatment effects became more apparent when each *Camassia* species was analyzed separately (Table 3.9). Effects of individual treatments were plotted over time for percent cover and all population characteristics of both *C. leichtlinii* (Figure 3.18a-e) and *C. quamash* (Figure 3.19a-d). Significant effects, if they occurred, are noted on each graph. Flowering plant density of *C. quamash* was not included as the data could not be normalized.

Overall, percent cover of *Camassia leichtlinii* decreased 29% in the first year (2000), but then increased to pre-experiment cover levels by 2002 (Figure 3.18a). As *C. leichtlinii* cover increased at Devonian when both species were analyzed together, this effect for *C. leichtlinii* data alone was likely moderated by the changes in camas cover at Tower Point. *C. leichtlinii* density also increased 11% from 2000-2002 (Figure 3.18b). Overall, the trend in percent cover for *C. quamash* was opposite as that for *C. leichtlinii*: cover increased initially by 9%, but then decreased over the next two years to 84% of the pre-experiment cover mean. Again, the decrease of *C. quamash* cover seems to be influenced by the reduced camas cover at Mill Hill.

Treatment had no significant effect on either *C. leichtlinii* cover or density (Table 3.9), but leaf number and flowering plant density were significantly affected (Figures 3.18d,e). The control plots had the highest mean leaf number (2.4 leaves/plant), and the highest density of flowering plants (6.2 flowering plants/400 cm^2). For both variables, treatment did not significantly differ among all applied treatments, possibly indicating that mature camas plants had shifted growth forms (i.e. became vegetative) to compensate for the disturbance. Although it seems plausible that the density of flowering plants would decrease in the harvest treatment plots because the larger, and hence mature, bulbs were permanently removed from the plots, the harvesting and burn combined

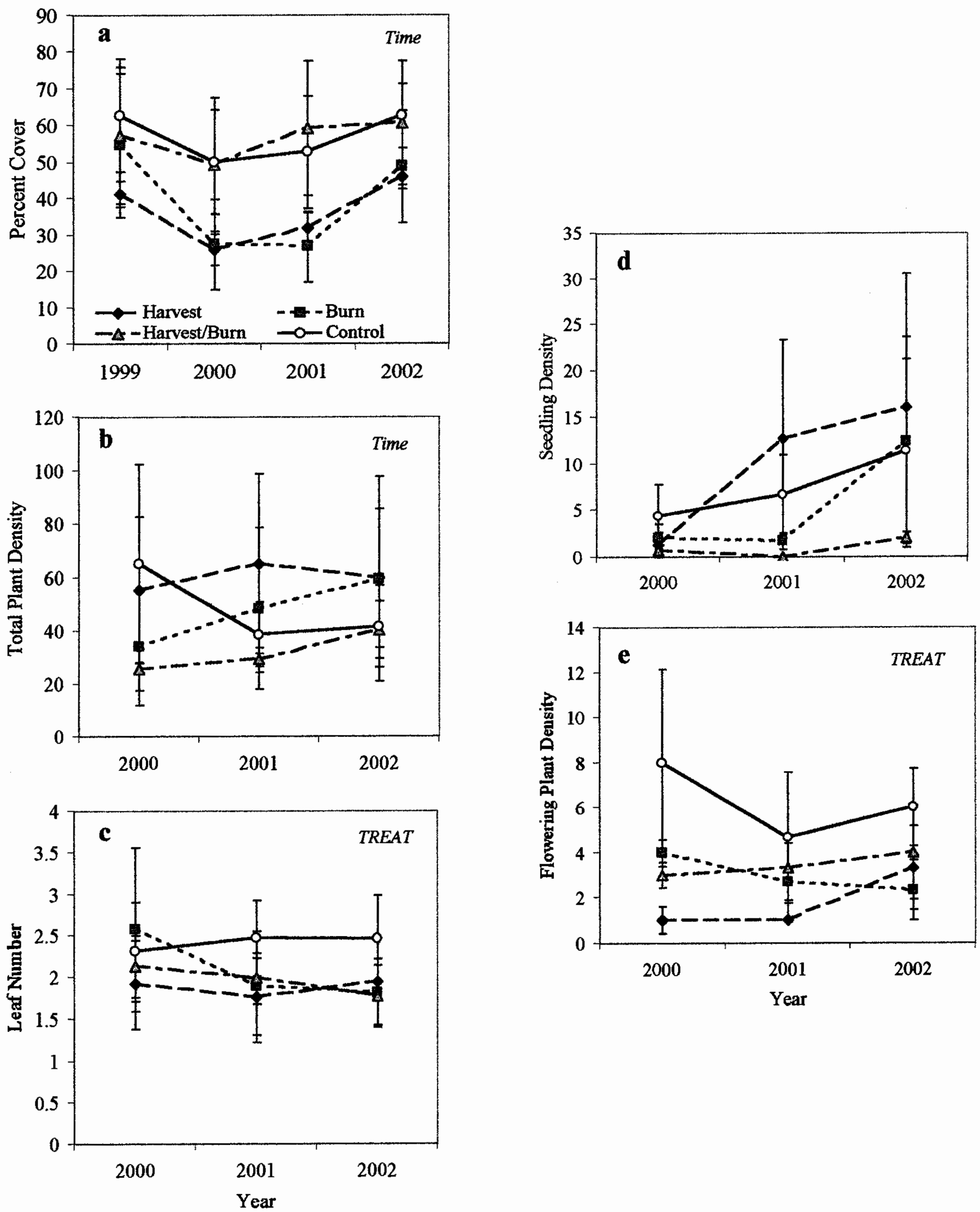

Figure 3.18 Treatment effects over time for *Camassia leichtlinii* (a) cover, (b) total plant density, (c) leaf number, (d) seedling density and, (e) flowering plant density. Data show untransformed means ± 1 SE. Significant results from repeated measures ANOVAs in italics (see Table 3.9).

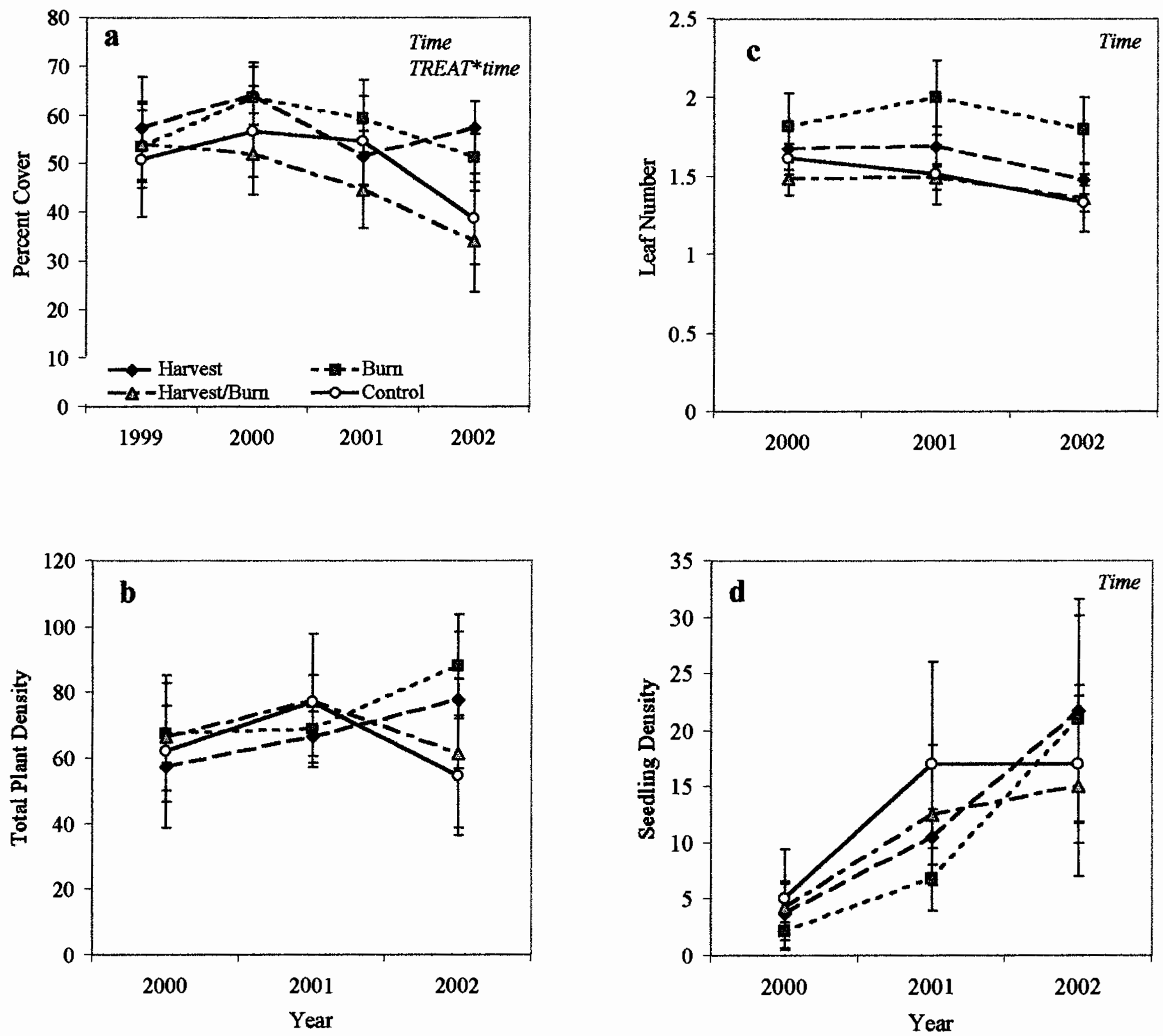

Figure 3.19 Treatment effects over time for *Camassia quamash* (a) cover, (b) total plant density, (c) leaf number and, (d) seedling density. Data show untransformed means ± 1 SE. Significant results from repeated measures ANOVAs shown in italics (see Table 3.9).

(harvest/burn) treatment (Figure 3.19e) recorded the second highest mean value (3.4 flowering plants/400 cm^2) for *C. leichtlinii* plots overall.

For *Camassia quamash*, harvesting caused variable cover effects when applied alone, but negatively affected cover over time when the harvesting treatment was combined with burning. There were no treatment effects for *C. quamash* population data, but means for leaf number and seedling density significantly changed over time (Table 3.9). The percent decrease in leaf number was slight (6%), whereas the mean number of seedlings increased by 80% from 3.8 seedlings/400 cm^2 (2000) to 18.7 seedlings/400 cm^2 (2002) (Figure 3.19d). Although not significant, the sharp increase in seedling density appears to be influenced largely by the positive results of the harvesting and burning treatments. Furthermore, other environmental factors (e.g., weather, off-trail hikers), could have influenced *Camassia quamash* growth.

3.3.4 Discussion of Field Study

The study plots in the three CRD Parks all showed significant site heterogeneity at both regional and local scales. Regional variation, or the ecological differences among the sites, was likely influenced by climatic, environmental, and edaphic factors. Local, or intrasite, variation was likely influenced by varying composition of plants of different life forms and microsite differences (e.g., soil depth) (Kost and De Stevens 2000). Low-impact disturbances are common within local park environments. Furthermore, although they exist within suburban or rural settings, these parks are not exempt from larger-scale disturbances: the 1998 wildfire which occurred at Devonian Regional Park being an example.

Generally, spatial variability appeared to affect the results of this field study. For example, a high degree of environmental heterogeneity was visually demonstrated through DCA ordination graphs of plant cover. Moreover, when *Camassia* spp. data were analyzed together by repeated measures ANOVAs, significant site differences were the predominant effects. These differences supported the conclusions that the two *Camassia* species demonstrate substantial variability in their ecological requirements, as the four study sites exhibited different compositions of camas species. For example, Witty's Lagoon had over twice as many mixed-camas plots as Mill Hill indicating that *C. leichtlinii* is more prevalent at this site. Only *C. leichtlinii* was identified at Devonian and Tower Point, but these sites varied in both environmental conditions and site histories. Habitat heterogeneity was also confirmed by the high incidence of significant covariate effects in the analytical results. These effects signified that the initial variability within the camas populations at each site affected the outcomes of each analysis.

Temporal variability became apparent when the two *Camassia* species were analyzed separately. The effect of time was recorded for all plots indicating that some outside factor, such as weather patterns, were affecting camas growth and phenology, more than experimental treatments. Temporal variability was also clearly seen in the ordination of the control plots for all years of the field study, especially in the first year. Finally, the large standard errors which were recorded for the single-species analyses are consistent with the high temporal and spatial variability in this ecological research overall. Rideout *et al.* (2003) also theorized that environmental factors, such as weather or soil disturbances, rather than fire, resulted in high variability in plant communities.

Although *Camassia* development generally appears to be regulated by an annual dry season (Statham 1982), and *C. quamash* grows well in xeric conditions and shows high resilience to disturbance (see Hebda 1992), drought conditions appeared to be unfavourable to *Camassia* growth on shallow-soil sites such as rocky outcrops. These effects most strongly influenced the *C. quamash* populations at Mill Hill (Figure 3.20), but likely affected the *C. leichtlinii* plots situated in the area of the 1998 fire at the Devonian site as well. Extreme xeric conditions result from changing weather patterns on a regional scale (e.g., low rainfall, extended summer drought), or from intensive disturbance on a local or microhabitat scale (e.g., wildfire or experimental treatments). The combined factors of repeated disturbance and drought conditions impacted plant recovery by contributing to very limited moisture availability in the soil.

Camas plants responded to unfavourable environmental conditions and changes in community stature by changing their growth patterns (e.g., Huffman and Werner 2000;

Harvested (July, 1999)

Burned (September, 1999 and 2000)

Harvested and Burned (same dates as above)

Control

Figure 3.20 Mill Hill study block of four treatment plots in 2002, the last year of the study. Note the mature Scotch broom (*Cytisus scoparius*) in the control plot.

Rideout *et al.* 2003). Although the 1998 fire at Devonian was reportedly very intense (T. Fleming, CRD Parks Biologist, pers. comm. 2003), and was no doubt more intense than the small experimental burns, perennial subterranean structures, such as camas bulbs, were likely protected by the insulating effects of the soil (e.g., Tompsett 1985). If environmental conditions are found to be suboptimal, abortion of the flowering stage can result (Loewen *et al.* 2001), or bulbs may remain dormant during the growing season until favourable conditions occur for reproductive growth in subsequent years (Anderson 1997). *Camassia leichtlinii* showed variable growth patterns, such as prolonged dormancy, in cold frames in the nursery study, a setting where environmental conditions were stable and more consistent than in natural settings.

One way that *Camassia leichtlinii* appeared to respond to disturbance was by reducing its number of leaves, an effect that likely contributed to the low percent cover overall. *C. leichtlinii* plants at Devonian had fewer leaves per plant on average than the mixed-camas population at Witty's Lagoon, although *C. leichtlinii* commonly has more leaves than *C. quamash*. This effect was likely influenced by the 1998 wildfire at this site. Reduced leaf number or modification of vegetative stature was likely a method for established camas plants to lessen nutritional stress but maintain photosynthetic capacity in unfavourable habitats (e.g., Jewell 1978). These results reflected changes within the established population as the leaf attribute analyses did not include seedling data. However, this site also recorded a high total plant density, including many seedlings, indicating that seedling recruitment was enhanced (e.g., MacDougall 2002). Aggressive weed species may also reduce seedling development (Chambers 2001). Treatments that negatively impact growth of weedy species would likely favour the establishment of camas seedlings. Changing environmental conditions (i.e. nutrient pulse) following the wildfire possibly influenced the recovery of *Camassia leichtlinii* at this site.

Of all sites, the *C. leichtlinii* at Tower Point had the greatest number of leaves per plant. The verdant appearance of this site primarily occurred because of the high density of large vegetative camas wherever a soil pocket existed, but where trampling from the nearby trail was minimal (pers. obs.). Although the Tower Point plots no doubt receive occasional minor disturbances from off-leash dogs, the large stature of the *C. leichtlinii* on-site may be an indication that a major disturbance has not occurred for some time. As an additional point of speculation, the lush camas growth at Tower Point may possibly be a remnant condition of past Indigenous cultural use associated with the adjacent fortification and midden features (e.g., Site DcRv58, Beram 1988).

The two species of *Camassia* did not appear to co-dominate, in terms of flowering potential, when growing together in mixed-camas plots. For example, *C. quamash* flowering plants were more abundant than those of *C. leichtlinii* after the harvest and burn treatments were applied at Witty's Lagoon. It seems possible that the flowering potential for *C. quamash* was enhanced because of the reduction in the stature of, and therefore, reduced competition from, associated species, including *C. leichtlinii.* Verbeek and Boasson (1995) found that *C. quamash* racemes flower either at the same height as, or above, surrounding vegetation. Pollination, predation, and nutrient competition all affect the flowering potential of the raceme (Verbeek and Boasson 1995). Moreover, if *C. quamash* can tolerate drier and more exposed habitats than *C. leichtlinii* then it is plausible that the altered microsite conditions of the mixed-species plots from harvesting and burning may favour the growth of *C. quamash* over *C. leichtlinii.*

3.4 CHAPTER DISCUSSION AND CONCLUSIONS

The applied ecological studies on camas growth and development described in this chapter represent the first research of this kind on southern Vancouver Island. Although camas bulbs are a well-recognized staple food in the former diet of local Straits Salish peoples, the specific ecological outcomes of their management practices for this important cultural resource were poorly understood. How do Indigenous management activities translate to the ecological responses of the plants resources and resource communities? This chapter provides fundamental information to help describe these former ethnoecological relationships between Straits Salish peoples and *Camassia.*

3.4.1 *Camassia* Research: Major Conclusions

Camassia is an excellent candidate for regular management. *Camassia* plants are spring ephemerals, having a growth strategy commonly adopted by species in dynamic ecosystems. In general, plants, such as camas, in habitats that are heterogeneous or periodically disturbed (i.e., fire-adapted) tend to be generalists and display a wide range of reproductive strategies and growth forms. In fact, the results from fire experiments in other localities show a high degree of variation in responses in camas frequency and cover are more the rule than the exception. Hence, camas is capable maintaining a range of growth stages that are more resistant to suboptimal environmental conditions (i.e. dormancy).

The results from both my nursery and field studies support these interpretations. In nursery cold frames, even though the plants were grown in favourable growing conditions, the original cohort of surviving *C. leichtlinii* plants (n = 228) displayed prolonged dormancy, a pattern not reported previously for *Camassia* in this region. Some of these plants reproduced asexually through bulb division, another growth pattern formerly unrecognized for local camas populations *in situ*. It is widely reported in the horticultural literature, however, that *C. quamash* readily reproduces by bulb division in gardens and vegetative reproduction could be triggered through damage to the basal plate of the bulb. In my nursery study, vegetative offsets displayed 18 different growth patterns which included a high rate of sexual reproduction. A number of different growth trends were recorded for demographic attributes of the plants, such as leaf number and flowering stalk height. Flowering frequency, or the camas plant's capability to flower regularly, appears to be the best above-ground indicator of bulb size. On the whole, camas bulbs, including juvenile and offset bulbs, can be transplanted with limited mortality and dormancy. Camas populations need at least two years after transplantation to "settle in;" rates of flowering, bulb division, and bulb development could all increase after this time if favourable soil conditions are maintained.

The evaluation of how camas responds to simulated Indigenous management patterns was undertaken in the field study. With the exception of the xeric plots at the

Mill Hill site, *Camassia* populations remained relatively stable over time regardless of experimental treatment. When the two species were analyzed together, site differences were the predominant significant factor. This finding supports the idea that the two species vary from one another in their ecological requirements, but they vary in space and time, as indicated from the fact that both species were recognized in the same plots only after treatments were applied. Thus, with an environmental cue, camas plants can be sexually mature (means for positive identification) after a period of prolonged dormancy, a pattern confirmed from the nursery study.

Significant treatment effects proved difficult to detect in this field study. When the two species were analyzed separately, the primary measure of significance was a time effect, an outcome likely influenced by weather patterns (i.e. drought) during the study period. Treatment plots, as a whole, significantly differed from the control plots. Moreover, the effects of the combined treatment of harvesting and burning often differed from individual treatment effects. *Camassia* growth patterns vary over time regardless of specific treatment effects, but cumulative effects from combined disturbance patterns could play an important role in affecting camas development. Hence, the main ecological objectives of Indigenous management may have been for the enhancement of certain desirable growth outcomes (e.g., bulb division and big bulbs), as well as the general maintenance of environmental conditions favourable to camas and control of associated plant species (e.g., invasive woody species) which did not fare as well as camas or other geophytes.

