

The Ethnobotany and Descriptive Ecology of Bitterroot, *Lewisia rediviva* Pursh
(Portulacaceae), in the Lower Thompson River Valley, British Columbia:
A Salient Root Food of the Nlaka'pamux First Nation

by

Robert W Bandringa

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Department of Resource Management and Environmental Studies

The University of British Columbia
Vancouver, Canada

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Abstract

Bitterroot, *Lewisia rediviva* Pursh, is a geophytic, leaf-succulent perennial endemic to the arid, intermontaine grasslands of western North America. Its fleshy tap root has been and remains an important food stuff for many indigenous groups, including the Nlaka'pamux First Nation in the Lower Thompson River Valley of British Columbia. Among the Nlaka'pamux, bitterroot's high salience as a root food vegetable is evidenced by its practical use as a powerful foodstuff delicacy and medicinal morsel. This is further heightened by traditional beliefs and mythologies linking it to human ancestry.

Ethnobotanical texts of the Nlaka'pamux encode an array of sophisticated management strategies and harvesting techniques that have enhanced this plant resource. The surrounding anthropogenic influences were identified and openly weighed in direct connection with the autecology of the species throughout the Lower Thompson River Valley. Descriptive ecological sampling was undertaken at the floristic level alongside a number of environmental variables in order to evaluate the local status and community characteristics of bitterroot. The gathered data exhibited high levels of variability within and between populations, signifying adaptation to a disturbance regime likened to long-term, human-induced manipulation. These ethnobotanical and ecological findings serve to promote an integrated mediation of the cultural and vegetational aspects of the species.

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1.0 Introduction

Bitterroot, *Lewisia rediviva* Pursh, is a geophyte native to the cool steppe, intermontaine grasslands of west central North America. Continental evaluation of the species is considered to be 'not endangered', that is, in correspondence to definitions given by the 'Flora of North America Project' (Taylor and MacBryde 1977). Within British Columbia, however, this conventional ranking is challenged in light of the species rather limited and oft marginalized habitat abreast its traditional and provisional importance as a root food of Interior First Nations. Many view bitterroot's present and future status to be provincially threatened (Couplan 1998, Kuhnlein and Turner 1991).

The Nlaka'pamux First Nation of British Columbia have raised earnest and emphatic comment as to the species' localised diminishment caused in part by the cumulative effects of development. As contained within their territory, the area of the Lower Thompson River is an historically rich locality for bitterroot. While being part of the 'dry belt' biome in British Columbia, it remains a largely neglected region of study for the species, in both botanical and cultural terms.

Past research on bitterroot has been broad but shallow, especially in address of anthropogenic influences. Studies have looked at its ecological life-history (Daubenmire 1975), ecophysiological characteristics (Marvel 1986) and systematic implications of the wood anatomy of Portulacaceae (Carlquist 1998). Perhaps the most fascinating and historically pertinent papers however are by Davidson, who in 1914 and 1915 recorded some preliminary information specific to the species in the Lower Thompson River Valley. Of interest also is a paper by Wilson et al. (1988) who included cultural means as a possible dispersal mechanism of the species into southern Alberta. As to the content

and nutritional value of bitterroot, chemical analyses have also been made; Daubenmire (1975) cites a brief investigation made a century ago by Paillieux and Bois (1899) while more recently, Kuhnlein and Turner (1991) made a thorough documentation of its nutritional constituents.

Ethnographic research related to the species has been of moderate consequence. Among the many indigenous Nations of arid North America, bitterroot is frequently mentioned and referenced as an important root food and medicinal plant as well as a valuable cash crop (Moerman 1998). However, these citations are within the context of multiple plant inventories and little if any attention has been given to it on an individual basis. Pertinent to the Nlaka'pamux, ethnographic study by Teit (1898, 1900) as well as inventorial ethnobotany by Steedman (1930) and Turner et al. (1990) have given introductory attention to the species.

With many intriguing ethnobotanical plants and subjects worthy of exploration, it is significant to note that the genesis of this study emerged through a felt need of the Nlaka'pamux. Chiefs, Elders and administrators took initiative to cooperatively delve into the status and traditional knowledge of bitterroot, the plant they so intimately know as *lhQuoopen*. The species remains to be a precious and delighted upon resource for their people, holding rich traditional and contemporary value. The need for attention to this species was born not only in protection of the highly venerable plant but also in affirmation and sustenance of their culture.

It is in this complementary nexus of biocultural diversity that ethnobotanical and ecological investigation shines. They are interrelated and coactive aspects of the same history; human activity and influence on flora can affect the latter's ecology, while the

genetic and phenological makeup of a species may govern its degree of cultural significance. The objectives of this study are twofold: 1) to add to the greater ethnobotanical text of the Nlaka'pamux by summarising the cultural, spiritual, social and physical saliency of the species' use and management, and 2) to give analytical attention to how the roles of human activity and their consequences have influenced the structure and evolution of local vegetation, thereby elucidating that the species ecology cannot be separated from its ethnobotany and vice versa.

Subsequent to the remainder of this chapter outlining the people and place of the Nlaka'pamux as well as a botanical overview of bitterroot, the following chapters explore the ethnobotany and ecology of the species. Chapter 2 focuses on the traditional knowledge and use of bitterroot by the Nlaka'pamux, while Chapter 3 describes its autecological status in the Lower Thompson River Valley of British Columbia.

1.1 Cultural and Physical Landscape

The unique geology, climate and biological environment of the Lower Thompson River Valley has given rise to a delicate but unyielding land coloured with the desert hues of sagebrush, cacti and bunchgrass. Its dry, sandy soil and undulating hills have provided a becoming backdrop for a kinship, enchanted and enacted between bitterroot and the Nlaka'pamux People.

As a semi-arid habitat, the Lower Thompson is unmatched in situation across the whole of Canada. It has a profound and rich natural history that parallels a startling chronicle of Nlaka'pamux connection to the land. Archaeological evidence suggests First Nations have occupied the region for over 9000 years (Bordon 1968) while oral

tradition affirms indwelling since time immemorial. The unique climate and terrain coupled with historical interaction of the Nlaka'pamux has led to its emergence as a kind of 'biocultural epicentre'. Truly, it is a place of invaluable biological and cultural wealth.