Research in both the nursery and the field clearly indicate that the two camas species have been greatly underestimated in terms of distribution and density. This geophyte is highly adaptable and when the two species on southern Vancouver Island - *Camassia leichtlinii* and *C. quamash*- are both taken into account, the genus has a wide local distribution and can grow together in a range of habitats. The distribution and abundance of each species appears to be related to environmental conditions, especially microsite heterogeneity, and site history including disturbance patterns on different spatial and temporal scales. It is possible for *Camassia* to remain in a vegetative or dormant state for several years. As well, seedlings and juvenile plants appear to represent well over 80% of the total camas density in natural habitats.

Clearly, there are still many unknowns regarding camas ecology and the role of disturbance, anthropogenic or otherwise, in camas habitats. These results reveal merely tips of the research iceberg: many more questions were generated from this research than were answered.

3.4.2 *Camassia* Research: Reflections and Directions

The nursery and field studies proved challenging to design and implement and the results from both left many openings for the advancement of revised and new research methodologies. With a lack of local native plant nurseries, for example, plant stock for nursery studies is difficult to find. Obtaining plant material for the study from a natural setting limited my ability to describe accurately the pre-study conditions and characteristics of the camas plants. Working in open cold frames outside also meant that the beds needed to be regularly weeded and monitored to make sure the plants were not damaged or disturbed.

There are many aspects of demographic study that should be considered for future nursery research. A better understanding of prolonged dormancy and the variety of means by which camas plants regulate development is needed. Seed production and seedling establishment could be tracked, as well detailed monitoring of the development of juvenile and offset individuals could be implemented. By what means do camas bulb produce offsets? How do the bulbs move through the soil? Specific experiments involving aspects of Indigenous management need to be conducted under nursery conditions. How do digging, burning, ash or fertilizer addition, and offset removal and replanting all affect camas growth and development in controlled settings, for instance? These experiments could be set-up in a nursery study where the plants are placed further apart in cold frames or grown in individual pots. Bulbs could be dug up on a regular basis (i.e. monthly) to more accurately describe bulb movement and rates of bulb division. For example, Pütz (1993) successfully studied underground bulb movement by growing *Nothoscordum* in pots with removable apertures. Nursery studies are key to the future ecological and ethnoecological experimentation of *Camassia* due to the high degree of variability in natural habitats. A more in-depth analysis of crop research and horticultural studies would be useful.

Camas habitats of today are highly restricted to shallow-soil sites. The establishment of sound ecological studies is challenging in habitats that show tremendous heterogeneity at both regional and local scales. Finding accessible camas habitats that meet with prescribed research criteria and where novel forms of experimental management (i.e. fire) are permitted is difficult in this region. Moreover, in these habitats, the degree of environmental variability is often not detected without ecological experimentation. Apparent and unanticipated site differences make the scientific interpretation of *Camassia* distribution and composition a difficult task, a situation also found by other researchers working in highly heterogeneous locales (e.g., Chambers 2001). High levels of significant site and covariate results indicated that the plots and the study sites were significantly different from one another. Limited sample size also affected the results of the individual species analyses. If not in controlled settings, future ecological studies and management involving disturbance on any scale in typical camas habitats (i.e. shallow-soil sites) will need to be assessed at a local or "finer grain scale" (Rideout 2003:39), or occur in more homogeneous sites (deep soil sites).

More research on the relationships between camas growth and phenology and soils (e.g., type, moisture, pH, texture, and chemical composition) would prove valuable. How does soil moisture affect *Camassia* growth on Vancouver Island? Could the camas growing in bogs and estuarine meadows represent a hygric end of an environmental continuum of camas habitats? At the other end of the range, shifting weather patterns (i.e. climate change) may adversely affect camas populations in xeric habitats (i.e. Mill Hill). An important question that needs to be addressed is how disturbance agents, such as digging and burning, affect soil conditions. Do treatments affect nutrient availability for camas bulbs?

More ecological research on camas communities is needed. How do other plant species respond to simulated Indigenous management, and how do their responses affect camas populations? Other important questions are how exotic species are affected by disturbance, and the overall efficacy and feasibility of re-introducing Indigenous management into ecosystems with a very different vegetation composition. More research is also needed on the effects of animals, herbivorous insects, and other pests and pathogens on camas productivity. How do herbivory and trampling affect camas growth? Exclosure experiments in natural settings or simulated disturbance (e.g., clipping of leaves) in a nursery could be conducted to answer these questions. Furthermore, a better understanding of the former (i.e. pre-contact) natural agents of soil disturbance would be useful information in landscape reconstruction models.

Molecular research on *Camassia* over its entire range is long overdue. No research on the genetic variability of camas has been done to date on a possible correlation between past Indigenous manipulation and transplantation of camas bulbs and the current taxonomic divisions and geographical distributions of the *Camassia* subspecies. First Nations have been known to increase the ecological amplitude of resource plant species (Anderson 1993). What role did humans play in the speciation of *Camassia* and the sub-speciation of *C. quamash* (Thoms 1989). Furthermore, how do seasonal fluctuations in carbohydrate composition affect nutrient availability for camas harvesters? Research on the chemical structure of the bulbs should be undertaken.

Solid evidence of hybridization is unknown within this region even though it has been suspected for the two species (Hebda 1992). Do the two species hybridize? In 1890, Luther Burbank (1914) successfully hybridized *Camassia* under experimental conditions. However, his attempts at making aesthetically striking varieties with large edible bulbs were commercially unsuccessful (Burbank 1914; Griffiths and Ganders 1983).

Finally, there are many outlying occurrences of camas populations recorded from herbarium specimens that could be groundtruthed. Do these occurrences represent past Indigenous gardens or remnant populations from a warmer and drier time in the geologic past? What is the current range of camas in western Canada? The taxonomic identification on herbarium specimens should also be updated and/or clarified.

4.0 CAMAS CULTURE: ETHNOECOLOGY OF A STRAITS SALISH ROOT FOOD

> ...concerning the native population. Poor creatures! their future presents a sufficiently miserable prospect:... The salmon, on which they relied for subsistence, is caught by the white man, and by him pickled and exported; the camass, on which they almost equally relied, is exterminated as a noxious weed. ...Where the white man settles, there the red man disappears:...
>
> -- Capt. W.C. Grant (1861:210)

Over time camas has continued to play a role in the livelihood of Straits Salish peoples. Today, camas bulbs are once again being harvested and managed by members of the Songhees First Nation, although these restoration-focused activities are largely ceremonial and educational at the present time. It is impossible to know exactly when the two species of *Camassia* that grow on southern Vancouver Island were initially incorporated into the Indigenous diet, but it is clear that camas has been an important vegetable food for several thousand years.

In this chapter I elucidate the complex ethnoecology of Straits Salish camas cultivation. The management of root foods will be first summarized generally on three levels based on spatial scale, the degree of interaction, and the relative extent of disturbance. I will then describe the ecological effects of management activities at these different environmental levels. Based largely on the findings of Chapters 2 and 3, camas management is described at both spatial and temporal scales, and environmental factors are considered. I will consolidate this multiscalar information into a reconstruction of the dynamics of the camas harvesting grounds of the past. The influence of patterned and coordinated Indigenous management practices on ecological structure and function is illustrated in a ethnoecological model. Two conceptual questions will also be addressed: which camas species was preferred, and how many bulbs were harvested annually by Straits Salish peoples? With the incorporation of ecological data on camas habitats, an approximation of on-the-ground harvesting yields by Indigenous peoples is computed and described.

I end this chapter with a detailed depiction of a possible continuum of camas management over the last 6000 years. This section, drawing from the environmental and cultural histories reviewed in Chapter 1, describes how management activities likely evolved over thousands of years to produce a camas food production system in this region. The end of the camas culture occurred rapidly with colonization, and the supplanting of the native root crop with an introduced one, the field potato (*Solanum tuberosum*), is briefly discussed as a contributing factor to this breakdown.

4.1 OVERVIEW OF ROOT FOOD MANAGEMENT

The ethnoecological evaluation of root foods presented in this chapter represents only a fraction of Indigenous management activities from this region (see Turner and Peacock in press). First Peoples across North America influenced the abundance and range of important plant resources through these activities, both intentionally and inadvertently (McCann 1999). Ecosystems can become less productive (i.e. reduced yields) and less diverse over time without periodic disturbance to maintain resource populations and diversify ecosystem structure and function (Anderson 1993; Peacock 1998). The management of plant species maintained variable "dimensions of disturbance" (c.f. Palmer *et al.* 1997:296) that varied through different spatial and temporal scales and served to promote the productivity, availability, and reliability of resource species and enhance plant growth and development (e.g., Anderson 1993). These patterned cultural practices of plant production served to reduce economic risk in variable environments.

Plant resources have "cycles of productivity" that fluctuate in response to both ecological processes and cultural practices (Peacock and Turner 2000:153). For Indigenous peoples of the Pacific Northwest, the patchiness of plant resources resulting from the inherent spatial and temporal variability of the environment was not only maintained directly through applied management practices, but was also addressed through long-standing socio-economic structures that included broad family networks, proprietorship of resource sites, and patterns of redistribution of commodities (e.g., potlatch, trade) (Suttles 1987; Turner and Loewen 1998), as well as specific techniques of resource preservation and storage (Suttles 1987).

Plant management strategies were structured around the fundamental economic needs of a society but rooted within a socially-conceived context (Peacock and Turner 2000). First Peoples understood ecological processes and successional pathways, and likely had extensive knowledge of the developmental pathways of their local resource plants (Boyd 1999b; Turner and Peacock in press). Moreover, Indigenous people traveled across their economic territory in patterned seasonal movements to access plant and animal resources that were culturally desirable in both quantity and quality (c.f. Peacock and Turner 2000).

Investigations of Indigenous plant management, including root foods, as it exists on different ecological scales have been described in the works of Ford (1985), Harris (1989), Anderson (1993, 1997), Nicholas (1999), Deur (1999, 2000, 2002), and Peacock and Turner (Peacock 1998; Peacock and Turner 2000; Turner and Peacock in press), among others. This chapter draws from, and builds on, their research.

4.1.1 Levels of Root Food Management

It should be noted that this general review of root food management represents synthesized information from many different academic sources, different researchers, and from different Indigenous groups (c.f. Turner and Peacock in press). There is a great diversity of First Peoples who live in the Pacific Northwest and the intricacies of past root production systems, like their other facets of their cultures, varied from group to group and from family to family. Furthermore, this work incorporates data from sporadic and incomplete references. Therefore, the following information should be reviewed as a necessarily conservative reconstruction. The extent and complexity of Indigenous practices, and of the accompanying traditional environmental knowledge, were probably more extensive (c.f. Turner and Peacock in press).

Geophytic plants were likely tended and manipulated by First Peoples on variable scales of intensity and effort, depending on the social importance and economic contribution of the resource to the village community or family unit, and on the relative distribution and degree of abundance of the root species across the landscape. The Indigenous management continuum included basic foraging activities, intensified horticultural practices, and planned and coordinated cultural knowledge including criteria for selective harvesting, methods for regulating resource access and use, and other socially based protocols of resource use and management (c.f. Turner and Peacock in press).

For this general discussion, management activities are categorized into three levels – population, community, and landscape – based on spatial scale, the degree of interaction between people and their resources, and the relative extent of disturbance within the ecological system (c.f. Peacock and Turner 2000). These levels work in concert with one another to maintain a resource site within a given environment (Figure 4.1). The population level includes the spatially focused management activities that occur at the harvest site. This level involves a high degree of people-resource interaction and environmental disturbance, and includes the scheduling and selection criteria for harvestable resources (e.g., specific period of annual growth, root size or composition), and the horticultural practices applied during harvesting (e.g., tilling, weeding, sowing, transplanting). The community level involves more spatially diffuse activities across the resource habitat. Management on this level includes cultural practices which act to shift ecological processes, such as clearing, fertilizing, and burning. Landscape-scale management, the final level of root food manipulation, represents the "totality of peoples' management effects," and includes the land use principles and social mechanisms that regulate, control, and shape their economic territory (Turner and Peacock in press). This last level is the most spatially diffuse and embodies the social context of management.

4.1.1.1 Management at the Population Level

The population level was the fundamental unit of Indigenous management (Peacock 1998; Turner and Peacock in press). The most direct, tangible interaction between harvester and plant resource occurred at this spatial scale. For root resources, management included the specific harvest criteria, such as the precise scheduling of the harvest (Peacock and Turner 2000), to meet with both environmental (e.g., seasonal variation) and cultural (e.g., frequency of use) constraints. Also included at the population level were the different horticultural techniques employed to remove the roots from a resource site and maintain the resource population. The activities of digging, tilling, and weeding generally occurred in conjunction with harvesting and principally served to facilitate easier extraction of roots from the soil. The horticultural practices of sowing, and the manual removal and replanting of root resources, involved greater human input and planning; these activities incorporated the purposeful, and sometimes inadvertent, rearrangement of propagules (i.e. seeds, offsets, or juvenile plants) within the same harvest site or their redistribution into new resource localities. These activities may have also affected resource plants on a genetic level (Anderson 1997; McCann 1999).

Harvest strategies for root plants included the deliberate selection criteria based on cultural preferences for resources in certain stages of growth or maturity, as well as on the biological capacity of the harvesting site (Turner 1997; Peacock 1998; Peacock and Turner 2000; Turner and Peacock in press). Timing and methods of harvesting were strongly influenced by the environmental conditions of the resource site. Age class or size was the most often used criterion for selection of harvestable roots (Peacock 1998; Turner and Peacock in press). Most commonly, the larger growth forms were sought out. Parts of roots, juvenile roots, or offset propagules were often purposefully left in harvested plots to increase in size or finish maturation (Daubenmire 1970; Loewen 1998; Deur 2002; Turner and Peacock in press). Even before digging began, the size of the below-ground roots was estimated from the size or developmental stage of above-ground plant structures (Thoms 1989; Turner 1997). For example, multiple flowers in yellow glacier lily (*Erythronium grandiflorum*) were correlated with large bulbs (Loewen 1998; Peacock and Turner 2000), and multi-stemmed spring beauty (*Claytonia lanceolata*) plants had larger corms than single-stemmed plants (Turner *et al.* 1990). A particular stage of annual growth could have also been linked to a certain preferred texture or composition of the root resource (Daubenmire 1970; Turner 1997; Suttles in press).

Many root vegetables were harvested just after peak flowering or while in seed

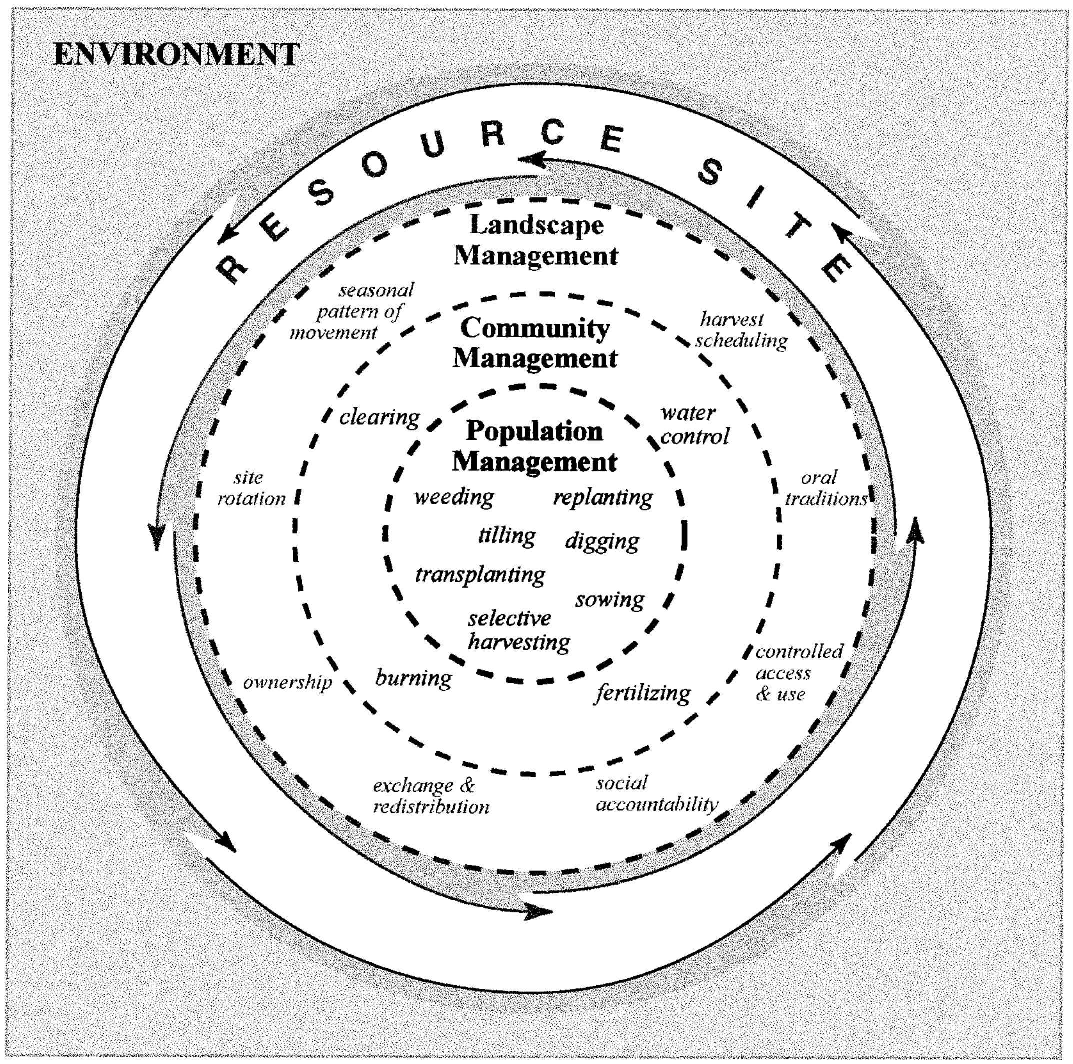

Figure 4.1 Cultural management model for root foods showing the three integrated dimensions of resource management, with representative examples, practiced by Indigenous peoples within a given environment.

(Daubenmire 1970; Turner 1995, 1997; Loewen 1998). However, harvesting just prior to flowering was recognized for some species of roots (e.g., wild onions [*Allium* spp.], bitter-root [*Lewisia* spp.]) (Turner 1997).

Cultural preferences for particular habitat conditions served as selection criteria as well (Peacock 1998; Turner and Peacock in press). Camas (*Camassia* spp.) bulbs were best harvested from rocky sites, because the bulbs were shallow and easy to extract (Suttles 1951a; Suttles in press). Yellow glacier lily bulbs were dug while the soil was moist and soft, because the bulbs were difficult to remove from hard summer soils (Turner *et al.* 1990). Sandy soils were purportedly better for root gardens of the Nuu-chah-nulth and Kwakwa̱ka̱'wakw because the soil was more easily dug, and the roots (springbank clover [*Trifolium wormskjoldii*] and silverweed [*Potentilla anserina*]) tended to be a larger size and more easily cleaned (Turner and Kuhnlein 1982; Deur 2000).

Physical methods of harvesting were largely determined by the population structure of the resource. For roots growing just below the soil surface (e.g., spring beauty and rice root [*Fritillaria* spp.]), the sod or turf containing the plants was cut in sections and inverted or sorted (Kuhnlein and Turner 1991; Turner 1997). Selected roots could then be simply removed from the underside of the cut section or from the ground immediately beneath. This procedure was also utilized in the past for camas in shallow-soiled locales, such as rocky outcrops (Suttles in press). For deeper growing roots (e.g., yellow glacier lily), bulbs were harvested from sub-surface soils after the sod layer was removed (Peacock and Turner 2000). In both cases, the sod was generally replaced after harvesting.

In western North America, a variety of horticultural practices were used to extract root vegetables from the soil and affected the growth and development of plant populations (Peacock 1998; Turner and Peacock in press). In general, digging was the most common method used to harvest plants for use as food, as well as for medicines and various technological products (Turner and Peacock in press). Digging facilitated the harvesting of geophytic resources through the mechanical tillage of the soil (Ford 1985; Anderson 1993; Turner and Peacock in press). A digging stick made of a hard wood, horn, bone, or after European contact, iron, was the principal tool used to harvest root resources in the Pacific Northwest (e.g., Suttles 1951a; Babcock 1967; Thoms 1989; Peacock and Turner 2000; Turner and Peacock in press), and around the world (e.g., Tonkinson 1978; Anderson 1997; Dunmire and Tierney 1997; Rea 1997).

Weeding of unwanted or non-utilitarian plants from a resource plot may have occurred during harvesting (Turner 1995; Peacock 1998; Peacock and Turner 2000; Turner and Peacock in press; Deur 2002). For example, both camas (Turner and Kuhnlein 1983) and bracken (*Pteridium aquilinum*) (Norton 1980) beds were weeded, as were coastal root gardens of springbank clover and silverweed (Deur 2002).

Vegetative propagules, juvenile roots, and root fragments were often replanted within a resource plot (Turner and Efrat 1982; Loewen 1998; Deur 2000; Peacock and Turner 2001; Turner and Peacock in press). Sowing, or the deliberate broadcasting of ripe seeds directly back into the soil, was not widely recorded for these cultural species (but see Stern 1934; Peacock 1998; Suttles in press).

Whole plants, seedlings, cuttings, or other propagules could have also been removed from a harvesting site and replanted into new resource locales (Peacock 1998; Turner and Peacock in press; Suttles in press). Nlaka'pamux transplanted the bulbs of yellow glacier lily to low elevation sites (Turner *et al.* 1990). The Colville peoples transplanted camas bulbs from the Kalispel peoples (Turner *et al.* 1980), and the Nuu-chah-nulth transplanted camas bulbs obtained from the Straits Salish (Turner and Efrat 1982; Turner *et al.* 1983). Springbank clover rhizomes and silverweed root fragments have been planted into village gardens to increase the resource density and maintain readily accessible supplies for trade (Deur 2002; Turner and Peacock in press).

4.1.1.2 Management at the Community Level

In addition to manipulation of individual populations, Indigenous peoples managed root resources on a larger scale to achieve a particular community structure or successional pattern (Turner and Peacock in press). The two main objectives of community-level management were clearing and fertilizing, and both were most often realized through the use of fire.

As a form of weeding, the clearing of woody debris or rocks from a harvest site could have occurred during the time of harvesting. However, purposeful clearing of vegetation on a larger scale, and at different times than the harvest period, also occurred. This was likely the case for limited-use sites, especially those to which Indigenous peoples were confined for access after European contact. For example, Christopher Paul (Saanich) described the clearing of camas beds in the fall or spring to facilitate easier harvesting of camas bulbs in the following harvesting season (to Babcock 1967).

Although fertilizing could be considered a localized horticultural activity as well, it is discussed here briefly as a form of general soil enrichment, similar to that which could result from naturally-occurring water inundation or regular burning of resource patches. Records of the manual application of fertilizer on root resource populations are rare in the Pacific Northwest, although White (1999) reported that Coast Salish peoples worked plant refuse into the soil around the bulbs of tiger lilies (*Lilium columbianum*). Mary and Agnes George (T'sou'ke) (in Suttles in press) described adding seaweed to camas beds as a fertilizer. However, Suttles (in press) cautioned that this practice may have been a post-contact treatment. Indigenous peoples also sometimes fertilized their berries and crops of introduced field potatoes with seaweed (Turner and Peacock in press).

Water was directed and controlled to affect resource plant populations on a community level. The Kwakwaka'wakw and Nuu-chah-nulth maintained "raised beds" or human-made impoundments in tidal flats to retain nutrient-rich sediments deposited during high tide events for their root gardens (Deur 2002:19). The T'Sou-ke may have been utilizing the flat floodplains of the Sooke River for their root vegetables, as they did after European contact with introduced crop plants (see Grant 1849). Finally, as previously mentioned, the estuarine meadow located on Johnstone Island in the Alberni Inlet (Figure 3.2C) was likely a productive root garden in pre-European contact times, although specific impoundment structures are not reported from the site.

Fire was the most powerful and common form of management tool used by Indigenous peoples (e.g., Pyne 1982; Anderson 1993, Boyd 1999a, Nicholas 1999; Peacock and Turner 2000; Vale 2002; Turner and Peacock in press). In some cases, First

Peoples burned selected habitats to achieve multiple management goals at one time (Nicholas 1999), such as the promotion of the growth of many types of food plants. Bob Akerman (pers. comm. to B. Beckwith and N. Turner, 1999) of Salt Spring Island recalled, as paraphrased by Turner: "if you focus the burn in one place, that's where you'll have the concentration of lacamas [camas] and berries, all in one [easily accessible] locality." Generally, the burning to enhance the productivity of both root beds (*Allium* spp.; *Camassia* spp.; *Lupinus* spp.; *Pteridium aquilinum*) and berry patches (*Fragaria* spp.; *Rubus* spp.; *Vaccinium* spp.) was widely recorded in the Pacific Northwest (Turner *et al.* 1980; Norton *et al.* 1999; Boyd 1999c). Fire was often used to maintain the open or patchy structure of seral ecosystems, such as oak savanna, meadow, and prairie (Anderson 1993; Peacock 1998; Boyd 1999c; Turner 1999a).

Fire behaviour was affected by the timing, return interval (i.e. frequency), and spatial scale of the burn, as well as by the composition and structure of the fuels. In general, anthropogenic fires were of low-intensity; the burning of light fuels consisting largely of ground litter and organic debris on the soil surface with little to no injury to trees or below-ground plant structures (c.f. Anderson 1993). Most often the burns would be scheduled to coincide with the dormant periods of the resources. For example, geophytic resources would have been ensconced underground at the time of summer burns (Norton 1980; Loewen 1998). In general, burns were most often reported during the early spring or fall when there was sufficient ground moisture, humidity, and cool temperatures to maintain a low intensity surface fire (Anderson 1993; Peacock 1998; Barrett and Arno 1999; Nicholas 1999; Turner 1999a; Peacock and Turner 2000).

4.1.1.3 Management at the Landscape Level

Extensive management activities included a planned seasonal pattern of movement across the economic territory, control or restrictions over use of harvest sites, and ceremonial obligations and social mechanisms (Berkes *et al.* 2000; Peacock and Turner 2000). The principles of resource use and maintenance on the landscape level were governed by a larger administrative system of land stewardship and tenure, and provided the social context for sustainable human-plant interactions (c.f. Turner *et al.* in press).

The gathering of plant resources or plant parts was most often correlated with a specific harvest window (Peacock 1998; Turner and Peacock in press). Compromises in economic choices were likely necessary when the harvest times of resources overlapped (Peacock 1998; Peacock and Turner 2000), or when the harvest window conflicted with other cultural activities. The timing and duration of this window was determined by the type of habitat and resource plants, the annual growth patterns of the plants, and annual assessments of local habitat productivity.

Planning access to specific harvest sites was moderated by environmental factors, such as local weather conditions, topography, soil conditions, and genetic variation (e.g., Hart 1976; Peacock and Turner 2000). Because biotic resource sites were widely distributed across the landscape and the annual growth cycles of plants were spatially and temporally variable, the seasonal rounds of many Indigenous peoples traversed tremendous geographic distances and elevation gradients (e.g., Hart 1976; Turner 1997; Norton *et al.* 1999; Turner and Peacock 2000).

Indigenous peoples likely managed multiple resources and resource sites based on different objectives and schedules throughout the year. In the Willamette Valley, for instance, where the Kalapuya harvested camas bulbs during three distinct harvesting periods within the year, it was possible for people to be burning one harvest site while concurrently harvesting camas bulbs from another (Kramer 2000). Exploiting root grounds in a range of ecosystems and locations broadened the period of seasonal availability for harvesting (e.g., Daubenmire 1970). The camas grounds near Moscow, Idaho, for example, were vernal wetlands which, according to altitude, dried out at different rates in the spring. As a result, camas phenology varied among the harvesting sites and each site could be harvested in succession as the resources became ready (Gould 1977). Elevation gradients were also widely utilized to lengthen the harvest window of yellow glacier lily (Loewen 1998). Seasonal indicators were likely important tools utilized in the interpretation of the temporal variation of the harvest window (Lantz and Turner 2003; Turner and Peacock in press).

Over the course of the harvest season, Indigenous people needed to balance the time associated with broad travel patterns across the economic territory with resource diversification and availability. Both the quantity and quality of plant resources were maintained to accommodate the nutritional needs and social obligations of Indigenous cultures throughout the year (c.f. Ford 1985). Widescale movements across the landscape allowed people a greater capacity to access and use biologically diverse ecotones and ecological edges, maintained, in part, by community-level management (c.f. Lewis 1993; Turner *et al.* 2003). 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 (Turner and Peacock in press).

The necessity of allowing a resource site time to rest and regenerate, whether on an annual cycle or multi-year rotation, was well understood by Indigenous peoples (Anderson 1993; Peacock and Turner 2000). First Peoples were cognizant of ecological processes and heterogeneity, biological associations, as well as environmental variability in the yield and productivity of plants (Peacock 1998; Suttles in press; Turner and Peacock in press). The seasonal round was not strictly predictable and fixed, but remained dynamic and flexible, directed by adaptive management practices (c.f. Peacock 1998).

Control of access and use of productive sites was often maintained through ownership, stewardship standards, and kinship patterns (Peacock and Turner 2000; Turner *et al.* in press), although the degree of control varied among resource sites (Suttles in press). The concept of ownership could also be very different among Indigenous groups (Turner *et al.* in press). Generally, resource ownership patterns ranged from open communal harvesting grounds to strictly controlled sites with inherited tenure protocols (Peacock 1998).

Generally, ownership was widely reported for root beds and berry patches in the Pacific Northwest (Turner 1997; Turner *et al.* in press). Examples of documented root resources that were owned, and managed in plots, by Coast Salish individuals or families include wild onions, camas, tiger lily, bracken fern, as well as wild carrot (*Conioselinum gmelinii*), chocolate lily (*Fritillaria affinis* var. *affinis*), Gairdner's yampah (*Perideridia* *gairdneri*), and wapato (*Sagittaria latifolia* var. *latifolia*) (Suttles in press; Turner *et al.* in press).

Resource yields and plot establishment were regulated and supervised by chiefs or elders to maintain optimal harvesting efficiency (Turner 1997; Peacock and Turner 2000). Katzie families, for example, would establish a seasonal claim to a wapato patch through clearing, and this resource tract would revert back to common property the year after harvest (Suttles 1955). In northwestern British Columbia, the harvest of rhizomes of the spiny wood fern (*Dryopteris expansa*) and bulbs of riceroot (*Fritillaria camschatcensis*) were supervised by a knowledgeable female elder (Gottesfeld 1994). The delineation of resource plots was also practiced for some root resources (Theodoratus 1989; Deur 2002; Turner and Peacock in press).

With ownership of a resource site came stewardship responsibilities, and certain expectations for ceremonial and social accountability (c.f. Turner and Peacock in press). Spiritual and symbolic relationships with the geographic environment were intricately related to the ways in which people interacted with and perceived the natural world, and, in turn, linked to their cultural identity (Tyler 1993). This holistic connectedness was embedded in oral traditions, public and private ceremonies, and moral obligations (c.f. Peacock 1998; Peacock and Turner 2000). The conservation of natural resources was maintained through religious significance, political influence, and cultural ideology (E. Anderson 1996).

Root resources can have prominent places in stories and ceremony (Deur 2000), and harvest celebrations, or "First Foods" ceremonies, were common among some Indigenous groups (e.g., Gritzner 1994; Turner 1997). For example, the Bitterroot Ceremony was the first roots celebration of the Flathead and Okanagan peoples in the interior of BC (Hart 1976; Malouf 1979; Turner *et al.* 2000). Larger berry and root harvesting sites in the interior (e.g., Botanie Valley) served as centres for inter-community exchange (Turner 1997). Ceremony was a way for resource owners or stewards to share in the harvest but was also a ritualized means for people to connect with natural resources in socially and emotionally meaningful ways (c.f. E. Anderson 1996; Turner and Peacock in press). Ceremonies and public gatherings were events that shaped people's perceptions of resource sustainability and were formal ways of honouring the living landscape and a people's role within it.

4.1.2 Ecological Effects of Root Food Management

The resource management activities of Indigenous peoples served specific economic needs and social responsibilities, and were guided and shaped by cultural values and spiritual perceptions of natural phenomena. Cultural practices needed to be coordinated with ecological processes to meet with socially mandated measures of landscape sustainability and resource choices. Furthermore, the appropriate ecological timing to ensure optimal sustainability and productivity of the food resource populations would have been synchronized with the appropriate cultural timing to supply adequate nutrition and palatability. Indigenous peoples were adept at manipulating landscape dynamics, and in doing so, intentionally enhanced naturally-occurring productivity within a range of resource habitats (e.g., Deur and Turner in press, 2004b).

Resource management at different spatial scales ensured that culturally significant plant resources were productive, available, and reliable across the landscape. Both intentional and incidental ecological effects occurred as a result of these purposeful manipulations (c.f. Turner and Peacock in press).

4.1.2.1 Effects from Population Management

Environmental and cultural factors affected growth, quality, and abundance of root plants, as well as the density, longevity, and distribution of plant populations (c.f. Anderson 1993). Harvesting activities, such as the specific selection of harvestable roots and the horticultural practice of digging, were integrated into a locally intensive and spatially focused suite of anthropogenic disturbance patterns (Norton 1979; Anderson 1993; Peacock 1998; Turner and Peacock in press).

Specifically, selective harvesting reduced intraspecific competition and reduced living biomass by decreasing the overall population density in the plot (Thoms 1989;

Anderson 1993; Gottesfeld 1994; Peacock 1998; Peacock and Turner 2000; Turner and Peacock in press). By harvesting only specific growth forms or size classes of plants, the population was sorted and thinned, and the remaining individuals redistributed within the resource plot. The age structure of the population was altered by the removal of large individuals with slower growth rates (Gottesfeld 1994; Peacock 1998). Harvesting activities at the population level affected biological diversity by altering the composition of plant species within the community (Nicholas 1999).

Preferences for particular growth forms or habitat characteristics concentrated human activities, and the accompanying disturbance patterns, within the resource community (c.f. Peacock and Turner 2000). Some plant populations, especially of species with small edible parts, might have been "encouraged to grow in a clumped or aggregated pattern" to facilitate more efficient harvesting (Anderson 1993:75). The promotion of dense or clustered populations also reduced labour and transportation costs by focusing the attention of the harvesters on productive harvesting locales rather than across a potentially wide geographical region (c.f. Anderson 1993).

The principal act of concentrated soil disturbance was digging. Digging contributed to the enhancement of resource productivity and abundance through the maintenance of soil conditions that were favourable for resource plant growth and development. Tillage with digging sticks aerated and mixed the soil components. The incorporation of litter and other organic matter into the mineral soil recharged nutrient levels and enhanced soil texture (Daubenmire 1970; Harris 1989; Thoms 1989; Turner and Peacock in press). These "manufactured" soil conditions likely promoted the growth of juvenile and offset geophytes. Digging may have also enhanced the rate of seed germination by increasing the moisture-holding capacity and shifting the biochemical composition of the soil (Daubenmire 1970; Ford 1985; Anderson 1993; Turner and Peacock in press).

The use of the digging stick likely caused incidental detachment of propagules or injury to roots which could have, in turn, triggered vegetative reproduction (Thoms 1989; Peacock and Turner 2000; Loewen *et al.* 2001; Turner and Peacock in press). Intentional replanting of propagules (i.e. vegetative offsets, seeds) or juvenile roots or root fragments aided their dispersal and maintained the productivity of the resource population (Harris 1989; Peacock and Turner 2000; Turner and Peacock in press). Replanting also increased the size of resource patches (Ford 1985; Anderson 1993). The transplanting of propagules into new habitats would expand the range of resource plants (Turner and Peacock in press).

Weeding removed unwanted species from resource patches, and thereby reduced interspecific competition for target root foods (Ford 1985; Harris 1989; Peacock 1998; Turner and Peacock in press). For coastal root gardens, specifically, reducing competition by weeding and increasing the porosity of the soil through tillage, promoted the expansion of rhizome growth into new areas of the resource site and enhanced overall yields (Turner 1995; Deur 2000). Some species, including resource plants, could have been destroyed during harvesting, further reducing competition (c.f. Thoms 1989).

4.1.2.2 Effects from Community Management

Management on the community level focused on the maintenance of ecosystem structure and function. Resource sites in seral communities need periodic pulses of disturbance to maintain their openness and fertility. As explained earlier, in the case of camas management, the practices of manual clearing and fertilizer applications were probably post-European contact phenomena. These objectives probably were achieved by other means prior to contact.

Regular or periodic burning by Indigenous peoples promoted environmental heterogeneity (Anderson 1993; Peacock 1998; Lewis and Ferguson 1999; Peacock and Turner 2000). The maintenance of a landscape mosaic enhanced the abundance and diversity of plant and animal species (Lewis 1993; Boyd 1999b). Furthermore, productive and dynamic ecological edges were also important resource sites for many culturally important plants and animals (Lewis 1993; Boyd 1999c), and served to maintain economic diversity and to increase cultural resilience (Turner *et al.* 2003).

Burning enhanced plant food availability, productivity, and yields (e.g., Anderson 1993; Boyd 1999c). In many ecosystems, the principal cultural goal of repeated burning was to reduce interspecific competition by killing undesirable plants, especially invasive woody species (Norton 1980; Anderson 1993; Lewis 1993; Loewen 1998; White 1999). Other benefits of fire use included the promotion of growth and reproduction of a resource population and the recycling of nutrients (Harris 1989; Anderson 1993; Lewis 1993; Peacock 1998; Turner 1999). Burning also aided seed germination by maintaining microsites with favourable levels of insolation to the ground (Anderson 1993). Ethylene in smoke may have also contributed to the enhancement of the root populations by breaking dormancy patterns and enhancing sexual reproduction (e.g., Tompsett 1985; Chambers 2001).

4.1.2.3 Effects from Landscape Management

Management practices described at the landscape level were akin to the integrated land use systems (e.g., agroecosystems) described from around the world (Peacock 1998; also see Chapter 1). Through the planned and regulated applications of management activities and the continued maintenance of social constructs and ceremonial obligations, First Peoples' management strategies served to sustain both ecological diversity and economic flexibility of root food populations. Socio-ecological interfaces resulting from an overlap of land management practices for different plant and animal resources would enhance the greater landscape mosaic (c.f. Anderson 1993), as well as serve to foster and maintain diverse intercommunity networks among families (c.f. Turner *et al.* 2003).

On the whole, management activities on all levels worked in concert with one another to create patterns of ecological diversity across the landscape beneficial to people (Peacock and Turner 2000), and to promote resource health (c.f. Nicholas 1999). The maintenance of favourable soil conditions, for example, combined with the selective thinning and replanting of roots, directly enhanced the overall growth and development of resource plants. Transplanting of plants or propagules, either intentionally or incidentally, could have fostered the development of new populations, thus broadening the distribution and range of resource sites (Harris 1989; Deur 1999; White 1999; Peacock and Turner 2000; Turner and Peacock in press), and possibly the ecological amplitude of culturally important plant species (Anderson 1993). Successful establishment of new resource locations from transplanted stock would have affected the genetic variability within the range of the species (c.f. Ford 1985). Finally, management activities from different scales could have been integrated to fulfill multifaceted economic goals: for example, the clearing of a resource site (community level) to establish ownership or rights of use for a given season (landscape level) (C. Paul in Babcock 1967).

Regular disturbance probably increased the longevity of native flora (Anderson 1993). Many resource plants lose vigour and productivity over time without periodic disturbance. Harvesting was a disruptive event that affected both interspecific and intraspecific space within a resource population. Selective harvesting maintained the resource population below biological capacity, thus promoting rapid growth and recovery (Thoms 1989; Anderson 1993). Digging and burning stimulated regenerative tissues and growth through reducing or recycling dead wood and litter, increasing nutrient, moisture, and light levels, and impacting the life cycles of pest and pathogens (c.f. Anderson 1993).

4.2 ETHNOECOLOGY OF STRAITS SALISH CAMAS MANAGEMENT

This section describes the role of camas use and management in the ethnoecological organization of the Straits Salish economic territory, including the broad cultural patterns of camas procurement, production, preservation, and customs of exchange and redistribution. As the general management activities associated with root foods widely apply to camas bulbs, as noted in the previous section, the material presented in the first part of this section will focus on new information regarding specific camas management activities unique to this region and to Straits Salish peoples.

In the previous section, the basic dimensions of root food management were described, albeit primarily on a spatial scale and from a cultural point-of-view. However, landscapes are affected by both social practices and ecological processes over space and time, and the resulting complex of socio-ecological and spatio-temporal factors affect the dynamics of the anthropogenic landscape. Camas management will therefore be described on different ethnoecological scales; the population, community, and landscape levels described earlier will take into account both spatial and temporal aspects of each level. Environmental factors which could affect camas resource grounds will also be considered.