1.1.1 Ethnographic Background

The Nlaka'pamux are an Interior Salish First Nation in the province of British Columbia. Their language is one of twenty-three Salishan languages and a member of the Northern Interior subgroup of the Interior Branch of the family (Thompson and Thompson 1996). The traditional territory of the Nlaka'pamux covers a large region of south-western British Columbia and a portion of northern Washington that encompasses a part or whole of the Fraser, Thompson and Nicola River valleys (see Figure 1-1). Their culture is classed in the Plateau cultural area although the influences of coastal (Northwest Coast) and northern (Athapaskan) traditions are also prevalent. These influences are due in part to historical intermediate trade and travel between the adjacent groups.

Earlier this century, the ethnographer James Teit (1900) reported that the Nlaka'pamux lived in 66 village communities, arranging themselves into five distinct bands. Extensive contact with other First Nations combined with adaptation to dissimilar resource environments brought about notable cultural differences among the bands. Based on these geographical and lifestyle contrasts, Teit (op. cit.) gave reason to categorise the Nlaka'pamux into 'Upper' and 'Lower' divisions. Roughly, the 'Lower' division encompassed the Nlaka'pamux residing south of Lytton whose sedentary lifestyle had a strong dependence on the salmon (*Oncorhynchus* spp.) resources of the

Fraser River. Members of the 'Upper' division inhabited regions west of Lytton whose semi-nomadic subsistence was based over a greater number of natural environments.

The semi-nomadic movements of the Upper Nlaka'pamux (whose territories equate roughly with that of the concerned bitterroot populations) did not cover great geographic distances but was based on more local, elevational transitions. In general, they would dwell in the valley bottom of the Thompson River during the winter months, living on subsistent gatherings of the previous seasons. From there, as temperatures warmed into summer, the Nlaka'pamux would follow game up into alpine regions, collecting plant materials and berrying along the way. Evidence of *sh.EEshkin*, or cache pits in which they temporarily stored gathered goods, spaced out at various elevations throughout the Valley also points to this local migration.

The name Nlaka'pamux is thought to be formed from the lexical root *nkukuma*, meaning 'above' or 'to the north', combined with the suffix *mux*, meaning 'people' (Teit 1900). Depending on the orthography chosen,¹ Nlaka'pamux has been variously spelled *Ntak a'pamux*, *Nlha7kapmx*, *Ntlakapamuq*, *Nl'Akapmx* and *Ntlakyapamuk*. Originally, this was an internal name in reference to the 'Nlaka'pamux' living towards the northern boundary of the territory or those of the 'Upper' division. However, it is now used commonly to denote the entire Nation. Past, non-indigenous names for the Nlaka'pamux have included the 'Couteau' or 'Knife' people, as by early French explorers, and less recently the 'Thompson Indians', as they were called by settlers because of their proximity to the Thompson River.

¹ Unless otherwise noted, all orthographic transcriptions throughout this paper are as provided by Chief Robert Pasco on behalf of the Nlaka'pamux Nation Tribal Council.