The timescale of camas management activities was crucial to the longevity of productive and reliable camas harvest grounds. Important time elements probably considered included the sequence of management activities for the resource; the ecological timing of plant species and habitat characteristics; and the scheduling of harvest activities to fit within the desired cultural specifications for the resource and within the social patterns of daily life. Environmental factors, such as the role of animals, as disturbance agents in camas landscapes are also considered.

The second part of this section presents a conceptual reconstruction of the camas landscape in terms of its structure and function. The environmental dynamics of the former ethnoecological system will be assessed qualitatively, and the cultural demands (i.e. sustainable yields of bulbs) on this system on camas populations will be estimated numerically.

4.2.1 Ethnoecological Scales of Camas Management

How is time incorporated into a model of cultural resource management? The population scale focuses on the ethnoecological interactions between people and their resources within harvest plots (i.e. place of interaction) at the time of harvest (i.e. period of interaction) (Figure 4.2). Interactions at the community scale occur on a seasonal or sub-annual scale and, therefore, incorporate additional cultural and ecological factors apart from the harvest period. Lastly, the landscape scale includes the cultural constructs and social mechanisms which govern the control and use of the resource site, as well as the on-going site dynamics, including the possible cultural and environmental factors which affect a landscape on a continuing basis. The landscape scale includes the resource site during the year of harvesting, and also the time between harvest seasons, or "fallow" periods.

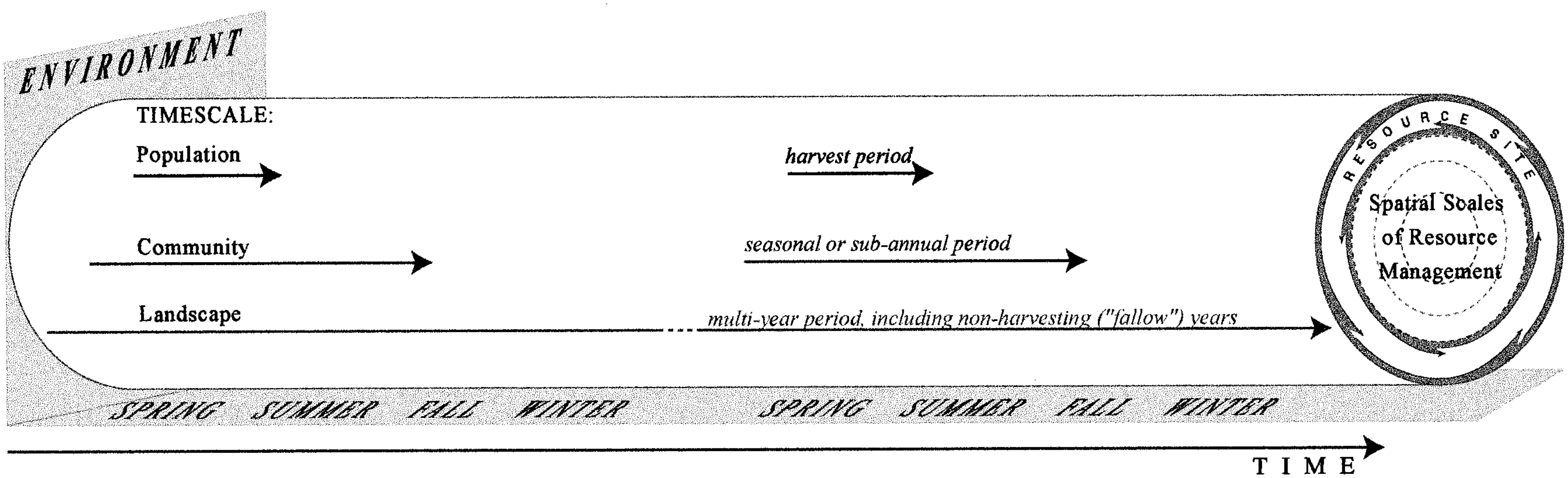

Figure 4.2 Ethnoecological model showing a central system of integrated cultural management (see Figure 4.1 for details) over time. The resource site within a spatial environment (disk) is affected by management on three temporal levels or timescales (cylinder).

4.2.1.1 A Harvest of Two Camas Species: Population Level

During harvesting, the identification of edible camas bulbs based on the presence of flowering or fruiting stalks appears to have been a universal selection criterion for Straits Salish peoples. The differentiation between the edible bulbs of *Camassia* and the poisonous ones of death camas (*Zygadenus venenosus*) was a serious and widespread consideration and likely served to influence the harvest criteria for camas. However, it seems unlikely that long-tenured and well-managed camas grounds would have contained death camas in pre-European contact times. It is possible that targeting a particular developmental stage, such as flowering individuals, could have served harvest selection criteria other than the distinguishing of death camas alone.

Harvesting during a specific phase in the flowering period may have been a key factor in the determination of a certain bulb size or bulb quality. Generally, the size of a harvestable bulb on southern Vancouver Island was 3-6 cm in diameter (Turner and Kuhnlein 1983). If the presence of flowering stalks was a standard for harvestable bulbs, then this practice may have ensured that vegetative, as well as dormant bulbs, remained in the plot, as well as injured bulbs, bulb fragments and offset bulbs, or bulblets arising from asexual reproduction. The very largest bulbs, which were also usually left in the harvest plots, were most likely the oldest and had the greatest capacity for reproducing both sexually and asexually (Turner and Peacock in press). Camas plants which reproduce asexually are more inclined to flower regularly. Furthermore, some bulbs could have produced multiple offsets which were capable of developing flowering stalks (Chapter 3).

Camas (*C. leichtlinii*) plants that regularly flower have bulbs which are most often over 10 g, the calculated minimum weight for harvestable sized bulbs according to findings from the nursery study (Chapter 3). Other than this relationship, the nursery study showed no significant size correlations between above- and below-ground plant parts. Therefore, the presence of a flowering stalk may have been a way of guaranteeing a higher percentage of bulbs of a culturally preferred size.

Camas bulbs change in texture and flavour during their annual growth cycle (Daubenmire 1970). If the bulbs are harvested before senescence (seed set) the bulbs are soft, watery, and unpalatable (Brown 1868; Daubenmire 1970). Christopher Paul described bulbs that were harvested both before and after their summer dormant period as "unsatisfactory" (to Babcock 1967). Harvesting camas bulbs just after flowering ensures that they are easier to process (Malouf 1979), and are firm (i.e. not mushy) (Turner *et al.* 1980; Turner 1997). Harvesting bulbs after the annual growth is completed for the year also guarantees that the bulbs are of a maximum size and have the greatest caloric value (Thoms 1989).

The optimal harvest window for camas bulbs depends on a number of factors. Although there is no evidence for nomenclatural differentiation between the two *Camassia* species on southern Vancouver Island, the choice of a particular camas species could affect the length and timing of the harvest season. Generally, the window of opportunity for harvesting is greater for *Camassia leichtlinii* than for *C. quamash.* Because of a greater flower number and taller flower stalk on *C. leichtlinii*, the flowering period is usually much longer than that for the shorter-stalked, fewer-flowered *C. quamash.* It is common for fruit, open flowers, and closed flower buds to appear on the same *C. leichtlinii* stalk simultaneously. Seed-bearing dry capsules of both species are generally not produced until all the flowers have bloomed and the leaves have withered for the season. The period during which camas could be harvested would have been much longer if both species were actively gathered than if only one species was sought after.

The two camas species not only have different flowering periods but also different (though overlapping) environmental requirements (Chapter 3). The presence of sustained soil moisture through the growing season could have affected camas phenology (i.e. prolonged the flowering season), as well as the conditions of the harvest site (Thoms 1989). As seen with camas in the US interior, and with other roots in general, some camas harvesting sites are saturated or inundated with water through the early growing season, but become dry and develop hard soils during the summer drought period. If too dry, then the soils might be impenetrable testing the technological limits of the digging stick. Digging in loose and moist soil would have reduced labour costs resulting in a more efficient harvesting rate (c.f. Thoms 1989).

Spatial distribution within populations was another reported selection criterion for camas. According to the research of Babcock (1967), clumps of camas plants were targeted for harvest by the Saanich. Ernie Olsen, for example, associated clustered camas growth, a pattern he deemed favourable for camas, with areas undisturbed by European settlements. On their harvesting trips to Flattop Island (San Juan Islands), Johnny Sam and his wife would first locate "nice-sized" plants growing in clumps as their main criteria for harvesting. Mary George (T-Sou'ke) used the relative density of plants to determine her claim to a harvesting patch for the year (to Suttles 1952; W. Suttles, pers. comm. 2003). This practice of targeting camas growing in clumps or in high densities may have focused harvesting attention on those bulbs which were reproducing vegetatively through bulb division. However, areas with clumps of camas plants could also represent a cohort of seedlings which all became established at one time. Either way, the sites were favourable microhabitats for camas growth.

Sorting and thinning of camas plants promotes camas growth by reducing intraspecific competition and maintaining intermediate population densities (Thoms 1989; Anderson 1993). Crowded growth can prevent the establishment of adventitious species, but may also limit the reproductive output of target resource species (Hebda 1992). The *Camassia leichtlinii* plots at the Tower Point study site consisted of large juvenile and mature individuals growing near 100% cover. Very limited seed germination occurred in these plots, even though there was a high proportion of reproductive individuals. Shading by both living and dead biomass negatively affects germination, and hence plant diversity, by limiting light penetration to the soil surface (e.g., Hebda 1992; Foster and Gross 1998; USDA 2000). Reduced stature or densities of competing plants promotes the sexual reproductive potential and affects camas phenology.

Tillage of the soil could have enabled camas bulbs to reach greater depths sooner, as well as promoted favourable soil conditions (e.g., aeration, texture, water-holding capacity) for growth. The resulting redistribution of bulbs could be beneficial for juvenile bulb development. Under natural conditions, juvenile bulbs take a number of years to reach optimal depth and maturity for reproduction (see Chapter 3). Much of the time required by a developing bulb to reach maturity is taken up by downward movement through the soil (Pütz 1993). In general, bulb depth depends on plant maturity, soil and substrate conditions, and hydrology (Thoms 1989). Camas development is also affected by variations in soil types and environmental conditions (i.e. nutrient level, light), as well as genetic variability (Thoms 1989; Turner and Peacock in press)

The weight of the bulbs may have been a significant factor in determining the quantities of bulbs harvested if people were traveling across country on foot and carrying the bulbs in baskets on their backs (i.e. with a tumpline). Likely the 3-6 cm size criterion is an approximate or target size for harvesting, and selection criteria were likely adaptive and varied among sites or families, or on an annual basis. During lean years (i.e. times when sites were inaccessible or productivity low), people may have adjusted their harvest criteria (e.g., reduced yields, lowered size thresholds) rather than not harvesting any camas at all (c.f. Kramer 2000). Alternatively, certain size thresholds may have been in place precisely to control the amount of harvesting and provide specific criteria for bulb selection in lean years.

4.2.1.2 Fire and Water: Community Level

The two primary ecological objectives at the community level were clearing and fertilizing. When these objectives were met on a regular or periodic basis then a specific habitat structure or successional pattern could be maintained. In general, the manual clearing and application of seaweed fertilizer, which were both reported for camas management, were probably 20th century adaptations. The use of fire, however, is a centuries old management tool. Post-harvest burning usually occurred in the summer or early fall, specifically between the months of July and October (Finlayson 1846-49; Grant 1849; Norton 1979; Gorsline 1992a; Boyd 1999c). These burns were most often characterized as low-intensity and short-duration. Although fire was probably regularly used by Straits Salish peoples for a myriad of land management objectives and cultural uses, there is no concrete evidence that Indigenous peoples burned the same resource sites annually (c.f. Agee 1993).

The principal reason for burning was most likely the maintenance of the open structure of seral resource communities. Periodic burning adversely affected the encroachment and establishment of woody plants, such as Douglas-fir (*Pseudotsuga menziesii*), snowberry (*Symphoricarpos albus*), and Nootka rose (*Rosa nutkana*) (Anderson 1993; Boyd 1999a). Camas may have been indirectly favoured by fire because of these effects on the competing invasive species and the overall maintenance of open prairie habitats. The timing of the fires coincided with the warm and dry summer dormant period for camas, as well as for many other herbaceous perennial species. Reduced biomass after burning increased the incidence of bare ground and degree of light penetration, which favoured camas seedling establishment the following spring.

Increased soil fertility and the promotion of bulb growth were recognized Indigenous objectives for the management of camas. However, because of the nature of the burns (i.e. low fire intensity), any nutrient availability likely would have deceased rapidly in the post-fire environment. Fires may have resulted in decreased soil moisture and litter, although these changes may have been slight or may have been modified by harvesting effects.

There are additional naturally-occurring processes which may also have affected the resource population at the community level. Seasonal saturation or inundation may have contributed to the maintenance of open and fertile camas grounds (Turner and Peacock in press) in this region. As described by Norton *et al.* (1999:69) for the prairies of south-central Washington:

> Survival of aboriginal prairies into historic times was the result of one of two processes: regular inundation, which inhibits or retards tree growth during part of the year; or regular burning which destroys adventitious species. Without one or both of these processes, fast-growing trees eventually would have moved into the prairies, overtopping and thus eliminating the unique prairie flora.

Historic records of the greater Victoria region, such as the early maps presented in Chapter 1, regularly reported that the landscape was annually saturated or inundated with water. Many accounts described a relative lack of freshwater creeks and rivers, but a high distribution of standing surface water (e.g., Grant 1849; Forbes 1864; MacFie 1865; Ludrin 1928; Hazlitt 1966; Bowsfield 1979). In his recollections of the Fairfield district of his childhood (circa late 1800s), for example, Charles Pemberton (1941) depicted a large proportion of this area as swampland. In January, 1876, George Dawson wrote: "There are beautiful spots along the sea shore here, at least they must be beautiful when the trees have leaves on them & the ground is not in a State of a quagmire" (Cole and Lockner 1989:131). A deciduous tree commonly reported from coastal locales is the Garry oak (*Quercus garryana*), the prominent tree species of the regional oak-camas parklands.

Although neither *Quercus* nor *Camassia* are known to grow in highly wet soil conditions on southern Vancouver Island today, camas occasionally occurs in bogs and estuarine meadows (*C. quamash*) in other regions of Vancouver Island and is nearly ubiquitous in wet prairies and meadows east of the Cascade Mountains (*C. quamash*, *C. cusickii*) (Chapter 3). Wet camas prairies on southern Vancouver Island may have been much more widespread before European colonization and agricultural expansion. The open, and possibly wet, prairies were the first ecosystems to be destroyed with the introduction of European settlement in the region (Gorsline 1992a).

4.2.1.3 Fallow Camas Grounds: Landscape Scale

Camas ethnoecology on the landscape level represented the totality of the root food production system within the Straits Salish cultures. Resources of the oak-camas parklands varied greatly over the heterogeneous landscape of southern Vancouver Island. Many components of the Straits Salish socio-economic structure reflected, and were adapted to, this environmental variability (Suttles 1987). Management performed on different scales to maintain adequate levels of resource productivity, availability, and reliability would have played a critical role for cultural survival.

"Fluidity" of social structure was a trademark of Coast Salish cultures (Suttles 1987:60) and a key landscape-scale component of a sustainable economic territory. Straits Salish culture was fairly mobile as bilateral descent was recognized. Hence, with each new generation the potential to expand the accessibility to new resource sites grew. Rights to use resource sites followed affinal and kin networks and the redistribution of food resources was common practice. Using a harvest site belonging to a family member may have been a way to maintain and reinforce valuable social connections and to honour long-established customs of reciprocity. The social units of these peoples were dynamic and not discrete (Suttles 1987:57); their relative territories formed a continuous geographic and economic area (Suttles in press).

Within this integrated framework, therefore, the camas harvest was a planned system of coordinated activities which integrated environmental factors with social customs, such as decision-making mechanisms and adaptive resource choices. Successful camas food production included significant scheduling considerations and logistic concerns. Optimal harvest conditions would likely shift from year to year and from patch to patch. Some period of rest (i.e. rotation) probably occurred, determined in part by annual assessments of productivity.

Weather was likely a primary factor that regulated not only the timing of the harvest and burn, but the scheduling of the main processing of camas bulbs. In other regions of the Pacific Northwest (e.g., Oregon, Idaho), camas could have been harvested at other times of the year. However, given the semi-Mediterranean climate characteristic of this region, and the substantial commitments of labour and time associated with the proper harvesting, processing, cooking, and drying of camas bulbs, the window of camas production was relatively narrow. As with other roots, fresh camas bulbs store best in cool and dry places, so the preservation of the bulbs during the summer was likely unproblematic. Processing also probably occurred during the summer months as well to get the bulbs into a suitable preserved condition for long-term storage before the cool and wet weather in the fall. Food spoilage may have been a serious problem during the winter period (e.g., Stern 1934; Suttles 1987; Thoms 1989; Turner 1995). Time (scheduling) constraints of the workers may have limited the quantities of bulbs harvested by families in this region.

There were additional logistical issues associated with the processing of camas bulbs. Investments of travel were high for harvesting on smaller islands at a distance from the main village site. Coastal Salish peoples traveled extensively on water among the islands of the Strait of Juan de Fuca, and Haro and Rosario straits. If camas grounds were not near processing sites, the bulbs had to be transported to a place where they could then be processed. Managed camas grounds near permanent village or camp sites would significantly cut travel and handling costs. Sites could be accessed regularly if necessary throughout the harvest season and the harvesters could return to the village for processing after a day's work. In general, as the distance to camas harvesting sites increased, so do the costs, decreasing the relative importance of these sites overall (Thoms 1989).

Considerations for adequate localities for processing camps for camas would include a number of factors, including adequate supplies of fire wood, as well as suitable rocks (i.e. cobbles) and foliage for pit-cooking. Proximity to other resource sites (e.g., berries, deer, fish) with resources in a preferred state of harvest could have also been considered. The availability of fresh water was probably one of the most important factors, thus the knowledge of the locations of ephemeral streams and seasonal wetlands may have been valuable in this region.

More extensive, productive, or accessible harvest sites were probably associated with families of higher status (C. Bryce, pers. comm. 2002) and, hence, more closely controlled and protected. Ownership carried with it responsibilities to the environment in the form of sustainable management practices, but also obligations to social accountability within the local community and among the kin and affinal networks (Turner and Peacock in press). The ideological relationships between people and their resource communities were recognized through oral traditions (e.g., *Legend of Camosun*), ceremony (e.g., First Roots), and other social rituals (e.g., potlatch, trade, offerings) (Chapter 2). Careful and respectful use and stewardship of resources, combined with the adherence to reciprocal relationships of exchange, ensured continued ownership and sustainable yields of culturally important resources.

Finally, animals, especially native ungulates, were important environmental agents of regular disturbance in ethnoecological systems. Geophytes often have high ecological value for animals and insects (e.g., Chambers 2001). Herbivory from black-tailed deer, and in the past, Roosevelt elk, early in the growing season would have impacted the annual growth of the camas population. In the fall, deer would have been attracted to the regrowth of plants in post-fire camas grounds (Nyberg 1990; Lewis 1993).

4.2.2 Reconstruction of Camas Cultivation

It is clear from the qualitative evidence and from the results of nursery and field studies synthesized in this chapter that camas bulbs were cultivated by Straits Salish families on southern Vancouver Island. The integration of the three scales of management results in a complex ethnoecological system of cultivation involving a sustainable patchwork of resource sites across a culturally maintained landscape. However, what kinds of estimates can be made regarding the cultural and economic demands on local camas populations? Was one camas species favoured over the other? What were the annual yields of camas bulbs harvested by Straits Salish families and how do these yields translate ecologically to harvest pressures within local camas grounds? These questions, and the reconstruction of camas cultivation, are the focus of this section.

4.2.2.1 Ethnoecological Dynamics of Camas Grounds

A harvest site was essentially a managed agroecosystem that experiences successional pulses of development in response to patterned anthropogenic disturbances and on-going environmental influences. Agroecology, according to Anderson (1993:19) is "based on the premise that past civilizations often modeled their farms after the natural environment." The extent of Straits Salish camas grounds may have been delineated or regulated by environmental boundaries, most notably rock formations found around naturally forming terraces, outcrops, or bluffs. Natural features may have also been used to further demarcate resource ownership of a particular harvest patch or plot.