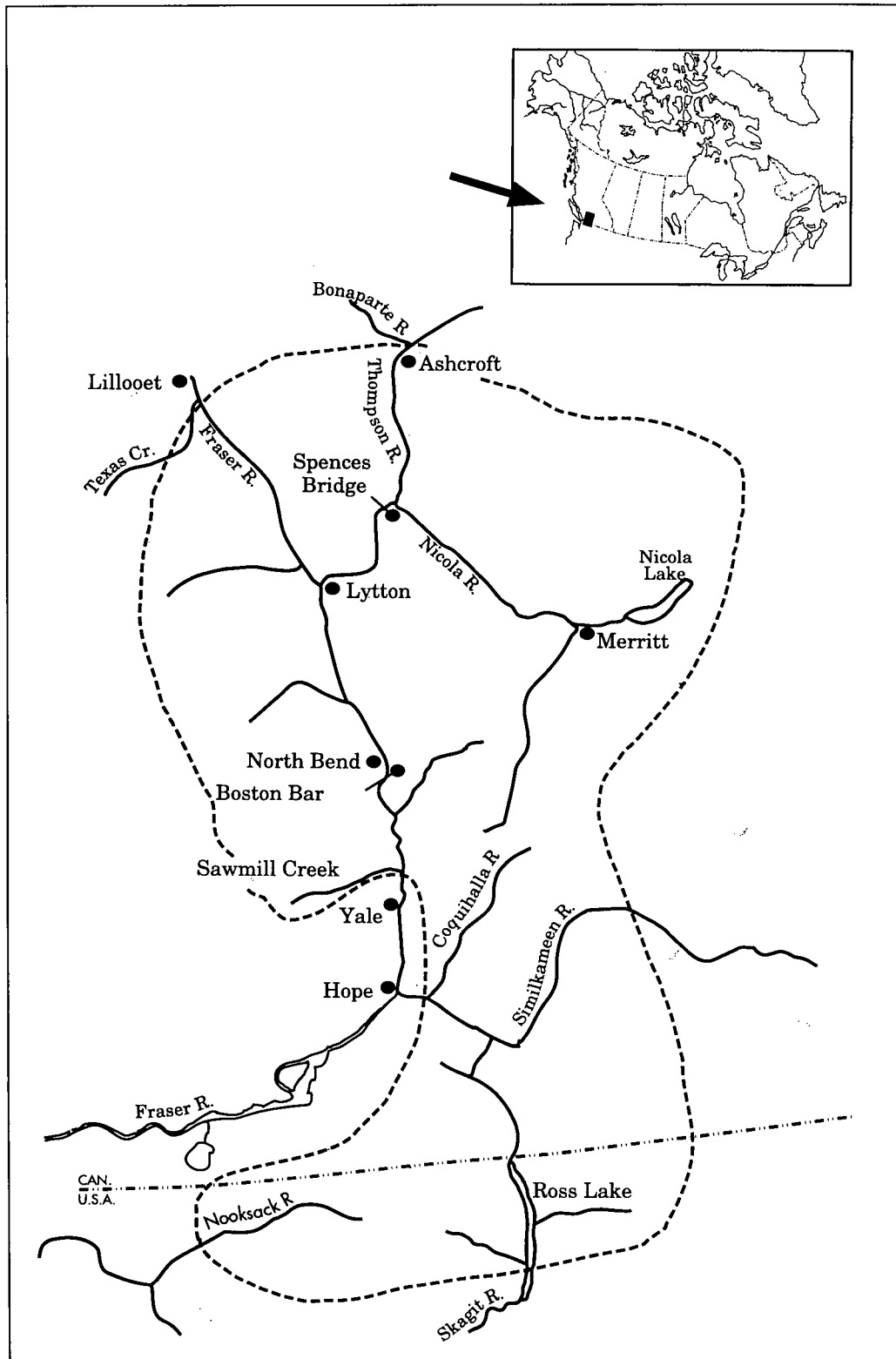


Figure 1-1 Map of Nlaka'pamux Territory (as modified from Tepper 1994, p.#x)

Currently, as is the case with the majority of First Nations in British Columbia, the Nlaka'pamux now organise themselves by way of bands and tribal councils. Of late, the Nlaka'pamux Nation is made up of 16 bands, with a population of roughly 7000 within the commission of three councils; namely the Fraser Canyon, the Nicola Valley and the Nlaka'pamux Nation Tribal Council. Despite traditional and contemporary cultural variations between the various bands and councils, the Nlaka'pamux remain to share a common identity, speak a common language, use a common name and cite a common origin (Wyatt 1998), a relationship strengthened by the sharing of common resources as well.

1.1.2 Geographic and Climatic Environment

The Lower Thompson River Valley is located in the central interior of southern British Columbia. It is a fringe land, nestled in the rainshadow outskirts of the Coast Mountain Range while left hanging on the northern most fingers of an arid belt reaching from the heart of Mexico; consequently, mean annual precipitation is relatively low (206 mm). The climate is comprised of moderately dry and cold winters (mean daily minimum temperature in January is -10.1°C) but with especially dry and hot early summers (mean daily maximum temperature in July is 29.61°C) (Atmospheric Environment Service 1982).

The regional area of the Lower Thompson contains a handful of biogeoclimatic zones; however, the boundaries of this study are contained within a single zone, the Ponderosa pine - bunchgrass zone (Krajina et al. 1978). Although the plant communities of interior regions are less productive in terms of biomass as compared to coastal forests,

they house a far greater diversity of species. This makes the interior an extremely important and unique biome within British Columbia and all of Canada.

The jagged and rock-strewn channel coursed by the Lower Thompson River arose from the plate subduction of a tectonic fault line. From this rugged volcanic beginning the valley opens up onto the fertile steppe plains that made early settlers in the nearby town of Ashcroft famous for their vegetables. Gradually these plateaux round into windswept grassland hills where upper edges eventually give way to forest and alpine meadows. Known as part of British Columbia's dry belt, this picturesque intermontaine valley supports a vast array of life. Along with human inhabitants (*Homo sapiens*), mule deer (*Odocoileus hemionus* [Rafinesque]), black bear (*Ursus americanus* Pallus), cougar (*Felis concolor* Linnaeus), western rattlesnake (*Crotalus viridis* Rafinesque), osprey (*Pandion haliaetus* [Linnaeus]), hummingbird (various species) and many other species commonly share the valley as home.

1.2 Botanical Classification and Description of Bitterroot

Bitterroot's rosette of fleshy, cylindrical leaves appear immediately after the snow melts and pump food into the thick, starchy root. By early May the leaves have completely disappeared and the flowers sprout off the ground without any sign of green, as if the plant was some leafless saprophyte (Cannings and Cannings 1996).

1.2.1 Taxonomy and Nomenclature

Lewisia rediviva is a member of the Portulacaceae (Purslane Family). This dicot family, which is classed in Order Caryophyllales, contains 19 genera and roughly 500 species that are widespread in warm temperate climates around the world (Zomlefer 1994). The Family is especially abundant in southern Africa, southern America and western North America; succulence is recognised to be extensive (Hitchcock et al.

1964). The genus *Lewisia*, which contains 15 species, is endemic to western North America, residing almost entirely within the United States (Hitchcock and Cronquist 1973).

Although *Lewisia rediviva* has been a well recognised and heavily used plant by many Indigenous Peoples of western North America for millennia, it is a relatively recent addition to the floral inventories of western science. *Lewisia rediviva* was first collected by Captain Meriwether Lewis (1774-1809) of the famed Lewis and Clark expedition, purportedly on July 1 or 2 in the year 1806. The type specimen was collected by Lewis, after whom the Genus is named, near a gravelly stream at or near what is now known as Traveller's Rest, along Lolo Creek near its confluence with the Bitterroot River in Missoula County, Montana, which has since made bitterroot its state flower (McCourt 1999). The lectotype is presently housed at the Academy of Natural Sciences in Philadelphia, PA.

Frederic Pursh was the first to describe Lewis' specimen, establishing himself as the authority of both the genus *Lewisia* and species *L. rediviva* in *Flora Americæ*, published in September, 1814 (Jackson 1895); *Lewisia rediviva* remains the type species of the genus. Events surrounding the specimens' description are astonishing and curious (Daubenmire 1975). A gentleman by the name of Mr. M'Mahon, with hint that the plant still contained life though already being stored for some time, took the specimen out of the herbarium and replanted it. Amazingly, it took root and lived for over one year! With this account in hand, as the Latin epithet suggests, Pursh gave testimony to its reclamation of life; *redivivus* meaning to 'revive from a dry state', 'to restore', or 'to live again' (Featherly 1965). The plants reviviscence was also insinuated through a voucher

collected by John Davidson on the 15th of May, 1915 and deposited at the University of British Columbia's Herbarium (collection number not stated; Accession #063207).

Anecdotal information as to the vouchers preparation reads that the "...specimens had to be dipped in boiling water to kill them in order to prevent them from growing after they were mounted on the paper." More recently, the author of this paper faced the challenge of curating *Lewisia rediviva* by making use of a quick stint in a microwave oven!

Succeeding nomenclatural history of *Lewisia rediviva* has remained relatively straight-forward. Although variations in perianth colour and flower size have been distinguished, with consequent names *L. alba* (for white flowers) Kell. and *L. minor* (for small plant size) Rydb. respectively, their classification was not conferred by modern taxonomists, namely Munz, 1968 (Hitchcock et al. 1964, Daubenmire 1975). The differences were seen as mere biotypical variations with only varietal status being given to the latter, *L. rediviva* var. *minor* (Rydb.) Munz (Daubenmire 1975). No other varieties or subspecies have been successfully described or brought forward.

Lewisia rediviva is known in vernacular English as "bitterroot". As reported by Coues in 1899, it appears the name arose as a literal translation of *racine amère*, as given it by French explorers (Daubenmire 1975). Additional, more idiomatic names abound but are rarely applied today. These include "sandhill rose", "desert rose", "rock rose", "reviving lewisia" and "resurrection flower" among others. Names for the plant also have been plentiful among indigenous peoples, usually varying regionally from Nation to Nation. *Spæt'lum*, *spitlum*, *lkupen*, *chita* and *kon-ah* are readily used today; *IhQuoopen* as used by the Nlaka'pamux First Nation. On the whole, however, "bitterroot" is widely accepted and well representative of the species for those obligatory to common names. It

should be noted that in the Pacific Northwest, the hyphenated spelling variant “bitter-root” has also be used as one of the common names for *Apocynum androsaemifolium* L. (Apocynaceae), as well as for other species in the genus *Lewisia*.

1.2.2 Distribution and Habitat

Endemic to western North America, the overall distribution of bitterroot reaches southward to southern California, eastward to Wyoming and northward into southern British Columbia. However, principal populations are found west of the continental divide, being most widely throughout the northern cordillera of the Rocky Mountains. Within intermontaine steppe grasslands, bitterroot is limited to arid, mostly exposed locations where the majority of precipitation falls during the winter. The edaphic ecology of this species is characterised by thin, rocky to gravelly, heavy or serpentine soil that is dry and often desiccated in early summer. Terrain varies from scabland to rimrock areas throughout bunchgrass plains and lower elevation mountain slopes.

The overall distribution of bitterroot reveals a preference for areas with dry and hot summer patterns but with winter temperatures ranging from mild (as in California) to severe (as in Montana). The apparent broad discontinuities of range in some of the more southern and eastern states have been interpreted by Daubenmire (1975) as being of a climatic nature. It is suggested that retractions moving in the north-west direction are a result of “post-xerothermic weakening of the westerlies” that have also been accompanied by northward range extensions into the warm valleys of British Columbia (p.11). Past xeric climatic changes with dispersal during the Altithermal have also been argued in explanation of a newly discovered disjunct occurrence of the species in southern Alberta (Wilson et al. 1988).

Within British Columbia, local distribution is on the east side of the Cascades, being limited to the driest regions of the southern interior, namely the Okanagan, southern Kootenay and lower Thompson River valleys. A brief scan of provincial collections deposited at the University of British Columbia's herbarium reveals a strong southern representation of the species in and around Penticton and Osoyoos with peripheral collections being few. As a crude parallel to range limits, the easternmost locality is recorded near Kimberly with the northernmost collection being made near Clinton, a town roughly 35 kilometres north-northwest of Ashcroft.

1.2.3 Morphology

Bitterroot is a succulent 2 - 6 cm tall geophytic herb (see Figure 1-2). Its root system is composed of a thick, fusiform and often forked taproot with one to several lateral roots originating just below the hypocotyl. The roots are very tenacious and when stripped of their thin brown peridermal layer reveal a bright white to slightly pink mucilaginous flesh.

The foliage of this ground-level, acaulescent plant is in the form of a rosette, arising from a simple or branched stout woody base. The basal cluster of lance-like leaves can be up to 10 - 12 cm in diameter. The leaves are succulent and numerous (up to 30), subterete and obtuse, dark green and glabrous, from 3 - 7 cm in length. They usually shrivel and turn red immediately prior to anthesis.

The flowers arise from 2 - 6 cm high scapes, which are jointed just above middle of scarious bracts; although a rosette usually bears no more than 10 flowers, some plants were recorded with over 20 flowers collectively. The flowers are solitary, 3 - 5 cm broad. Sepals are 5 - 9, oval and imbricate, 10 - 25 mm long with the inner ones



Figure 1-2 *Lewisia rediviva* in flower

appearing petal-like. The petals are 10 - 16, oblong, entire to erose, 18 - 35 cm long. Petal colour ranges from white to rose to deep pink, at times displaying prominent pink veins. The fruits are capsules containing discoid seeds 2 - 2.2 mm in width. The seeds are black to dark brown, smooth and shiny.

1.2.4 Phenology and Biological Development

Bitterroot is a hardy perennial that flowers in May to June, habitually disappearing as quickly as its flowers first appeared in the spring. As a winter ephemeral, this disappearance is due to a summer dormant period; after abscission of the flowers, the leaves as well as scapes are completely withered, making it almost impossible to locate specimens between the months of July to September. High soil



Figure 1-3 Developmental / seasonal stages of *Lewisia rediviva* (clockwise from upper left): 1) rosette form (most obvious in midwinter - April); 2) budding (May - June); 3) flowering (May - July); 4) a mature fruit disseminule (species remains dormant throughout summer months, July - September)

temperatures maintain the species' dormant condition while thermoperiod rather than photoperiod influences are thought to break its dormancy in the fall (Daubenmire 1975).

At least in the northern regions of distribution, the entire growing season is contained in roughly a seven month window; early October to mid May (Daubenmire 1975). Aestivation is broken in mature specimens with the first rains of the wet season (usually in early October), when the short, erect, rosette foliage is at its smallest diameter. This autumn growth phase is also when germination of seeds usually starts, with small taproots beginning to appear soon after. Foliage is maintained through the winter with leaf elongation continuing into the early spring months. Maximum rosette size is reached just before the appearance of floral buds.