If the goal of camas cultivation was to maintain reliable and available quantities of bulbs of a harvestable quality over time, then the primary method for achieving this goal was the active maintenance of the three-dimensional environment (Figure 4.3). Straits Salish cultivation of camas not only affected the harvesting grounds across the landscape, but by definition, the management of resource geophytes was focused *within* the landscape, or rather, within the ground. As discussed in Chapter 1, the definition of cultivation generally includes the systematic manipulation of their growth and abundance, as well as the physical modification of the soil. Through the consistent application of management activities on different spatial and temporal scales, certain cultural standards of camas productivity (i.e. yields and desirable qualities) could be maintained across the cultural landscape.

Straits Salish peoples essentially promoted bulb banks (Figure 4.3): populations of a resource in various stages of growth and development (c.f. Anderson and Rowney 1999). My results from both the nursery and field studies showed that *Camassia* exhibits a range of patterns of growth. The development of seedlings and juvenile plants also may be enhanced from disturbance indicating that management could serve to promote a population of multiple age classes (Figure 4.4). Plants showed patterns of prolonged dormancy and "opting-out" of growth at different stages in their annual development. Moreover, camas has the capacity for both sexual (seed production) and asexual (bulb division) reproduction when the plants are grown in favourable conditions. The maintenance of vegetative offsets is a long-standing practice in the cultivation of root resources around the world. Furthermore, camas appeared to respond well from transplantation with limited mortality, another attribute favourable to cultivation.

Both cultural and ecological factors could have contributed to the maintenance of larger bulb sizes in the past. As indicated from the nursery studies, bulbs of *Camassia leichtlinii* can attain a large size and weight after four years of growth in cold frames. As well, bulb size may have been positively affected by burning or wetter soil conditions.

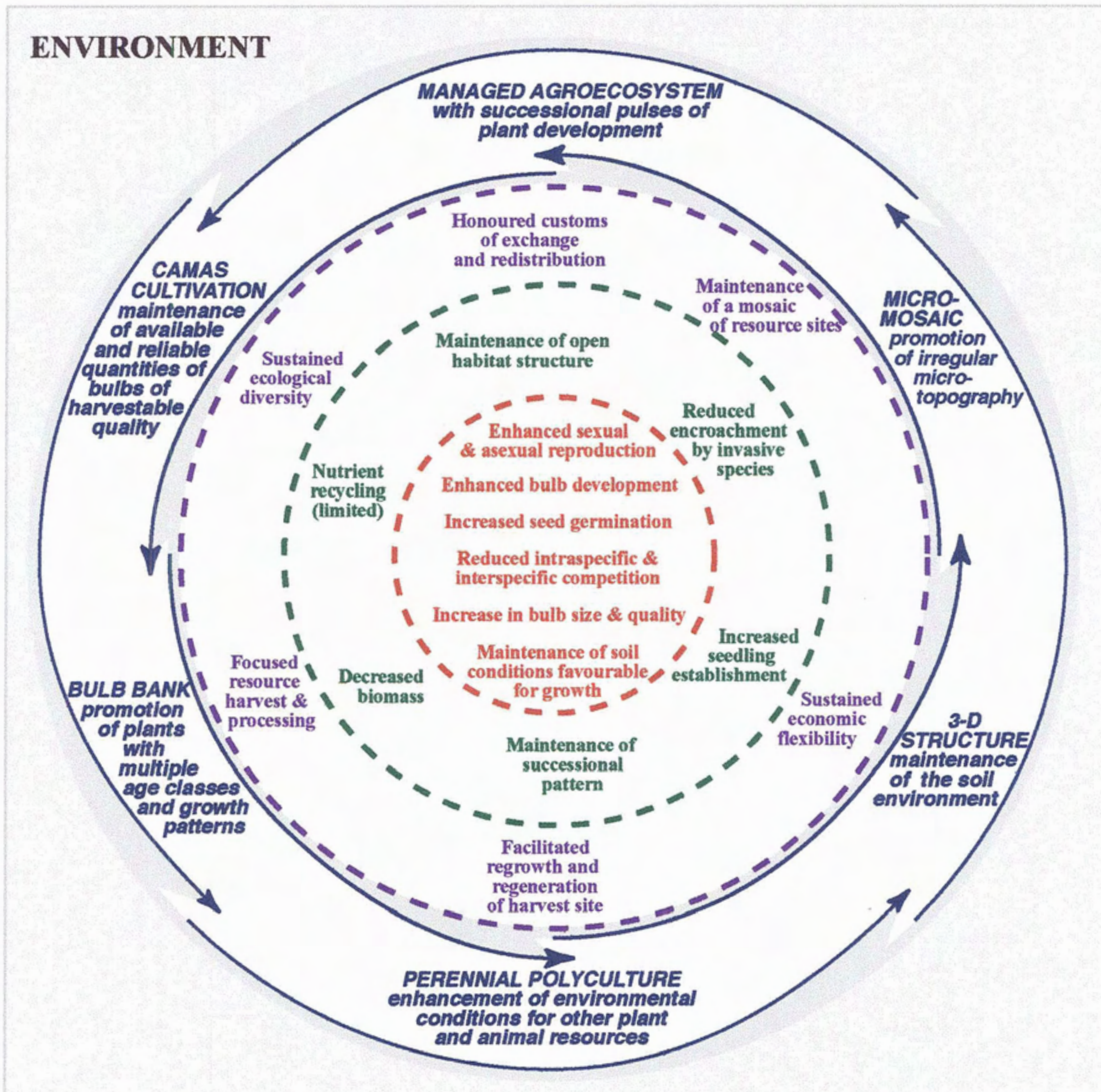

Figure 4.3 Camas managment model showing the ethnoecological effects of the three integrated scales of cultivation - population (red), community (green), landscape (purple) - and the major landscape features of a dynamic camas landscape (blue).

An increase in soil pH from regular burning (Parminter 2001; Heitzmann 2001) could have been, in part, responsible for larger bulb sizes formerly, even though the rise in pH may have been slight (Campbell 1978). In general, acidic soils are related to smaller bulb mean size, whereas alkaline soils compare well with larger bulbs (Stratham 1982). Bulb size is also related to soil texture (Gould 1941; Plew 1992). In general, smaller bulbs are associated with dry soils, and larger bulbs with wet loam or muck. As postulated earlier, some of the most productive camas grounds in this region were likely deep-soil, wet meadows.

Regular management of these productive meadows may have promoted "perennial polycultures" (Figure 4.3) (c.f. Higgs 2003:236). There were many other plant species that were affected by camas cultivation, both positively and negatively. As noted previously, the growth of other resource species with similar phenologies and growth patterns (e.g., springbank clover, silverweed, wild onions, and bracken fern) could have been enhanced by the ecological effects of cultivation. Vegetable foods were indispensable and valued components in the diet of Indigenous peoples of the Northwest Coast (Norton *et al.* 1984). The camas beds in the coastal regions of Oregon (Tillamook) and western Vancouver Island (Hesquiat), and the root gardens of the Kwakwaka'wakw and Nuu-chah-nulth are excellent examples of Indigenous root polycultures (Deur 2000). Management activities employed for camas could have also been coordinated with other resource management objectives at different time of the year, especially the enhancement of other food resources, such as berries, and of browse plants for ungulates.

A key structural outcome of camas management activities was the establishment of an irregular microtopography – a "micro-mosaic" – within the resource site (Figure 4.3). Family-regulated plots within the camas grounds would have been harvested at different levels of intensity because of the general harvest methodology (i.e. subplot by subplot) and the likely differences in the labour investments of the different harvesters (i.e. the number and aptitude of the harvesters and harvest duration). Intrasite variation in the ecological productivity and phenology of the camas population would have also affected harvest intensity, focusing peoples' attention in areas where the camas met prescribed criteria for harvest. Variability of soil moisture and other environmental factors on a microhabitat scale affected camas development, density, and maturation rates (Campbell 1978; Thoms 1989).

The small-scale rough topography could have maintained a dynamic patchwork of micro-environmental conditions on the soil surface and thereby functioned to redirect and retain camas seeds, water, and organic matter within a localized area. The micro-mosaic structure also affected fire behaviour (Figure 4.5). For example, a high degree of spatial variability of above-ground vegetation no doubt resulted as the ground was dug and mixed during the harvest period. Plants that were damaged or killed during the harvest, as well as senesced plants, would continue to dry throughout the summer. Therefore, by the time of the burning season in later summer or early fall, there may have been a layer of dry fine fuels that were continuous across the surface of the harvesting grounds but patchy on a finer spatial scale. It seems plausible that burning with these micro-environmental conditions created by Straits Salish harvesting activities resulted in a quick and sporadic surface burn. In sum, an intensive digging regime followed by burning could have maintained an agroecosystem characterized by low fuel loads, fine scale patchiness, and micro-topographic variability that would have subsequently influenced the camas development and growth, fire patterns, and other ecological effects.

4.2.2.2 Cultural Demands on Camas Populations

Vast quantities of bulbs from both *Camassia leichtlinii* and *C. quamash* must have been harvested every year in order to support the economic needs of Indigenous peoples. Taxonomic clues indicating whether one species was preferred for harvesting over the other, are not found within either the Indigenous or western scientific nomenclatures. The two *Camassia* species were apparently not differentiated in the dialects of local First Nations (Turner and Kuhnlein 1983), and, as in the English vernacular, both were often referred to as "edible" camas, as opposed to the poisonous death camas. The taxonomic designations of *Camassia leichtlinii* and *C. quamash* were not used to describe local camas species by western trained scientists on southern Vancouver Island until the 1880s (Gould 1941), by which time extensive camas

Figure 4.4 A harvest and burn field study plot at Mill Hill Regional Park in 2002, two years after the last burn treatment and three years after harvesting. Photograph shows many camas plants of multiple age classes.

Figure 4.5 Burning treatment of a previously harvested field study plot at Mill Hill Regional Park. Photograph shows patchy microtopography resulting from digging and weeding.

harvesting had apparently disappeared (see Ethnohistory section of Chapter 2).

Land use strategies, and possibly harvest criteria, were likely adjusted by Straits Salish peoples to fit within the given environmental parameters for each species. The two species, as observed from the field study, occur together more often than previously recognized in this region, but they do not appear to flower concurrently when growing together. The two camas species appear to fluctuate in dominance based on disturbance patterns and harvest rotation. Moreover, the inherent heterogeneity of the landscape likely allowed for a range of camas habitats to reach optimal harvesting potential at different times during the growing season. As a result of both temporal and spatial variability between the two species, it is possible that both species could have been exploited at different times, thus extending the length of the harvest season. Maintaining a rotation of camas beds in different communities, and maybe ecosystems, could have moderated the likelihood of harvest failure due to seasonal or annual variability, and increased the availability of harvestable bulbs each year.

If enough bulbs of both species were therefore available, how many camas bulbs would a Straits Salish family gather during the harvest season? Although there is no clear evidence for the quantities of bulbs that were annually harvested, the harvest potential of the landscape and probable yields obtained by Straits Salish peoples can be estimated (Table 4.1). The criteria and methodology for this discussion follows the calculations used by Thoms (1989) based on his anthropological camas research in the US interior, with some important alterations that take into account local circumstances. Thoms' research focused on one camas species, *C. quamash,* in seasonally wet and deep-soil habitats, whereas my analyses concerns *C. quamash* and *C. leichtlinii* which, at present, are largely constrained to shallow-soil ecosystems characterized by high levels of heterogeneity. Furthermore, with landscape degradation over the last 160 years, the structure and function of the remaining camas habitats have probably been dramatically altered. Therefore, it should be emphasized that this analysis is conservative and subjective (c.f. Thoms 1989), and should be viewed as an approximation of the relative scale of harvest pressures on local camas populations based on limited ecological and anecdotal information.

For camas density, Thoms (1989:166) estimated a total 300 plants/m^2 in a "typically productive camas meadow." This population density proved to be very low when compared to similar estimates from southern Vancouver Island. Camas density in this region, based on quantitative measurements in the field, ranged from 900-1300 plants/m^2 for *C. leichtlinii* and 1700-2100 plants/m^2 for *C. quamash*. Thoms indicated that his quantity, which was an average estimated from data from both wildland and garden sites, did not often include immature or smaller individuals. My quantities were counted in the early spring when camas seedlings could be included in the counts. In all plots, mature (i.e. flowering) plants accounted for less than 20% of the total number of camas plants (Table 4.1).

Thoms used a weight of 5.0 g for the minimum harvestable weight of a *C. quamash* bulb (5.0 g bulb = 2.0 cm diameter). This number equates to approximately 750 g/m^2 of fresh bulbs of harvestable weight, assuming that half the bulbs in the meadow of 300 plants/m^2 were of harvestable size (Thoms 1989:168). The weight of a harvestable bulb on southern Vancouver Island was calculated to be 10.0 g, based on ethnographic data (e.g., harvestable bulb = 3-6 cm across; Turner and Kuhnlein 1983:211), and my nursery studies (e.g., dimensions and weights for *C. leichtlinii*). Thoms estimated an annual harvest for a typical family in the interior to be one metric ton (1000 kg) of camas bulbs. For southern Vancouver Island, I used Jenness' (1934-35:7) estimation of "10 or 12 bags [gunnysacks]" of bulbs harvested by an "energetic" Saanich family for my calculation. The average bag number (11) was multiplied by 23.7 kg, or the weight of one bushel (assumed bag size by Babcock [1967], and Thoms [1989]). Therefore, the net weight of harvested camas bulbs for a Straits Salish family was about 260 kg/year.

If an estimated 260 kg of camas bulbs were harvested annually for a family's use as a staple root vegetable, then, by multiplying by the minimum weight threshold for a harvestable bulb (10 g/bulb), 26,000 bulbs were harvested by one family per year. This far exceeds Deur and Turner's (in press, 2004a) estimate of 10,000 bulbs (i.e. estimated from the volume of bulbs in one gunnysack) for an annual harvest allotment. However, if the weight of a harvestable bulb is calculated from an average width for harvestable bulbs

(4.5 cm) instead of the minimal bulb width (3.0 cm), then a harvestable bulb weighs greater than 30 g/bulb. This greater weight results in 8125 total bulbs being harvested annually for each Straits Salish family, a number much closer to Deur and Turner's

Table 4.1 Estimated yields and family patch sizes for camas harvesting sites for *Camassia leichtlinii and C. quamash.* Table adapted from Thoms (1989:172).

	Productivity Potential[1] (density of flowering individuals)			
Camas Ground Attributes	*C. leichtlinii*		*C. quamash*	
	Devonian (56 bulbs/m^2)	Tower Point (158 bulbs/m^2)	Mill Hill (74 bulbs/m^2)	Witty's Lagoon (252 bulbs/m^2)
Percent of total camas population	4.3%	17.5%	4.3%	11.6%
Maximum yield (at 10 g/harvestable bulb)[2]	5625 kg/ha	15,833 kg/ha	7396 kg/ha	25,208 kg/ha
Estimated annual yield[3]	2812 kg/ha	7917 kg/ha	3698 kg/ha	12,604 kg/ha
Estimated long-term yield[4]	1406 kg/ha	3958 kg/ha	1849 kg/ha	6302 kg/ha
Estimated sustained yield[5]	281 kg/ha	792 kg/ha	370 kg/ha	1260 kg/ha
Estimated family patch size at sustained yield[6]	1.07 ha	0.38 ha	0.81 ha	0.24 ha
Average patch size for each camas species	*C. leichtlinii* = 0.72 ha		*C. quamash* = 0.52 ha	

[1]Productivity potential (bulbs/m^2): See text for details.

[2]Maximum yield (kg/ha) = Productivity potential x 0.01 kg/bulb x 10,000 m^2.

[3]Estimated annual yield (kg/ha) = Estimated maximum yield x 0.5 (assumes 50% reduction in yield due to intra-site or inter-site variation).

[4]Estimated long-term yield (kg/ha) = Estimated annual yield x 0.5 (assumes 50% reduction in estimated annual yield due to long-term environmental variation).

[5]Estimated sustained yield (kg/ha) = Estimated long-term yield x 0.2 (assumes a 5-year rotation for harvesting site).

[6]Family patch size (ha) = 260 kg/yr (need) / estimated sustained yield.

estimate. These quantitative estimates emphasize the harvesting efforts that were likely involved for Indigenous peoples in this region by the time of European contact. Although these quantities seem immense, in terms of the number of individual plants removed from the overall camas populations, these coastal figures are low when compared to the estimated 200,000 bulbs/family that were harvested every year from the interior camas grounds of eastern Washington, Idaho, and western Montana (Thoms 1989).

How do these amounts of annual harvest yields translate ecologically to harvest pressures within local camas grounds? In other words, how big was a family's camas harvesting site? Following Thoms' (1989) original set of calculations (Table 4.1), the maximum yield of camas bulbs was calculated to estimate the size of a Straits Salish family's camas harvesting site at sustained yields. For southern Vancouver Island I used the densities of flowering individuals from my field sites at Mill Hill, Witty's Lagoon [including Tower Point], and Devonian regional parks as values of productivity potential. The selection of flowering or seeding plants was a near universal harvest criterion used by Straits Salish peoples in this region. It was found that camas (*C. leichtlinii*) bulbs grown in nursery cold frames are most often mature and regularly flowering when they weigh 10 g or more (Figure 3.10a). However, because camas plants have variable growth strategies it should be recognized that bulbs of harvestable weight could also be dormant or vegetative in any one growing season. Hence, the use of flowering individuals in this calculation most likely represents a conservative estimate of the number of harvestable bulbs. Maximum yield (kg/ha), therefore, is the collective weight of harvested camas bulbs (i.e. flowering) for a given site (Table 4.1).

As seen from the field study, there can be a substantial degree of finer spatial variability within a camas harvesting site and among sites. Camas phenology and growth are largely affected by changes in soil moisture, as well as other environmental factors such as the amount of open bedrock, soil chemistry, and exposure and aspect (see Chapter 3). With regular management, a harvested camas grounds could effectively be a micro-mosaic with camas in various stages of reproductive development and with a patchy distribution. The estimated annual yield (kg/ha) reflects that the harvest potential for any given year would vary based on both intrasite and intersite variation. Therefore, a 50 percent reduction in yield was calculated to account for this inherent environmental variability (Table 4.1).

There can also be variation in camas yields from year to year. As described by Suttles (1987), this region is also well-recognized for a high degree of temporal environmental variation. Straits Salish peoples had complex food production systems to maintain the productivity, availability, and reliability of significant foodstuffs in the face of seasonal, annual, and multi-year variation. Causes for this changeability could include climatic fluctuations (e.g., drought), pest infestations (Thoms 1989), or the cyclic patterns of regrowth and regeneration after anthropogenic disturbance (Suttles 1987; Turner and Peacock in press). As with the calculation for annual yield, the estimation of long-term yield (kg/ha) assumes a further 50 percent reduction in yield due to long-term variation (Thoms 1989) (Table 4.1).

Although there is little information on return intervals for camas harvest sites, it is highly unlikely that owned camas grounds would be harvested on a continuous basis without a period of rest (i.e. fallow period), although there may have been many communal sites that were harvested if needed. Camas populations likely need a period to "settle-in" and become re-established after intensive digging. For example, results from my five-year nursery study showed that rates of bulb division and flowering for *Camassia leichtlini* began to increase steadily two years after being transplanted into cold frames. The final number of camas plants exceeded the original number by 11 percent and over 50 percent of the plants were flowering regularly (i.e. at least three years during the study period) (Chapter 3). The original cohort of bulbs increased in weight by 67 percent on average over this time period. Furthermore, high flowering rates would maintain substantial seed production over time. It appears, therefore, that sexual and vegetative reproduction, as well as regular soil management, all maintained camas bulbs of harvestable size. Therefore, based on these calculations, I maintain a five-year harvest rotation as proposed by Thoms (1989) for an estimated sustainable yield (kg/ha) over time (Table 4.1).

Finally, to obtain the estimated size (ha)of a Straits Salish camas harvest plot at sustainable yield, the annual requirement of camas bulbs for one family (260 kg) was divided by the value of sustained yield for a given site. The average size of a family harvest site of *C. leichtlinii* was calculated to be 0.72 ha (0.38 ha - 1.07 ha), and for *C. quamash*, 0.52 ha (0.24 ha - 0.81 ha). An estimate of 2000 Straits Salish peoples on southern Vancouver Island at the time of European colonization (1843) (Floyd 1969) equates to about 250 families if there were approximately 8 people in a family (i.e. immediate family members and slaves) (W. Suttles, pers. comm. 2004). Hence, approximately 700 ha of productive camas grounds were needed to sustain local demands for camas bulbs by Indigenous families over time.