Anthesis usually begins mid May, roughly one month after buds become visible arising from the centre of the rosette. Flowering occurs for up to three weeks with dissemination taking place shortly thereafter. Open most fully from midmorning to midafternoon (with full sun not always essential), individual flowers attract pollinators for one to two days. Pollination is thought to be accomplished by a wide variety of wild bees (Daubenmire 1975); however, it should be mentioned that the author also commonly saw scores of ants crawling among open flowers, signalling them as practicable pollinators as well.

Seed dispersal occurs two to four weeks after initial pollination when the closed, dried flowers, serving as disseminules, drop from their respective peduncle. Seeds are arranged with free-central placentation and are loosely attached; Daubenmire (1975) found an average of 17 seeds per flower in one specimen. Disseminules, which measure about three cm in diameter, are papery and light and weigh no more than 0.1 g

(Daubenmire 1975). This makes wind the most conspicuous proponent for natural, unaided dispersal.

2.0 Nlaka'pamux Ethnobotany of Bitterroot

Modern ethnobotany is defined by and concerned with the “totality of the place of plants in a culture” (Ford 1978). It is the study of contextualised plant use, or “plant-human interrelationships embedded in dynamic ecosystems made up of natural and social components” (Alcorn 1995). As a constituent within the greater discipline of ethnoscience, ethnobotany examines the reciprocal relationships which occur between traditional societies and the natural world. Specifically, ethnobotany includes any such studies related to plants, including how they are classified and named, how they are used and managed, and how their exploitation has influenced their evolution (Cotton 1996).

Ethnobotanical texts of British Columbian First Nations are on the whole well documented. However, some texts remain fragmented, incomplete or even non-existent, at least in western academic formats. While the living knowledge of First Nation ethnobotany will continue to be a dynamic and growing process, recent attention has been given to view existing inventories in a more comprehensive manner. Ensuing special topics in First Nation ethnobotany has delved into distinct sub-topics such as archaeobotany, medicinal plants, plant foods, ethnoclassification systems and species investigations (Turner 1995). In regard to species investigations, various papers have already been written (Loewen 1998, Turner 1982, Turner 1988), incurring and bolstering the need for other salient species to be studied as to their use and management in autecological and specific terms.

2.1 Data Collection

Through the auspices of the Nlaka'pamux Nation Tribal Council (NNTC), representing the Lytton, Ashcroft, Oregon Jack Creek, Boothroyd and Boston Bar Bands, Nlaka'pamux Chiefs, Elders and other knowledgeable members were invited personally by the council to participate in the traditional use study on bitterroot. An enthusiastic and generous cooperation was given from the Nlaka'pamux Nation as a whole with opportunity to share key interviews with twelve individuals. Listed alphabetically below, the participating Nlaka'pamux consultants represent a range of demographics from a number of different bands:

Evelyn Beckett (Ashcroft Band)
Lorraine Campbell (Lytton Band)
Chief Leslie Edmonds (Ashcroft Band)
Rita Haugen (Lytton Band)
Saraphine Kirkpatrick (Ashcroft Band)
Madeline Lanaro (Lytton Band)
Maria Minnabarriet (Bonaparte Band; Secwepmc)
Percy Minnabarriet (Cooks Ferry Band)
Chief Robert Paska (Oregon Jack Creek Band)
Ruth Peters (Lytton Band)
Mary Sampson (Ashcroft Band)
Nathan Spinks (Lytton Band)

Informal qualitative methodologies were used to gather and document traditional botanical knowledge related to bitterroot². Open-ended (semi-structured) interviews with the Nlaka'pamux consultants were recorded on audio tapes as well as in field notebooks. These interviews took place in participants' homes, places of work and appropriate community settings with additional interviewing taking place on field trips to various

² Research methodology for the interview process and study in general was approved by the NNTC and the Behavioural Research Ethics Board at the University of British Columbia.

local harvesting sites. Copies of all interview records have been deposited at NNTC facilities for storage in their archives.

It is recognised that the interviewing format was a limited and relatively brief process (from April to June 1999) insomuch as representing the vast and diverse knowledge and use of bitterroot by the Nlaka'pamux in its entirety. As given by Campbell et al. (1986) if a species-area curve were to be graphed, with the number of interviews and applications taking their respective x-y axis', a highly salient species such as bitterroot would reach asymptote a great deal slower than a species of limited value or occasional use (c.f. Balick 1994). Thus said, the research was not conclusive and should rather be viewed as a snapshot in time. However, the Chiefs, Elders and other knowledgeable Nlaka'pamux do represent a comprehensive core and a wealth of knowledge that has been amassed over hundreds, if not thousands of years. The ethnobotanical data contains new information (that is at least previously unrecorded) that cannot help but strengthen the empirical text as to the place and plant of bitterroot in the Lower Thompson, as instituted by the Nlaka'pamux.

2.2 The Ethnobotanical Text

Plants have always been integral and meaningful in Nlaka'pamux culture. As confirmed by a plenitude of names and uses for the many plants found throughout their territories, their ethnobotanical text³ is one of, and possibly the largest in Canada. In the category of edible plants for example, the Nlaka'pamux have used some 120 species as foods, flavourings or beverages (Kuhnlein and Turner 1991, p.20). As a morphological

³ As used by Alcorn (1995), an *ethnobotanical text*, is "...derived partially from the natural, social, and cultural contexts ...around a human community's use and management of vegetation (p.24)".

annex within this host of plants, roots and their harvesting regimes are also prominent. Roots are often animate within Nlaka'pamux mythology and traditional calendars were even based on their consumption for digging (Steedman 1930); "...at Spences Bridge, the seventh moon was designated as 'the people dig roots' moon (p.478)". Roots have been used as sources of food, medicine, dye, basket material and cordage (Steedman 1930), but in both abundance and significance, most distinguished as food.

Among edible root vegetables used by the Nlaka'pamux, bitterroot has been pre-eminent, lending itself to heavy use as the roots are thick, high in starch and contain virtually no lignified xylem (Daubenmire 1975, Steedman 1930).⁴ It attained prized stature as well, in part because not only was its availability limited on a temporal and spatial basis, even locally throughout their territory, but it was a comparatively high time-consuming plant to harvest and prepare. Extensive systems of cultural (e.g. ownership, timing, mythologies) and cultivational (e.g. use of digging stick, transplanting) management strategies and techniques have surrounded its use. The resulting beliefs and practices of the Nlaka'pamux have placed the species in an almost ethereal light within their culture as well as creating an anthropogenic environment specific to the population and community scales which bitterroot grows.

2.2.1 Traditional and Contemporary Use

Although bitterroot has been a highly sought-after and cherished species of the Nlaka'pamux, its role in daily sustenance was not as extensive as other commodious-type root food species (i.e. *Claytonia lanceolata*, 'spring-beauty' and *Erythronium grandiflorum*, 'yellow glacier lily'). Bitterroot is considered a delicacy or speciality food

⁴ The nutritional worth of bitterroot also proved to be particularly valuable as a survival food in times of winter and / or early spring scarcity (Turner and Davis 1993).

with prominence arising out of its mythological, social, environmental and nutritional worth. Personal comments heeded by the Nlaka’pamux described bitterroot as a “strong plant”, an “all-body healer”, a “real concentrated food”, the “best meal there is” and a “powerful plant and a powerful food”. Given its multiple and diverse uses listed below (see Table 2.1), the species should be regarded as a unique and highly salient root food rather than an everyday staple root food.

Table 2.1 Ethnobotanical Use of *Lewisia rediviva* by the Nlaka’pamux

Categorical Use	Specific Use and Preparation Notes
Food	
main dish	<ul style="list-style-type: none"> • dumpling-like stew; known as ‘<i>lhQuoopen</i> soup’ with salmon eggs [<i>AQuen</i>], saskatoon berries (<i>Amelanchier alnifolia</i> [<i>shchAquem</i>]), sugar or salt added (flour was also added for extra thickening into a gravy) • fresh vegetable (alone); very lightly steamed, sometimes with salt and butter added or sugar lightly sprinkled on top • fresh vegetable (mixed); steamed together with Yellow Bell bulbs (<i>Frittilaria pudica</i>) • boiled vegetable; soak the dried <i>lhQuoopen</i> in water and then boil
delicacy / dessert	<ul style="list-style-type: none"> • fresh vegetable; eaten raw while harvesting or peeling • extra ingredient in bannock, a traditional flat bread; crush up a few dried <i>lhQuoopen</i> and mix well • soup-like pudding; mixture known by the name of its main ingredient <i>lhQuoopen</i> as well as flour, sugar and a little bit of beef fat all mashed together (the more sugar added prior to cooking, the less needs to be added after)
Medicine	
general therapeutic	<ul style="list-style-type: none"> • general all-body-healer medicine; “good for colds and everything”, steep roots in boiling water and drink as a hot tea, or for a fuller effect eat entire preparation like a hot soup • blood purifier and cleaner; cooked roots (preparation not specified) • digestive tract & body cleanser; an after winter ‘clean out food’, eaten like a fresh vegetable as a ‘first food’ in the spring to clean digestive tract out after all the dried meat and dried fish consumed during winter months • tonic; as a medicinal to keep one from ageing too quickly, keeps hair from going grey and skin is slow to wrinkle; used year round as a weekly supplement added to diet; (preparation not specified) • eyesight enhancer (general); eyes will become clear when large volume of roots eaten quickly all at once (preparation not specified) • lozenge and vocal chord enhancer; raw roots chewed and juices swallowed to prevent voice from growing hoarse while singing or chanting over long periods of time • immune system enhancer; eaten (preparation not specified)

acute treatment	<ul style="list-style-type: none"> • poultice; dry, ground up root made into a powdery ash-like poultice and applied directly on cuts and abrasions; noted that preparation does not sting • eaten to soothe and heal stomach ulcers (preparation not specified) • laxative; eaten or prepared as a tea • eaten or prepared as a tea for treatment of diarrhoea, something to 'plug you up' • upset stomach soother; eaten (preparation not specified) • bronchitis [pleurisy]; eaten (preparation not specified) • tuberculosis [consumption]; eaten (preparation not specified)
Other	
amulet	<ul style="list-style-type: none"> • as used between newlyweds, two human shaped roots buried or stored together as a symbol of good marriage
spiritual offering	<ul style="list-style-type: none"> • dried roots presented as an alm and offering by Nlaka'pamux members at inter-tribal Powwow gatherings
ornamental	<ul style="list-style-type: none"> • occasionally transplanted to personal home gardens for practical and ornamental value

As an edible plant, preparation of bitterroot was not unlike other root foods used by the Nlaka'pamux. However, bitterroot was an extremely versatile plant in the sense that the roots could be eaten raw or cooked, alone or in a mixed dish; they were even steeped as a tea. If the roots were cured for storage, either before or after cooking, it was only a matter of soaking them for a few minutes in warm water to reconstitute and tenderise them before consumption. Fresh roots were consumed raw or lightly steamed while the dried roots were usually boiled to be eaten alone or added to a variety of soup-like stews of which salmon eggs were a common ingredient. As in traditional times, along with other root food vegetables, a favourite but occasional method of cooking bitterroot is to steam in subterraneous pit ovens (Frye 1993).

Bitterroot was also prepared in bannock and dumplings which had an almost dessert-like appeal. Their basic recipe called for water, flour, salt and or sugar with any combination of bitterroot, saskatoon berries (*Amelanchier alnifolia*) or other available berry ingredients. Even today, some Nlaka'pamux prepare this kind of bannock and store it in a crock to be given to children as a treat like a fruit roll. Of late, however,

bitterroot is most often treated as a delicacy, being prepared for special occasions like a potlatch. At gatherings, dried bitterroot is frequently presented to Elders as a respected take-home gift or served in a stew-type dessert soup of which everyone present is welcome to partake from the communal pot.