Although largely subjective, these estimates of sustainable yields of camas bulbs provide a conservative baseline assessment from which the contribution of camas, and more generally root vegetables, to the maintenance of the greater cultural landscape dynamics can be further investigated. It should be noted that this information, however, is very limited, and could misrepresent pre-contact camas harvesting pressures. The calculations are based on two ethnographic accounts of harvesting protocol (e.g., estimated harvestable bulb size, harvested quantities) both recorded in the twentieth century. It is likely that greater quantities of camas bulbs were harvested before the arrival of Europeans for various reasons; for example, before contact, more Indigenous people participated in the annual harvest, social networks of exchange and redistribution were intact and complex, and prime prairies habitats were available and could be devoted to camas use and management.

4.3 THE CAMAS LANDSCAPE OF SOUTHERN VANCOUVER ISLAND

The use of camas bulbs for food by First Peoples is likely a long-standing practice extending back in time for millennia. 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. Camas was the "queen root of this clime," and the "number one vegetable," as it was in many other regions of the greater Pacific Northwest.

This section assesses the published archaeological and palaeoecological research, and historical and archival information reviewed in Chapter 1, with the integrated camas management information presented previously to describe the continuum of Straits Salish camas production on southern Vancouver Island. The proposed timeline (Figure 4.6) presented in this section illustrates that camas management activities most likely evolved over thousands of years. Camas was not always a staple food: the intensity and scale of its use by Straits Salish peoples shifted over time. Undoubtedly, the most striking change – a dramatic decline - in Indigenous camas use occurred with European contact, and the end of regular camas use and management occurred in less than a century. The last part of this section describes how, in a time marked by tremendous social and economic upheaval for First Peoples, an introduced plant crop, the field potato, became an important alternative root food, eventually supplanting camas bulbs as the primary vegetal resource in the Indigenous economy.

4.3.1 Emergence of Camas Management Practices (pre-3500 BP)

The development of a Straits Salish camas economy, including intensive management practices and possibly the use of landscape fire, was likely in place by 3500 years ago (Figure 4.6). Strategic management practices for the maintenance of key resource communities and the enhancement of resource populations had likely been evolving for centuries (c.f. Brown and Hebda 2002). Furthermore, there is substantial archaeological evidence for broadscale camas use in corresponding camas growing regions of the Northwest United States (Thoms 1989).

Salish peoples adapted their food-getting strategies and patterns of land management to meet with changing environmental conditions through the Holocene (e.g., Thoms 1989; Gorsline 1992a). The long "settling-in" period of the early to mid-Holocene (10,000 BP to 4500 BP [uncalibrated radiocarbon years before present]) (Matson and Coupland 1995) represented a shift in subsistence strategies from people adapting to local environments to people purposefully modifying or even optimizing the ecological processes of a subsistence landbase. The complex technological, social, and

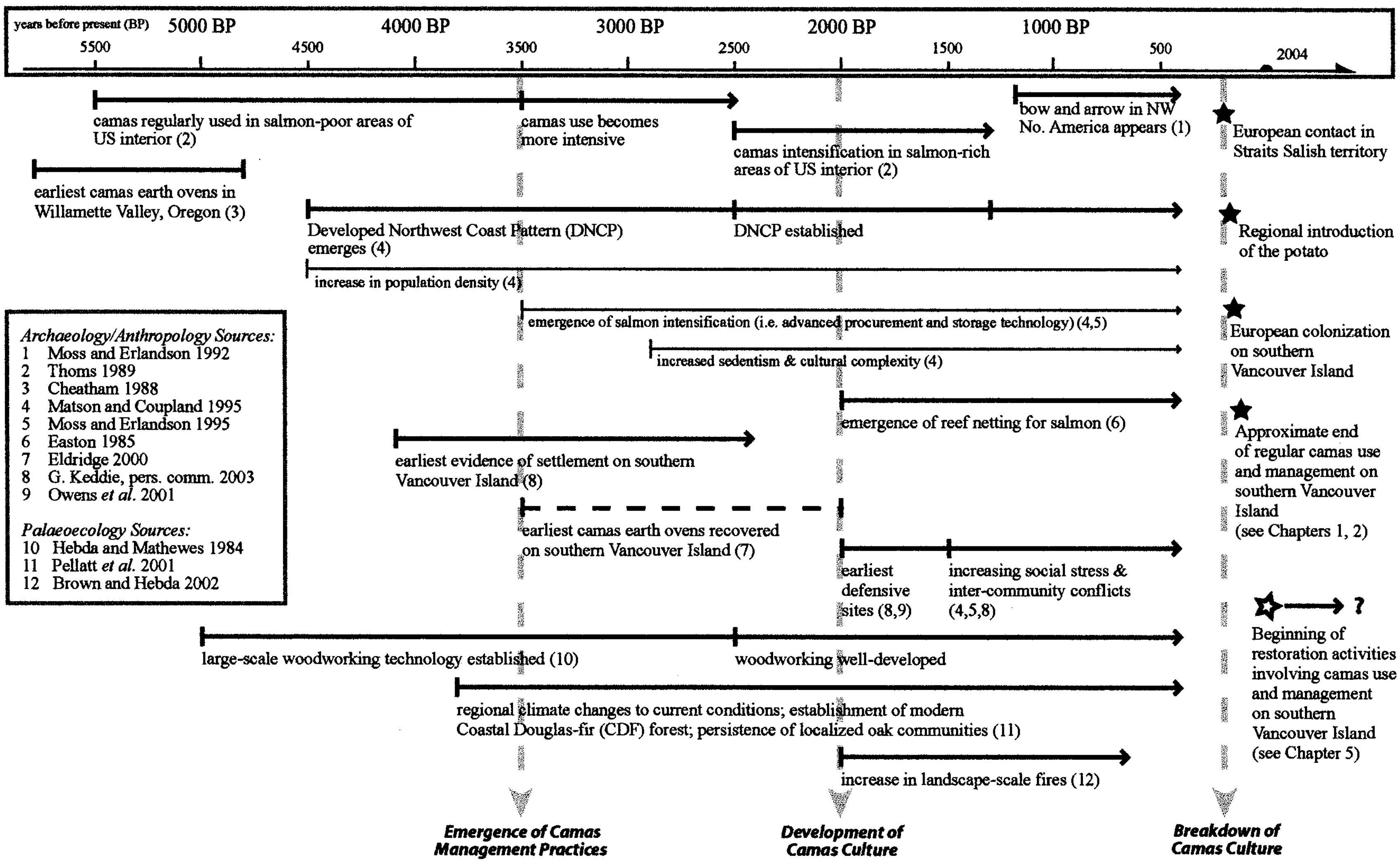

Figure 4.6 Proposed development of systematic camas food production ("camas culture") by Straits Salish peoples on southern Vancouver Island. See text for discussion.

ideological (i.e. belief systems) patterns documented for Straits Salish cultures over the last few centuries indicate two probable human-environment conventions that came into place during this time: (1) the adaptation to, and exploitation of, the inherent temporal and spatial variability of the Pacific Northwest environment, and (2) strong incentives to modify a broad patchwork of resource sites to meet with changing economic demands and social constructs (c.f. Suttles 1987; Berkes 1999; Peacock and Turner 2000; Turner *et al.* 2000).

From palaeoecological research it appears that the climate of the mid-Holocene (ca. 7040 BP to 3800 BP) supported oak-camas parklands, probably without the intervention of humans (e.g. Heusser 1983; Allen 1995; Hebda 1995; Pellatt *et al.* 2001). Oak communities continued to occupy much of the southern and southeastern areas of Vancouver Island through the more moderate and moist climate of this Mesothermic period (Pellatt *et al.* 2001). *Camassia*-type pollen has been found regionally since the early Holocene (Barnosky 1985b; Leopold and Boyd 1999; Pellatt *et al.* 2001), and for much longer in other Pacific Northwest locales (Barnosky 1985a; Thoms 1989) (see Chapter 1).

The establishment of coastal Douglas-fir forests around 3800 BP in this region coincided with relatively high accumulation rates for pollen of *Quercus* and Poaceae (grasses), and for *Pteridium* (bracken fern) spores, a palaeoecological signature also recorded for the early Holocene (Pellatt *et al.* 2001). According to Pellatt *et al.* (2001), the persistence of these taxa in the wetter and cooler climate of this time strongly suggests that some factor other than climate, such as Indigenous burning regimes, was responsible for the persistence of locally distributed oak parklands and meadow communities. The use of fire by Indigenous peoples to modify environmental conditions has been a common practice in this region (Brown and Hebda 2002), and Straits Salish increased the occurrence of fire within key habitats to maintain an open structure and resource productivity (c.f. Gorsline 1992a).

Archaeological and palaeoecological research (e.g., charred camas bulbs, camas pollen, earth ovens) from the northwestern United States has shown that the subsistence patterns of Indigenous peoples have included camas bulbs for at least 7000 years (Thoms

1989). Camas earth ovens dating to between 5800 BP and 4800 BP have been excavated from the Willamette Valley, Oregon (Cheatham 1988). Moreover, results from archaeological analyses on camas ovens and other camas related features in salmon-poor areas indicate that camas was regularly used between about 5500 and 3500 BP, but its use became more intensive after 3500 BP (Thoms 1989). Intensification (i.e. widescale food production) of camas and other geophytes did not arise in interior locations associated with productive anadromous fish runs until 2500 to 2000 BP, even though evidence for community semisedentism was present by approximately 5000 BP (Thoms 1989).

The Developed Northwest Coast Pattern, widely recognized from the ethnographic period for Indigenous peoples in this region, probably emerged around 4500 BP (Matson and Coupland 1995). The beginning stages of this cultural pattern included regional increases in population density and the establishment of a large-scale woodworking technology (Hebda and Mathewes 1984). The earliest archaeological evidence for Straits Salish settlement on southern Vancouver Island dates to 4100 BP (G. Keddie pers. comm. 2003).

4.3.2 Development of Camas Culture (3500 BP – 200 BP)

An intensive camas culture by Straits Salish families was emerging by approximately 2000 years ago. The Developed Northwest Coast Pattern continued to develop after 3500 and became fully established between 2500 BP and 2400 BP (Matson and Coupland 1995: Moss and Erlandson 1995) (Figure 4.6). The emergence of salmon intensification, including advance procurement strategies and storage technologies, occurred around 3500 BP. The development of Straits Salish reef net fishing possibly appears around 2000 BP (Easton 1985). Community sedentism and cultural complexity, social hallmarks of the Developed Northwest Coast Pattern, increased throughout the region after 3000 BP. Elaborate technologies and artwork, including the use of wood (e.g., western redcedar [*Thuja plicata*]) and perishable materials (e.g., woven items), were well developed by 2500 BP (Matson and Coupland 1995; Moss and Erlandson 1995). The earliest known evidence for camas earth ovens on southern Vancouver Island where from a small site that dates to about 3500-2000 BP (Eldridge 2000). It should be noted, however, that the archaeology of cam as exploitation or production has not been addressed directly by archaeologists on southern Vancouver Island. In the interior of British Columbia, early evidence of the use of earth ovens to cook plant foods arose around 3100 BP (Wollstonecroft 2002).

A transitional time of social change on the coast appears around 2000 years ago. Defensive sites began to be recognized from the local archaeological record at this time (Owens *et al.* 2001; G. Keddie pers. comm. 2003). Occupied fortification sites appeared in other areas along the coast at approximately 1400 BP, and their occurrences increase rapidly after 1000 BP (Matson and Coupland 1995; Moss and Erlandson 1995). The widespread appearance of the bow and arrow across North America about 1200 BP may have dramatically changed the face of warfare (Moss and Erlandson 1992; Hare *et al.* 2004). Furthermore, the "Wakashan expansion" occurring in the north likely had consequences for peoples along southeastern Vancouver Island (MacMillan 1999). Within this time, it follows, there were mounting intercommunity conflicts and social stress for Straits Salish peoples, which likely led to greater intensification and protection of valuable resources and increased territorial circumscription (Moss and Erlandson 1995).

Increased levels of charcoal in sediment cores from this region also indicated an increase in landscape fires around 2000 BP (Brown and Hebda 2002). Straits Salish peoples probably increased their use of fire in the last 2000 years to maintain the productivity and diversity of plant and animal resource communities in the face of rising human population densities and intensive harvesting pressures. This increase in landscape-scale burning, however, may have also been due to broader applications of fire for protection and defense during times of raiding or war. Fire was widely used for hunting, signaling, or clearing to make overland travel easier and to improve visibility (Boyd 1999a).

In summary, the cultural standards of camas use and management by the Straits Salish that were in place by 200 years ago evolved over millennia. The development of a "camas culture," including the advancement of a specific root production system, has probably been in place for the last 2000 years. Multifaceted cultivation activities, including social patterns of inherited resource tenure and decision-making mechanisms, intensive horticultural practices, and regular fire use could all denote a high demand for camas bulbs compared to a limited, or unpredictable, resource supply (c.f. Thoms 1989). Ownership patterns for camas grounds could have developed where inherent ecological productivity was high, or alternatively, where the relative abundance of the roots was limited or harvesting sites had variable digging conditions (c.f. Gritzner 1994). Specifically, the widespread descriptions of weeding, clearing, and burning as customary management practices in coastal camas grounds indicated that these resource sites were dynamic plant communities and reliable natural yields were not guaranteed.

It is important to note that Indigenous peoples had a continuous presence across the landscape within their geographical territory (c.f. Gottesfeld 1994). They returned to the same harvesting and hunting grounds on annual, regular, or periodic intervals. Therefore, their presence within many resource communities may not have been constant, but rather recurrent and consistent over time. Hence, adaptive and cumulative environmental knowledge and wisdom and the development of concepts of resource sustainability, if not a land use ethic, would have evolved from repeated movements across, and interactions within, a broad landscape over millennia (c.f. Gottesfeld 1994; Berkes *et al.* 2000; Turner *et al.* 2000).

4.3.3 Breakdown of Camas Culture: Potato Cultivation Introduced (post-200 BP)

Regular camas production ended within decades after European colonization on southern Vancouver Island due to the loss through disease and acculturation of large numbers of Indigenous practitioners and knowledge holders, rapid social changes, and the introduction of food alternatives. Moreover, because of the widescale development of Euro-Canadian settlement and agricultural lands, the introductions of new plant and animal species, and the cessation, or "disintensification" (Deur and Turner in press, 2004a) of Indigenous management, the regional landscape changed dramatically and irreversibly. The introduction of the field potato, however, remains one of the most underestimated causes of social change in the anthropological and ethnobotanical literature (see Suttles 1951b, in press; Deur 2000; Garibaldi 2003). If the cultural substitution of camas bulbs by potatoes in the face of demographic turmoil is examined, several important clues emerge which support the conclusion that an Indigenous camas culture was functioning on southern Vancouver Island at the time of contact (c.f. Deur 2000). The potato not only represented a major dietary change for Indigenous peoples but also a fundamental shift in root food economics. The rapid adoption of the potato and other agricultural crops is beginning to be seen as a logical progression in land use systems for Indigenous peoples fully capable of cultivating wild food plants (White 1999; Suttles in press).

The Straits Salish of southern Vancouver Island were probably cultivating potatoes acquired through trade from Fort Langley on the Fraser River for over a decade prior to colonization by the Hudson's Bay Company in 1843. By the early 1850s, Indigenous people were supplying enough potatoes for themselves, and for the settlers and colonists (Suttles 1951b). In 1858, the settlers were purportedly "indebted [to the Indigenous peoples]... for a supply of everything in season... at very reasonable rates" (Keddie 2003:36).

The potato may have become a supplemental root food to camas initially (Gorsline 1992a), growing with native root vegetables (Theodoratus 1989). In the face of dramatic social and demographic changes, the potato become the staple food, and subsequently a widely grown and highly marketable crop (Figure 4.7). With the economic demand for a regular and abundant supply of root foods, Indigenous people probably quickly learned that their root food, camas bulbs, could never match the continuous and abundant yields of the field potato. Moreover, working in large agricultural fields over a sustained period of time may have appeared highly unorthodox to Indigenous peoples, because management for camas bulbs was locally focused and time sensitive. However, with restricted land use and time, Indigenous peoples may have also tried European horticultural techniques or altered existing management activities to increase the productivity of native resource plants (e.g., Suttles in press).

Within the span of 30 years, approximately, Indigenous peoples were the primary potato producers in the Northwest Coast. The diffusion of potato cultivation was likely facilitated by Indigenous social organization of kin and affinal ties and local exogamy (Suttles 1951b:283), following similar patterns of cultural distribution as native foods. Straits Salish peoples, who fully understood the concepts of wealth exchange and redistribution, recognized the value and high status of the potato and other introduced root crops among the settler populations (c.f. Deur 1999).

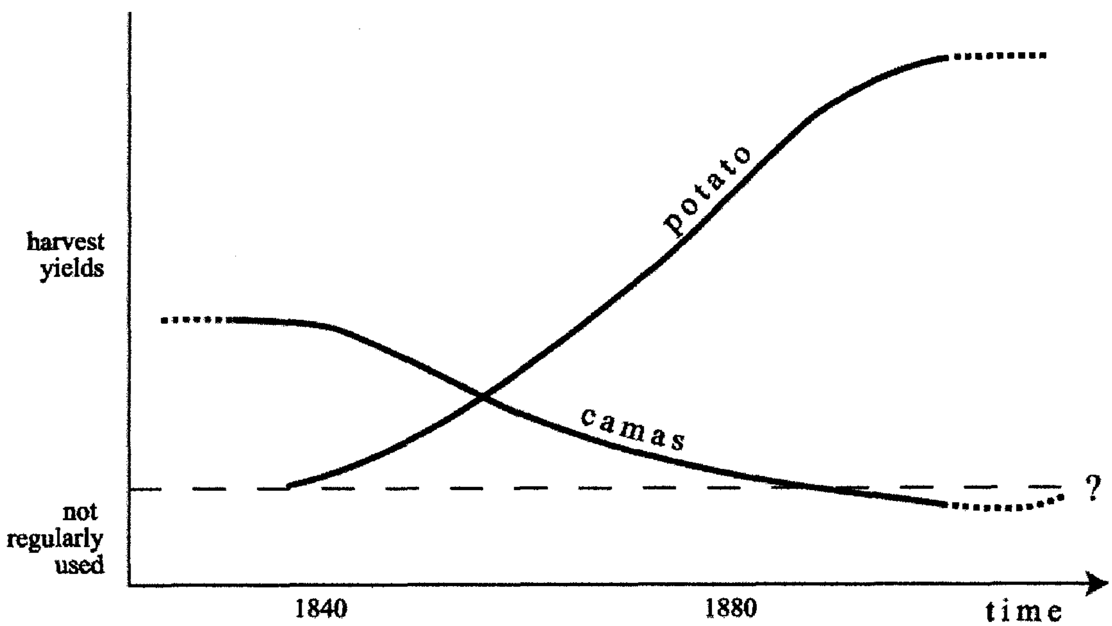

Figure 4.7 Proposed relationship between the native root crop, camas bulbs, and the introduced root crop, potatoes, in the Indigenous diet over time.

Although Straits Salish people were not cultivating domesticated crops *per se* before European contact, it is becoming more widely recognized that, through management activities, they were maintaining an anthropogenic or domesticated landscape (c.f. Deur and Turner in press, 2004a). Like a domesticated plant, a domesticated landscape is a cultural artifact which has been deliberately manipulated on different scales by humans to "make it more to the liking of [culturally significant] species" (Smith 1995:17). Was camas on its way to becoming fully domesticated? Can camas be domesticated, like the potato? Perhaps, *Camassia* was best managed at multiple scales or levels not because the geophyte was ecologically incapable of domestication, but because this cultivation system was integrated and operated effectively within the complex Indigenous economic structure of the region.

The Straits Salish economies disintegrated as a result of the decimation of countless Indigenous practitioners, the alienation of Indigenous families from their established resource sites, and the introduction of new social and economic structures. As a result of these changes, the traditional management practices for camas, and for many other plant and animal resources ended or were adapted to new harvest locations or adjusted to new food alternatives. The cultural landscape of the Straits Salish peoples was transformed dramatically and irreversibly after European contact because Indigenous long-standing cultural interactions changed. The camas culture may no longer be represented in the physical environment of southern Vancouver Island, but the symbolic importance of camas to Straits Salish peoples remains.