The bitter taste of the root (which is often an indicator of medicinal value in plants by signalling the presence of alkaloids or other phytochemical compounds), is thought to vary on a seasonal, environmental and preparatory basis. Teit reported that the roots were only palatable after cooking because they were too bitter in their raw state (Steedman 1930). However, the experiences of the Nlaka'pamux and the author found this to be quite the contrary. Never-the-less, the relative bitterness of the root body is acknowledged by most Nlaka'pamux as being slight, although some of the younger generations still prefer to sprinkle sugar or salt on the root as a countermeasure. On the whole, the Nlaka'pamux recognise that the astringency seems to dissipate when one becomes accustomed to it. As Chief Lesley Edmonds asserted, "if you acquire a taste for it you crave it, ...every year you think about it and crave for it", the "...bitterness, you can't notice it".

Also related to the culinary preparations of bitterroot, Kuhnlein and Turner (1991) found differences in nutritional value based upon how the root was prepared (see Table 2.2). The consumption of bitterroot via the drying process is the most widely used traditional and prevailing contemporary manner of preparation. Although it appears that the greatest nutritional values are found in roots that were dried versus those that were assayed in fresh or frozen states, it can be accounted for as a result of the dehydration process (i.e. 100g's dry weight is a quantity of greater concentration). The only notable

drawbacks to roots that had been dried were slightly lower or sometimes non-existent values for crude fibre, ash, some vitamins and other minerals. It should also be noted that although the outer skin or periderm of the root could potentially contain some vitamins as well, the Nlaka'pamux have customarily peeled the skin and have not been known to have ever consumed them.

Table 2.2 Nutritional constituents of *Lewisia rediviva* roots [per 100g] (Kuhnlein and Turner 1991, p.356-7)

	dry roots	frozen roots	fresh roots
Food energy (kcal)	343	94	94
Water (g)	12	76	76
Protein (g)	4.0	0.9	1.6
Fat (g)	0.6	0.2	0.4
Carbohydrate (g)	81.0	22.1	21.6
Crude Fibre (g)	-	1.3	1.5
Ash (g)	-	1.2	0.9
Thiamine (mg)	-	0.10	0.10
Riboflavin (mg)	-	0.03	0.02
Niacin (mg)	-	-	-
Vitamin C (mg)	-	17.0	27.0
Vitamin A (RE)	-	-	-
Calcium (mg)	168	22	39
Phosphorus (mg)	-	-	-
Sodium (mg)	-	20	16
Potassium (mg)	-	85	75
Magnesium (mg)	19.8	3.1	10.9
Copper (mg)	-	0.1	-
Zinc (mg)	1.3	0.7	1.0
Iron (mg)	5.3	1.6	4.9
Manganese (mg)	-	-	-
Molybdenum (mg)	-	-	-
Chloride (mg)	-	-	-

In defining the categorical use of bitterroot, although it is commonly referenced as a root *food*, some Nlaka'pamux thought it more agreeable in earmarking it as a *medicinal* plant. This supposive duality as to the plants' application lies in the fact that the Nlaka'pamux, as with many Indigenous Peoples around the world, often do not delineate between 'sustenance' and 'medicine' (Kuhnlein and Turner 1991). In compilation of a North American ethnobotany, Moerman (1998) balanced this dichotomy

in recognising that "...medicinal plants were not completely distinct from food plants - indeed, there was often substantial overlap in species that were used for both food and medicine (p.8)". Regarding the medicinal, therapeutic and nourishment value of bitterroot, Chief Bob Pasco put it succinctly; "... there is always the food value but we know just through the food value itself, there is always medicinal value to it... *lhQuoopen* is a medicinal plus food".

In this way, as its varied medicinal uses suggest, the Nlaka'pamux also beheld bitterroot as a kind of all-body healer, much in the same way ginseng (*Panax* sp.) is prized in modern herbal medicine. In fact, many elders gave reference to the recent prolificacy of ginseng fields in the Ashcroft area as confusing and unnecessary. To them, the redundancy of introducing a plant so similar to their native *lhQuoopen* was folly. One elder remarked that upon seeing an alike root anatomy and morphology as well as hearing of comparable uses, found reason to believe that bitterroot and ginseng were one-in-the-same species; "...it is the same thing".

The vigour and effectiveness of bitterroot as a medicine was repeatedly referenced to by the Nlaka'pamux. One example, first shared by Percy Minnabarriet, but also mentioned by other Nlaka'pamux elders, gives factual account of its potency over tuberculosis. Percy's Grandmother, Nancy Minnabarriet, who had an unofficial role as traditional doctor, was often called upon and visited by local Nlaka'pamux for assistance with various illness and other physical duress. Roughly 50 years ago, a 14 year old Nlaka'pamux girl was diagnosed with tuberculosis and instead of being conscripted to a sanatorium, sought Percy's Grandmother for healing. The young girl was cured of

tuberculosis in just under one year after being directed to eat a few pieces of steamed bitterroot every evening after dinner.

However, the Nlaka'pamux use of bitterroot as a medicine also has some discontinuities that may seem puzzling within western paradigms. What is presented as seemingly opposite applications in regard to its medicinal use as a treatment for both diarrhoea and as a laxative is a paradox of traditional plant use inherent and well documented among some other Indigenous Peoples of North America (Moerman 1998). In a self interpretation of this antilogy, the Nlaka'pamux Elder Saraphine Kirkpatrick stated quite light-heartily, "If you get too much of the bathroom you eat it and it will stop, ...and if you don't go to the bathroom you eat it and it will start; I don't know which is which [laughing]". This statement in a sense nulls reasoning that the discrepancy arose as an error in understanding on part of the investigator, the Nlaka'pamux consultant, or both. It could be explained as being a matter of medicinal worldview where western beliefs counter disease allopathically while traditional logic leans towards more homeopathic treatments. Or, it could be a matter of dosage or delicate differences in preparation. Whatever the case, Moerman (1998) is not quick to dismiss these apparent contradictions as nonsense; "...there is much in medicine, any form of medicine, that resists logic, rationality and explanation (p.15)".