4.4 CHAPTER CONCLUSIONS

This chapter represents the culmination of the synthesis of interdisciplinary data on the history, ethnobotany, and ecology of *Camassia* on southern Vancouver Island. Through this integrated case study a better understanding of the ethnoecological structure and function of the regional landscape – oak-camas parklands - has emerged. Systematic and multiscalar management activities associated with a broad social structure and an adaptive economic framework maintained a mosaic of camas harvest grounds over the landscape for over 2000 years. These resource communities represented a widespread network of locally focused and productive agroecosystems that, when taken as a whole, provided Straits Salish families with reliable yields of harvestable camas bulbs. Moreover, these pulses of disturbance enhanced ecological variation and, therefore, also served to promote economic diversity, flexibility, and security.

Environmental and social changes affected Indigenous camas use and management over time. Camas bulbs were likely not always a cultivated staple crop food; the scope of resource management became more complex and intense as the role of camas in the economic structure of the Indigenous cultures increased. As with the development of food production systems in other regions, the evolution of camas cultivation can be seen as a continuum of intensifying intervention between humans and their root resource. At the time of European contact, the camas culture on southern Vancouver Island was at its peak. *Camassia* was a principal component in the terrestrially-based economy. After contact, the end of the camas culture was rapid and irreversible.

With its long and complex social and ecological history as a native root crop, the camas culture deserves recognition and revitalization. The restoration of oak-camas parklands begins with the reconstruction of its former ethnoecological function and structure. In the form of an epilogue to the story of camas on southern Vancouver Island, the ethnoecological restoration of the degraded camas landscapes of today is discussed in the next chapter.

5.0 ETHNOECOLOGICAL RESTORATION OF *CAMASSIA* LANDSCAPES

We are involved now in a profound failure of imagination.

-- Wendell Berry (1999:16)

Little by little. ...The steps back in to the living world can be made, like Nature's own reclamation of an old field, in an organic succession, as the diverse and locally adapted community grows up, along with and around us. Neither our senses nor our ecological selves can be numbed or denied much longer.

-- Stephanie Mills (1995:208)

One hundred and sixty years after European colonization, camas bulbs are no longer consumed as part of the Straits Salish diet, but their former use and management remain as significant symbols of cultural identity. Today, *Camassia* is generally perceived as a distinctive herbaceous species within the nationally endangered Garry oak ecosystems, and current recovery action plans for these ecosystems include objectives that address traditional ecological knowledge and management programs by local First Peoples (Fuchs 2001). Despite the advances of the Garry Oak Ecosystems Recovery Team (GOERT), as well as the common recognition of Indigenous fire use within the scientific community, there is limited understanding of the overall biological complexity of Straits Salish resource management objectives and methodologies in pre-European contact times. Furthermore, the ethnoecological processes of the historical landscape and the resulting ecological impacts of Indigenous management cessation have received inadequate attention in conservation strategies to date.

Modern-day land management considerations have conventionally focused on elements of the natural environment, including the presence and abundance of native and exotic species, connectivity and fragmentation of habitats, and ecosystem sustainability (Povilitis 2002). Restoration activities on southern Vancouver Island have largely included volunteer-based introduced plant removal programs, specifically "broom bashes" and "ivy pulls." These efforts, although remaining fairly small-scale, have firmly established some exotic invasive species (e.g., *Cytisus scoparius* [Scotch broom], *Dactylis glomerata* [orchard grass], *Daphne laureola* [spurge-laurel], *Hedera helix* [English ivy]) on local environmental hit-lists (see GOERT 2003b). There has been significant strides in native plant rescue, but nurseries specializing in native plants have as yet remained unsuccessful. More sophisticated restoration programs and science-based recovery initiatives are gaining momentum in the region.

In this chapter, I discuss the ethnoecological restoration of today's camas landscapes. The general development and theory of ethnoecological restoration will be introduced. Management recommendations will be presented at the same spatial scales - population, community, and landscape - as described in Chapter 4. The last section will briefly describe the re-incorporation of camas bulbs as a modern-day resource.

5.1 ETHNOECOLOGICAL RESTORATION: BACKGROUND

The environmental knowledge held by contemporary First Peoples has generally been viewed by restoration ecologists and resource managers as anecdotal or imprecise because of, in part, the presumed loss of traditional knowledge (Blackburn and Anderson 1993). Acknowledgement that the effects of First Peoples' resource management practices and land-based subsistence economies are important and cannot be disregarded is growing, and definitions of ecological restoration have become more generalized to reflect the broader levels of complexity of past landscape dynamics. In *Ground Work: Basic Concepts of Ecological Restoration in British Columbia*, for example, Donald Gayton (2001) describes the general purpose of restoration as the alteration of a site or ecosystem to a given reference condition. Gayton (2001:10) further explains the complexities associated with the recognition and incorporation of Indigenous environmental knowledge into new ecological restoration theory:

> Life was much simpler when we assumed a clear separation between humans and ecosystems. Now, not only do we find that humans negatively impact ecosystems in new and unexpected ways, we are also discovering that certain ecosystems have evolved to rely on human disturbance.

The development of appropriate ecological restoration objectives can prove challenging when unmodified reference ecosystems are limited, or when the "naturalness" of historical target ecosystems is obscured by the presence of former Indigenous landscape management (see MacDougall *et al.* 2004).

The incorporation of culture into nature will require a re-evaluation and expansion of human ideologies and perceptions of what is natural. Some restoration writers have suggested that the eastern or Indigenous cultures should be consulted for clues as to how to model new relationships with the natural world (e.g., Janzen 1988; McMahan 1997; McGinnis 1999). Several new terms to address the need of amalgamating both cultural practice and ecological process in restoration have been developed (c.f. Higgs 2003). "Ecocultural" restoration, for instance, was first proposed by Dennis Martinez, founder of the Indigenous Peoples' Restoration Network (Higgs 2003). In a similar vein, Daniel Janzen (1988) suggests a "biocultural" approach to the ecological restoration of tropical biodiversity. Finally, Higgs' (2003) "focal" restoration is described as a way to foster value of place through the processes of active participation and exchange: an engagement, he deduces, that will result in stronger community connections with each other and with the natural landscape.

Collaboration of Native- and Western-based knowledge systems is overdue (Colorado 1988; Kuhn and Duerden 1996), and the benefits of cooperative partnerships are only just beginning to be appreciated in the areas of ecosystem management and co-management, biodiversity conservation, and ecological restoration (see Stevenson 1996; Schoonmaker *et al.* 1997; Berkes 1999, Thomson 2000; Ford and Martinez 2000). In Moscow, Idaho, the Palouse-Clearwater Environmental Institute, for example, includes camas restoration as part of its restoration of a local wetland-meadow habitat: an initiative to honour the natural and cultural heritage of the region, and to help people reconnect to the land (Driscoll 2003).

The role of Indigenous and long-term residents (e.g., "old-timers") should not be underestimated. In recognizing the limitations of conservation policy, according to Soulé (1995), the best approach is to combine the talents of different knowledge-holders, from economists and planners to Indigenous peoples and biologists. Mechanisms for recognizing and incorporating the environmental knowledge of Indigenous and long-standing residents that is local in geographical scale and solidly based in practice and observation need to be explored (e.g., Garibaldi 2003; Higgs 2003). As described in Chapter 1, landscapes are both the physical manifestations of human occupation and interactions within a given territory, and the conceptual representations of a culture's spiritual, social, and practical relationships with the natural world. Although First Peoples have been removed from active participatory interaction with many biotic resources for generations, the second part of the definition of landscape still holds true. The oak-camas parklands have intrinsic cultural value and Indigenous peoples' conceptual relationships with this landscape have remained intact even though the vast majority of the human-resource interactions have been lost.

The ecological consequences of the cessation of long-term occupation and land stewardship activities practiced by First Nations are beginning to be addressed in the human ecology and restoration literature (e.g., Anderson 1996; Gadgil and Berkes 1991; Deur 2000). As yet, a correlation between the loss of Indigenous cultures and loss of biological diversity is a largely unexplored concept (but see Anderson 1993; Berkes 1999; Boyd 1999a; Deur and Turner in press, 2004a). Although the conservation of threatened species and ecological integrity are principal goals of restoration ecologists, often policymakers and practitioners do not give due attention to the anthropogenic components of the past and the continuity of cultural integrity and identity into the future. Indigenous Elders are now speaking out about the decline in the quantity and quality of their culturally important plants and resource communities because of habitat destruction and the prohibition of traditional management practices (e.g., Turner *et al.* 1990; Anderson 1993). After decades of Indigenous management suppression and acculturation, many traditional plant resources could be seen as endangered today when the landscapes are depicted in a cultural context.

5.2 MANAGEMENT RECOMMENDATIONS FOR CAMAS LANDSCAPES

5.2.1 Introduction: Rediscovering Our Roots

Good landscape restoration occurs through reconstruction. One cannot hope to restore a cultural landscape to a prescribed future condition without some knowledge of the climatic, geologic, and cultural components of the past. Anthropogenic and natural influences, however, become increasingly indistinct across the landscape as time passes (c.f. McCann 1999), thus adding to the challenge of accurately interpreting the landscape to be. Ethnoecological restoration is not solely the re-creation of a prescribed environmental target, but a process of reassessing the appropriate social and ecological relationships within a landscape given historical and projected environmental parameters (e.g., climate change). It is important to realize that not all human activities have led to negative consequences and, as a community, we need to sift through past and present landscape values and policies in an integrative approach to restoration (McCann 1999).

The former oak-camas parklands were a dynamic landscape. Although the environmental conditions of these ecosystems have changed dramatically since European contact, there are some aspects of the ecology which are inherent to the landscape. Garry oak ecosystems of southern Vancouver Island are highly heterogeneous and a part of a greater landscape mosaic with other ecosystems, such as Douglas-fir forest (GOERT 2003a). The degree to which these ecosystems remained biologically diverse and ecologically dynamic was a function of the intensity, frequency, and scale of past anthropogenic and natural disturbance regimes. The elimination of these disturbance patterns helped to shape the ecosystems of today.

The cultural management models presented in Chapter 4 can highlight the former cultural and ecological parameters that have been lost or altered over time (Figure 5.1). More than just a landscape snapshot or a reference site, a reconstruction type model can depict how environmental and cultural factors interact to shape landscape dynamics on spatial and temporal scales. Instead of characterizing a reference target as a restored place in time, therefore, the goal in landscape restoration is the re-integration of historically accurate ethnoecological systems.

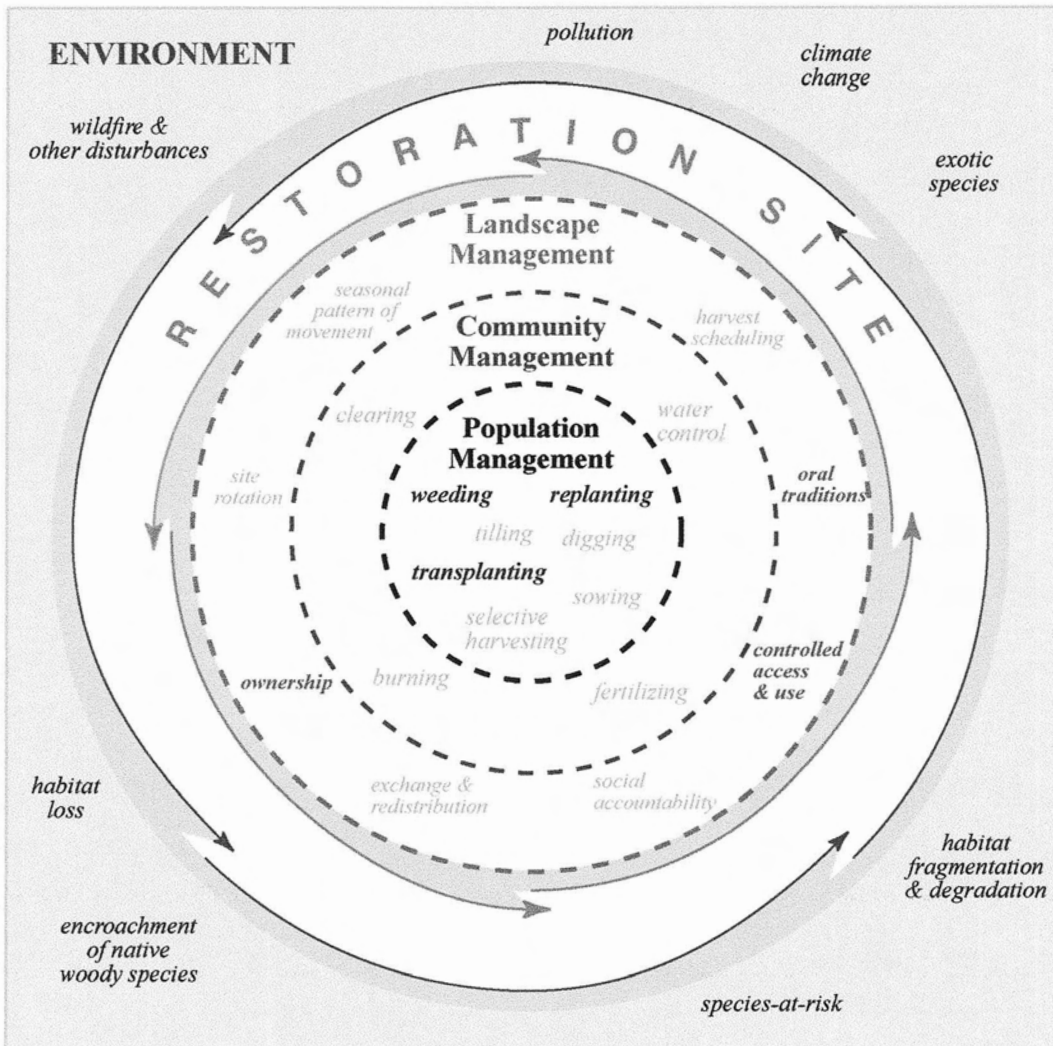

Figure 5.1 Management model for the restoration of geophytic ("root") species showing the three integrated spatial scales of cultural resource management. Former Indigenous management activities that are still practiced by people, to some degree, today are in bold. Examples of new environmental parameters are provided. (See Chapter 4 for full discussion of Indigenous management models.)

In light of significant social and environmental change, to what extent can current landscapes benefit from the re-implementation of past cultural management? The area of oak-camas parklands in the eighteenth century was greatly reduced and fragmented into reserves of parks, municipal right-of-ways, gardens, and other types of small urban and suburban patches. Intact deep-soil habitats (e.g., savanna, meadow) on southern Vancouver Island are scarce due to continued urban development, agricultural expansion, and the encroachment of invasive species. Today's Garry oak ecosystems are generally characterized as shallow soiled habitats (e.g., rocky outcrop and coastal bluff). If deeper soiled sites were the predominant camas harvesting grounds prior to European contact, can the Indigenous management used formerly on deep-soil camas grounds be successfully reintroduced on shallow-soil camas patches? Is it socially acceptable and ecologically sound for periodic burning or seasonal inundation to be restored to urban or suburban parks to help maintain an open habitat structure for camas and other native meadow species?

There are challenges associated with the re-implementation of ethnoecological processes at each of the three spatial scales of management (i.e. population, community, and landscape) and each, in order of increasing area, are harder to put into practice. Management activities on the population scale are the easiest to re-implement. Some practices, such as weeding (e.g., broom removal) and transplanting (e.g., native plant salvaging) have been in place for several years. The community scale of management is harder to re-implement as this spatial scale involves practices, such as burning, which act to shift ecological processes and affect ecosystem structure, but are associated with a high degree of potential risk in contemporary urbanized settings. The landscape scale, or the level that best represents the cultural context of management is the hardest to re-implement and sustain over time. This level of management is the "social glue" that ties the practices together in a patterned and coordinated system. The landscape scale may provide restorationists with the greatest challenges for re-implementation, but it is also needed for the future of the cultural landscapes of camas. These concepts are the focus of the rest of this chapter.

5.2.2 Population and Community Management: Getting Down to Business

The population scale of camas management is the most intense level of people-environment interaction and the fundamental unit of plant management. In a sense, many conservation organizations have already been implementing Indigenous management activities by weeding out unwanted species and transplanting native plants doomed to urban development. However, many restorationists today recommend against soil disturbance because of the likelihood of enhancing the conditions for seed germination of weedy species (e.g., Polster 2002). In general, there has been limited research on the effects of anthropogenic soil disturbance patterns or the cumulative effects of multiple treatments on culturally important geophytes. The maintenance of favourable soil conditions can enhance camas populations and likely the populations of other native geophytic plants (e.g., Anderson 1993). If localized and intensive interactions are coordinated with more diffuse management activities, biological diversity could be favoured through the enhancement of habitat heterogeneity (Palmer *et al.* 1997).

Clearly, if soil breaking is to occur there should be a commitment to on-going adaptive management and continuous monitoring. The intensification of human activities in restoration will increase the probability of biological invasion (Luken 1994), just as the management activities by Indigenous peoples included the maintenance of native weedy species (Chapter 4). The radical modification of the environment is associated with the success of weeds (Crosby 1986). Regular weeding and clearing appear to have been a part of the management system for these cultural landscapes, and likely will be for many generations. In a region where most of the human population is indeed introduced, people may do well to "learn to tolerate exotics" (McMahan 1997:75) in our landscapes.

Periodic disturbance, for the most part, enhances the growth and development of *Camassia* and the genus appears to be a good candidate for cultivation. Camas, well recognized for its horticultural merits, has been cultivated as a garden bulb for over 170 years, and was likely managed by First Peoples of the Pacific Northwest for thousands of years. Although the oak-camas parklands are continuously threatened and are nationally recognized for their rarity, this ecosystem fragility should not be mistaken for species vulnerability. Despite habitat loss and introduced species, many native perennial species have persisted in degraded ecosystems because of their tenacious adaptations to disturbance.

Management on the community scale includes clearing and fertilizing, although the principal agent of disturbance at this level is fire. The use of landscape-scale fire in urban or populated settings remains controversial. In addition to the potential risks of uncontrolled fire and its threat to property and life, smoke emissions and air quality standards in populated areas are a concern. Modern fire research models will need to incorporate not only past fire regimes, but also take into consideration the current social and environmental parameters.

The reintroduction of disturbance patterns, such as tilling, weeding, or burning, may not achieve the prescribed results in all cases because of inherent heterogeneity of these ecosystems. Furthermore, burn treatments may not succeed in ecosystems which have been long fire-suppressed (Huffman and Werner 2000), or in ecosystems where other disturbance regimes are suspected, such as former Indigenous root harvesting grounds. The reintroduction of fire use may need to be accompanied by supplemental management procedures, such as replanting with native species, in order to maintain native plant assemblages (MacDougall 2002; Polster 2002) and prevent increases in exotic plant populations. Management should be adaptive and, at least initially, conducted on a fine spatial scale. The ecological processes and successional pathways of contemporary Garry oak ecosystems are not well understood or even sufficiently studied in this region. In particular, more applied and integrative ecological research is needed to better assess the autecology of associated native plant and animal species (Polster 2002).

5.2.3 Landscape Management: From Cultural to Community

Straits Salish management regimes were imbedded in long-standing and evolving economies governed by a complex social organization (Chapter 4). The development and maintenance of a social context for the restoration of camas landscapes may be the most difficult to design or re-implement. The commitments of human involvement and investments of time associated with ethnoecological restoration challenges public inclinations. In general, people want a quick fix; whereas, the restoration of productive and functional natural habitats require years. No matter the landscape, "[time] is an essential ingredient" (Janzen 1988:243) in ecological restoration. As well, according to restoration polls, although most people favour restoration in principle, some remain unsupportive of altering nature in an active and manipulative way. For people reconnecting to nature, for instance, trees and critters have strong symbolic value; for trees, restoration volunteers prefer to plant them, not clear or cut them down (Barro and Bright 1998). These perceptions would appear to be contradictory to the objectives of meadow or savanna restoration initiatives.

Nevertheless, the restoration of degraded landscapes could aid in the restoration of community. Community-based restoration acknowledges the intricate diversity of human values and perspectives which could impact or enhance a given landscape at any one time. It also allows people to develop a *sense of place* within their local environments, a widely heralded objective of restoration activities today. However, although place implies a history, the sentiment generally does not delve into the intricacies of Indigenous people's interactions and relationships within their landscape. Hence, a *sense of origin* – more aptly, *a sense of roots* – could also be considered as a necessary ingredient for ethnoecological restoration (c.f. McGinnis 1999). This concept emphasizes the past environmental and cultural elements that shaped the landscape of today. The future must have its roots in the deep past, rather than in the shallow present.

Through ethnoecological restoration a landscape can resonate again through the human activities of mindful caring and skillful practice (c.f. Ingold 1993; Higgs 2003). Restoration that stresses the contributions of a community is akin to Eric Higg's "focal restoration" (2003:226). At the heart of focal restoration is the means to embrace cultural heritage and inspire community imagination (c.f. Higgs 2003). This attentive intervention supports careful experimental study and monitoring. In this context, information is gathered based on participation and observation, but also assessed by scientific procedures and theory and hands-on experience.

The argument that participation is integral to restoration process runs deep in the restoration and landscape theory literature (e.g., McGinnis 1999). The role of volunteers in restoration is immense, and many of these people stress the importance of feeling connected and in harmony with nature as a result of involvement with restoration (e.g., Barro and Bright 1998). According to Whittey (1997), people connect with nature in meaningful ways through the opportunities to encounter their own epiphanies. Connell (1999) suggests empathy, expressed through stories, as a way for people to engage with their natural surroundings. Stories can reflect landscape change; stories can enable culture change. Through intimate experience, as well as imaginative and integrative education programs, community-based restoration can affect human behaviour and initiate the reconnection between people and landscape (c.f. Janzen 1988; Whittey 1997; Helford 1999).

5.3 THE FUTURE FOR CAMAS AS A ROOT FOOD

Just as the landscape should not be solely described by its ecological keystone species, ethnoecological restoration should not simply revolve around scientific objectives alone. The restoration of camas production systems would take into account not only the re-establishment of appropriate management practices for continued maintenance of ecological productivity, but the development of camas, or any native plant, as a shared or marketable resource. As Chambers (2001) demonstrated in her applied ethnoecological experiments, balsamroot (*Balsamorhiza sagittata*), a highly valued Indigenous root food and medicine from the BC interior, has contemporary utility in horticulture, ecological restoration, and reclamation, as well as having a potential as a herbal medicine and food. Camas and other geophytes could have similar contemporary value on southern Vancouver Island.

There are several reasons, however, why the re-incorporation of camas processing and consumption may prove to be problematic in a modern-day context. Camas bulbs have not been regularly harvested in many decades, and hence, Indigenous practitioners with traditional harvesting knowledge are rare. The deep-soil sites where Straits Salish peoples likely maintained extensive and productive camas grounds no longer exist as well. Although camas has relatively high regional abundance, productive camas populations are locally restricted and more judicious ethnoecological research needs to be accomplished before wild harvesting or cultivation could be considered for cultural use and management programs.

Although nursery studies (Chapter 3) indicate that *Camassia leichtlinii* can transplant and grow well in these settings, there is insufficient research to date on the best horticultural growing conditions to ensure resource sustainability over the long-term, and whether these conditions can be maintained in natural habitats. Moreover, nursery studies involving *C. quamash* have yet to be carried out and detailed demographic studies that include bulb data have not been explored in natural settings.

The processing and cooking of camas is time-consuming and alternative cooking methods have not been fully explored. Suitable storage of camas bulbs is also of concern and efficient ways to dehydrate or otherwise preserve the bulbs need to be considered (c.f. Thoms 1989). Importantly, as well, the possibility of harvesting the bulb from a poisonous plant (e.g., *Zygadenus venenosus*) by mistake is a very important consideration in harvesting camas by inexperienced people from unmanaged camas sites.

Finally, efforts should be made to support local Straits Salish peoples with the re-establishment of their traditional management regimes and the reintegration of traditional foods. The re-introduction of native root foods into Indigenous peoples' diets could have great implications for health management, especially in reference to the high rate of diabetes among contemporary Indigenous peoples (Health Canada 1994). Consultation and collaboration with Indigenous peoples should be encouraged as much as possible in the restoration of their respective cultural landscapes with both ecological and cultural objectives given equal consideration. Areas that were known to be traditional cultural use areas should receive primary attention for protection (Beckwith 2002). Garibaldi's (2003) model of "cultural refugia," developed from her work on the root vegetable wapato (*Sagittaria latifolia*), recognizes the cultural context of landscape change and emphasizes the critical importance of consultation or collaboration with Indigenous elders and other key knowledge holders in ethnoecological initiatives.

The two species of camas - *Camassia leichtlinii* and *C. quamash* - have a long-standing ethnoecology. No other traditional food plant in the Garry oak ecosystems has such a long and complex history in this region. Hence, the story of camas can be told by using the "languages" of traditional environmental knowledge and of western scientific knowledge. When these two languages can be integrated into a collaborative framework, then a more complete and accurate story can be told of the past landscape dynamics than by using one language alone. In this dissertation I showed that by integrating the environmental knowledge of Straits Salish peoples and academic-based science the same research conclusions can be reached and the story carries greater weight. The story of camas will continue to evolve as long as there are people who care about it and who know its history.

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Appendix 1 Indigenous stories from Vancouver Island that include camas.

The Indian Story of "Jack and the Bean Stalk" (as told to Robert Brown by Tomo, from Cowichan (?); in Hayman 1989:179-180). Stories similar to this one are found throughout many groups of First Peoples, especially those of southern Vancouver Island, and are often referred to as the "Star Husband Tales."

Once on a time long ago (this was in the days no more remembered, when the heavens were nearer earth, and the gods were more familiar – it never happens nowadays), two Tsongeisth *[Songhees] girls were gathering gamass [camas], at* Stummas *(near Elk Lake, Vancouver Island), and after the manner of the gamass-gatherers they camped on the ground during the season. One night they lay awake, looking up at the bright stars overhead, thinking if their lovers, and such things as girls, Indians or English, will talk about. The Indians suppose the stars to be little people, and the region they live in to be much the same as this world down below. As one of the girls looked up at the little people twinkling overhead, one said to the other, looking at Aldebaran, the red eye of the Bull, "That's the little man to my liking; how I would like him for my lover!" "No," said the other, "I don't think I should: he's too glaring and angry-looking for me. I am afraid he would whip me. I would better like that pale, gentle-looking star, not far from him." And so the gamass-gatherers of* Stummas *talked until they fell asleep. But as they slumbered under the tall pines, Aldebaran and Sirius took pity on their lovers and came down to earth, and when the girls awoke in the morning it was in Starland, with their lovers by their sides, in the country up in the sky. For a while all went well and happily, until, after a manner of their race, they wearied to see their friends at* Quonsung *("The Gorge," in the Victoria Arm) and* Cheeuth *(Esquimault) [Esquimalt], and their gentle husbands grew sad at their melancholy wives. One day one of the sisters came upon the other busily engaged in Starland, and she said "What are you doing, sister?" "I am twisting a rope," she said; "a rope of cedar bark, by which to get back again to* Quonsung. *Come sister, our husbands are asleep, help me." So the sisters fell to work, and while their husbands slept they wrought, until they had twisted a rope long enough, in their opinion, to drop themselves down to earth again. This they concealed in the woods, and then commenced to dig a hole in the vault of heaven with a pointed stake.*

For many days they dug, until they heard a hollow sound, and then they knew that they were nearly through; and next day they finished their work (at a fitting time), and saw the clouds beneath, but the earth was a long way down. All this time their husbands were out hunting, or asleep in the lodge. They then fastened a stick transversely over the hole, and to this they attached the rope, and commenced to slide down. For long they slid, but yet did not come to the earth, and they began to fear for the results, for the rope was nearly ended, but Satitz *(the east wind) took pity on them, and blew them to the earth, and they knew not what had happened, but on recovering their senses they found themselves near the valley of the Colquitz – not far from their own home – with the rope lying beside them. So they coiled it up, and* Haelse *["Supreme Being"] made it into a hill as a monument [today known as Knockan Hill], to remain mortals not to weary for what is not their lot. And after this the girls went back to* Quonsung, *and became great medicine-women, but remained single, all for love of the "little people" above.*

Swan Women Give Place Names to the *Ho:pach'as?ath* Country (excerpt) (Arima *et al.*, 1991:233-234).

The ladies were digging for camas. They wee all daughters of Swan, and there were many of them. The weather was very nice, and they went farther into the forest as it got warmer. Their heads were bobbing up and down as they used their breasts (to push the digging sticks down). They had no way to stop it from being hot. The Swan women started to sing!

Next day they got a lot of camas again, and they packed the camas on their backs. They would continue digging roots whenever it got warmer. They started to sing. Whenever they would start singing again the next day, they would sing a different song. For a long time they sang and, as a result, they made possible a great feast by digging up a whole lot of camas.

Appendix 2 Locations of permanent plots used in field study in Mill Hill, Witty's Lagoon, and Devonian regional parks. A differential GPS unit was used to find plot positions. Note that the GPS unit is inaccurate at sites near sea level.*

Site	Plot	UTM Coordinates	Easting	Elevation (m) (uncorrected)	Description of Plot Location
Mill Hill	1	N5367138.34331	464604.852612	159.133	East of Summit Trail at first lookout
Regional Park:	2	N5367096.26119	464587.876451	150.565	South of lookout
Park (60.8 ha) is	3	N5367112.30345	464611.223153	152.657	South of lookout, 21° from Plot 2
classified as a	4	N5367130.94214	464574.816185	161.117	West of Summit Trail opposite lookout
regional	5	N5367144.09130	464537.186856	168.161	South ridge, east of Calypso Trail
conservation area	6	N5367153.11751	464551.088525	168.063	South ridge, 42° from Plot 5
and was	7	5367156.64944	464565.509858	165.752	South ridge, 50° from Plot 6
established in	8	5367157.65595	464624.670646	156.714	East of Summit Trail, 42° and 35 m from Plot 1
1981. It is located on Atkins	9	5367246.20927	464599.472977	168.780	Near new lookout bench, 360° and 25 m from bench
Avenue in	10	5367245.31403	464590.717536	168.781	Near bench, 270° and 6 m from Plot 9
Langford.	11	5367237.37695	464598.804362	168.585	Near bench, 360° and 15 m from bench
	12	5367234.65524	464600.748252	167.673	Near bench, South 2 m from Plot 11
	37	5367288.10892	464552.726311	172.965	36° from summit, west of Thetis Lake Trail
	38	5367282.24324	464549.004262	173.023	36° from summit, 5 m south of Plot 37
	39	5367279.68913	464549.618729	173.023	36° from summit, 2 m south of Plot 38
	40	5367280.58639	464552.718780	172.243	36° from summit, 2 m east of Plot 39
Witty's Lagoon	13	5359793.39654	462139.092901	29.484	192° and 12.1 m from Douglas-fir with tree fort
Regional Park:	14	5359800.27466	462128.537551	31.008	180° and 9.9 m from wildlife tree
Park (56.0 ha) is	15	5359804.56794	462131.846839	29.123	161° and 5.3 m from wildlife tree
classified as a	16	5359805.04192	462129.325062	28.749	187° and 5.1 m from wildlife tree
regional	17	5359861.96184	462144.426424	32.491	317° and 19.0 m from big, lone Douglas-fir
conservation area	18	5359854.45631	462150.375043	36.003	326° and 11.2 m from big, lone Douglas-fir
and was	19	5359860.26055	462150.647656	32.825	331° and15.4 m from big, lone Douglas-fir

established in 1966. It is located on Metchosin Road in Metchosin.	20	5359873.47655	462141.113442	32.942	319° and 31.2 m from big, lone Douglas-fir
	33	5359864.50180	462132.968357	26.071	298° and 28.7 m from big, lone Douglas-fir
	34	5359861.99226	462129.944059	27.300	290° and 29.2 m from big lone Douglas-fir
	35	5359859.29220	462131.925259	27.146	287° and 26.1 m from big lone Douglas-fir
	36	5359856.87392	462136.449510	24.990	290° and 20.9 m from big lone Douglas-fir
Tower Point: Part of Witty's Lagoon R.P., but located on Bradene Road.	29	5359120.37010	462544.914745	-10.735*	189° and 3.6 m from cut broom stump
	30	5359119.84857	462548.245416	-11.642*	130° and 4.1 m from cut broom stump
	31	5359102.39467	462543.984601	-9.026*	29° and 3.7 m from scrubby oak
	32	5359101.57593	462539.589200	-8.003*	279° and 2.1 m from scrubby oak
Devonian Regional Park: Park (14.4 ha) is classified as a regional natural area and was established in 1980. It is located on William Head Road in Metchosin.	21	5356771.80015	460320.839034	9.995	Burned swale, 81° and 4.8 m from oak at top of swale
	22	5356773.64805	460323.904185	9.093	Burned swale, 68° and 8.8 m from oak
	23	5356774.76261	460326.399606	9.360	Burned swale, 61° and 11.4 m from oak
	24	5356776.91126	460332.390837	8.278	Burned swale, 58° and 17.5 m from oak
	25	5356779.84678	460254.160777	17.517	Rocky knoll, 329° and 9.3 m from big Douglas-fir
	26	5356781.32154	460256.772853	17.451	Rocky knoll, 339° and 10.9 m from big Douglas-fir
	27	5356775.65828	460260.211979	20.271	Rocky knoll, 358° and 5.8 m from big Douglas-fir
	28	5356777.14698	460261.541671	16.550	Rocky knoll, 9° and 8.6 m from big Douglas-fir

Appendix 3 Sample SAS program used to analyze community and population data in field study.

```
%macro mix(dep);
proc mixed data=leicht;
        class block2 park treat time;
        model &dep=park treat treat*park time time*park time*treat
cover_cl/outp=stat;
        random block2(park);
        repeated time/sub=plot type=ar(1);
        title1 "Analysis of &dep (Camspecies2 data set – Leichtlinii)";

proc plot data=stat;
        plot resid*pred;
        title1 "Residual vs Predicted for &dep";

proc univariate data=stat normal;
        var resid;
        qqplot resid;
        title1 "Testing residuals for normality (&dep)";

run:
%mend mix;

%mix (clcov);
%mix (invden);
%mix (cllfn);
%mix (cllfn);
%mix (cllfw);
%mix (clsed);
%mix (clflw);

run;
```

Appendix 4 Presence/absence data for vascular plant taxa identified from experimental plots in four study sites, Mill Hill (M), Witty's Lagoon (W), Devonian (D), and Tower Point (T), over a four year study.

No.	Scientific Name	Common Name	1999	2000	2001	2002
1	*Achillea millefolium*	yarrow	M	M	M	M
2	*Aira caryophyllea*	silver hairgrass		MDT	MWDT	MWDT
3	*Aira praecox*	early hairgrass	MWDT	MWDT	MWDT	MWDT
4	*Allium acuminatum*	Hooker's onion	WT	MW	W	W
5	*Allium amplectens*	slimleaf onion	W	W		
6	*Amelanchier alnifolia*	saskatoon		W		T
7	*Anthoxanthum odoratum*	sweet vernalgrass	MWDT	MWDT	MWDT	MWDT
8	*Aphanes microcarpa*	small-fruited parsley-piert			WDT	WDT
9	*Arctostaphylos uva-ursi*	kinnikinnick	M	M	M	M
10	*Avena fatua*	wild oat	M	M		
11	*Briza minor*	small quakiing grass		D	D	
12	*Brodiaea coronaria*	harvest brodiaea	MWDT	MWDT	MWDT	MWDT
13	*Bromus carinatus*	California brome	D	WDT	WD	WDT
14	*Bromus hordeaceus*	soft brome	MWDT	MWDT	MWDT	MWDT
15	*Bromus rigidus*	rip-gut brome	WT	WT	WT	WT
16	*Bromus sterilis*	barren brome	MW	M	MWD	WD
17	*Camassia leichtlinii*	great camas	MWDT	MWDT	MWDT	MWDT
18	*Camassia quamash*	common camas	MW	MW	MW	MW
19	*Cardamine oligosperma*	little western bitter-cress				M
20	*Carex inops*	long-stoloned sedge	M	M	M	M
21	*Centaurea cyanus*	cornflower	W	W		
22	*Cerastium arvense*	field chickweed	W	D	WD	WD
23	*Cerastium glomeratum*	sticky chickweed	D	MD	MDT	MWT
24	*Claytonia perfoliata*	miner's-lettuce	WD	WD	WDT	T
25	*Collinsia parviflora*	small-flowered blue-eyed Mary	WDT	MWDT	MWDT	MWDT
26	*Comandra umbellata*	comandra	M	M	M	M
27	*Cynosurus echinatus*	hedgehog dogtail	MD	MD	M	M
28	*Cytisus scoparius*	scotch broom	MWDT	MWDT	MWDT	MWDT
29	*Dactylis glomerata*	orchard-grass	W	WT	WT	WT
30	*Danthonia californica*	California oatgrass	M	M	MD	MDT
31	*Delphinium menziesii*	Menzies' larkspur	M	M	MW	MD
32	*Dodecatheon hendersonii*	broad-leaved shootingstar	MW	MW	MW	MW
33	*Dodecatheon pulchellum*	pretty shootingstar	M	M	M	
34	*Elymus glaucus*	blue wildrye	WDT	WDT	WDT	WDT
35	*Eriophyllum lanatum*	woolly eriophyllum		M	M	M
36	*Erodium cicutarium*	common stork's bill		W		W
37	*Fescue idahoensis*	Idaho fescue	MW	M	M	M
38	*Galium aparine*	cleavers	WDT	MWDT	MWDT	MWDT
39	*Galium triflorum*	sweet-scented bedstraw	M	M	M	
40	*Geranium molle*	dovefoot geranium	MWDT	MWDT	MWDT	MWDT
41	*Holcus lanatus*	common velvet-grass	D	D		D

42	*Holodiscus discolor*	ocean-spray		T	M	T
43	*Hypericum perforatum*	common St. John's-wort	M	M	M	M
44	*Hypochaeris glabra*	smooth cat's-ear	M	M	M	M
45	*Hypochaeris radicata*	hairy cat's-ear	MWDT	MWDT	MWDT	MWDT
46	*Lamium purpureum*	purple dead-nettle		T	T	T
47	*Lolium perenne*	perennial ryegrass	WD	WD	WD	WD
48	*Lomatium utriculatum*	spring gold	MW	MW	MW	MW
49	*Lotus micranthus*	small-flowered birds-foot trefoil	M	MWD	MWD	MWD
50	*Lupinus bicolor*	two-coloured lupine		M	M	M
51	*Luzula multiflora*	many-flowered wood-rush	MW	MW	MWD	MWD
52	*Madia* sp.?	tarweed		M		M
53	*Montia linearis*	narrow-leaved montia		W	WT	
54	*Montia parvifolia*	small-leaved montia	D	D	D	D
55	*Myosotis laxa*	small-flowered forget-me-not	WD	MWDT	MWDT	MWD
56	*Navarretia squarrosa?*	skunkweed			M	
57	*Nemophila parviflora*	small-flowered nemophila		WD	WDT	WD
58	*Olsynium douglasii*	satinflower		M	M	M
59	*Orobanche uniflora*	naked broomrape			M	
60	*Phlox gracilis*	pink twink			M	M
61	*Plantago lanceolata*	ribwort plantain	MWT	MD	MW	MWD
62	*Plantanthera* sp.	rein orchid			M	
63	*Plectritis congesta*	sea blush	W	WD	WD	WD
64	*Poa compressa*	Canada bluegrass	WD	D	WD	WD
65	*Poa pratensis*	Kentucky bluegrass	MWD	MWD	MWD	MWD
66	*Poa secunda?*	Sandberg's bluegrass	M			
67	*Polypodium glycyrrhiza*	licorice fern	W	M	M	W
68	*Pseudotsuga menziesii*	Douglas-fir		MWDT	W	MW
69	*Quercus garryana*	Garry oak		M		
70	*Rubus discolor*	Himalayan blackberry	T	T		W
71	*Rumex acetosella*	sheep sorrel	WD	MWDT	MWDT	MWDT
72	*Sanicula crassicaulis*	Pacific sanicle	WD	WDT	MWDT	MWDT
73	*Sherardia arvensis*	field madder	MD	M	M	M
74	*Silene gallica*	small-flowered catchfly		MDT	MT	MDT
75	*Stellaria media*	common chickweed	WDT	WDT	MWDT	WDT
76	*Symphoricarpos albus*	common snowberry	T	T		T
77	*Teesdalia nudicaulis*	shepherd's cress	M	M	M	M
78	*Trifolium depauperatum*	poverty clover		MW	W	MW
79	*Trifolium microcephalum*	small-headed clover		W		W
80	*Trifolium microdon*	thimble clover		MD	MD	MD
81	*Trifolium variegatum*	white-tipped clover	D	W		MD
82	*Trifolium willdenowii*	tomcat clover	DT	MWDT	MWDT	MWDT
83	*Triteleia hyancinthina*	white triteleia	M	MWD	MWDT	MWDT
84	*Veronica arensis*	common speedwell	DT	MWDT	MWDT	MWDT
85	*Vicia sativa*	common vetch	WD	MWD	MWD	MWD
86	*Vulpia* spp.	annual fescues	MWDT	MWDT	MWDT	MWDT