The more contemporary uses of bitterroot are growing but are not always familiar to some of the Nlaka'pamux elders. One use that has become especially popular at powwows, is as a vocal chord enhancer.⁵ Traditional drummers from a number of different First Nations will often masticate the root and swallow the juices to strengthen

⁵ Bitterroot is noted by Scully (1970) to be chewed by North American Indians in alleviation of sore throats (c.f. Daubenmire 1975).

and keep their voices strong while they sing and chant, which can last for hours at a time. Another recent application at Powwows is as an offering for the sundance. The Nlaka'pamux give bitterroot in representation of the uniqueness of their people and territories, just as a coastal nation may present seaweed (various species) or salmon as an offering.

2.3 Harvest Design; Strategies and Techniques

2.3.1 Ownership

Traditional concepts of natural resource site ownership existed and were practised among many First Nations in British Columbia. Ownership of vegetable and berry resource sites, along with hunting, trapping, fishing, and the clam bed areas of coastal groups were usually the property of upper-class families where ownership was through inheritance (Suttles 1951). However, for the Nlaka'pamux, bitterroot and its harvesting sites remained in the control of the greater corporate Nation. The ground where the roots were dug was considered common property (Steedman 1930 p.478).

The main bitterroot harvesting sites for the Nlaka'pamux were and remain to be in and around the Ashcroft area corridor. Many members of the Upper Nlaka'pamux, from the Lytton and Merritt Bands for example, came yearly to this region for the bitterroot harvest. But not only were these harvesting grounds shared intra-tribally, they were also used heavily by the Secwepmc (Shuswap) First Nation, specifically the neighbouring Bonaparte Band. As understood by Maria Minnaberriet, "nobody owned the harvesting grounds; the Nlaka'pamux and the Secwepmc would both share it".

This communal outlook on harvesting sites, however, did not lack a sense of local jurisdiction and responsibility. The welfare of bitterroot populations remained in the hands of the Nlaka'pamux who dwelled in the area as it was they who most benefited from its trade and long-term sustainability. Chief Bob Pasco says that "...there was a lot of people who came in here. I don't think that it was sort of owned, ...but the people who lived here, they harvested a lot of it and traded it to other people within the nation and outside; so I guess there was a bit of ownership to it in that sense. ...the Okanagan have their own area..., but it would be the northern people who would come down [to Ashcroft] cause it doesn't grow any farther north".

2.3.2 Timing and Scheduling

"LhQuoopen is one of the first things to come around...; it is like a bird in the spring" (Chief Robert Pasco)

Subsistence activities of the Nlaka'pamux followed and were patterned after the cyclical seasons in nature. Migration patterns of game and fish as well as the climatic particularities of the seasons were adhered to; however, their variability also forced the Nlaka'pamux to prioritise their needs. In regards to the spring harvest of bitterroot (varying from late April to late June), no other subsistence activity took obvious precedence as it was one of the first important plants to be gathered in the vernal season. The inaugural and primary importance of bitterroot is also evident in some of the traditional "First Roots" ceremonies conducted by the Nlaka'pamux that were centred upon its fruition of harvest (see Section 2.6).

As winter lapsed into spring, bitterroot was one of the most available and recognised roots in the lower valleys. It was symbolic of spring in and of itself as there were no extrusive biological or environmental indicators observed by the Nlaka'pamux

to signal its arrival and eventual maturation. On a tertiary basis as indicators of the resource species, some Nlaka'pamux did bring reference to the flowering of 'saskatoon' shrubs, the greening of notable choke cherry bushes (*Prunus virginiana*) and the pocketed flowering of the concurrently harvested 'balsamroot' (*Balsamorhiza sagittata*). Also noted was the scented flowering of lilac bushes (*Syringa vulgaris*) as a more recent horticultural indicator species common to the home gardens of many Nlaka'pamux.

Along with the seasonal cycles preferenced in Nlaka'pamux culture, the physiology of bitterroot also had a role in the timing of its harvest. The tap roots were dug in the early spring when the rosettes were largest and most easy to locate before the flowers bloomed. This timing also allowed for the largest specimens to be located as the rosettes (whose diameter seems to have a bearing on root size - wider diameter suggests larger roots) had not yet completely shrivelled. Moreover, once flowered, no matter the size of root, all flowers were equally proportioned which made selection for the largest individuals troublesome. As a further indicator of this growth stage, the Nlaka'pamux also chose to harvest bitterroot after it had budded but before it reached anthesis. This made for a short but intense harvesting season as the species above-ground parts disintegrate and essentially disappear after flowering in order to conserve all energy in the roots during the hot summer months.

Some of the rationale behind this particular timing includes that thereafter the root becomes too bitter to eat or loses the majority of its nutritious substance (Couplan 1998). Although nutritional values of the root have not been quantified seasonally,⁶

⁶ The drought resistant capabilities of bitterroot are well documented and relay the fact that the species relies almost entirely on total nonstructural carbohydrate (TNC) reserves built up during the spring to support its autumn growth and winter maintenance (Marvel 1986). With high photosynthetic capacities

Nlaka'pamux reasoning is predominantly pragmatic in that it becomes too hard to peel after it flowers; the root is too elastic and the outer periderm is difficult if not impossible to separate from the muscilous root body without a lot of rubbing. As stated by Saraphine Kirkpatrick, bitterroot will "...stretch when they are getting too old, ...they won't even get clean; and they are ugly, bitter. I wouldn't touch it when it gets old. You have to get it before it flowers or just getting flowers." In addition, others mentioned that if harvested too late or too early, the stripped and dried roots would not remain a bright white colour but would eventually turn a light orange-red that was also equated to a bitter taste. The specific timing in harvest was not only important to, but in some ways also required, by the Nlaka'pamux. As upheld by Ruth Peters, "you have to pick them quick at a certain time. After that you leave it alone cause it is quite bitter and is not *safe* to eat (emphasis the authors)". Although phytochemical and ethnobotanical databases give no mention to poisons in *Lewisia rediviva*, reference to other First Nation plant foods containing toxins (Compton 1993a) justifies the possibility of seasonal toxicity and the need for further investigation.⁷

2.3.3 Harvesting Persons

Among the Nlaka'pamux, as with most foraging and pastoral societies around the world, women have been the principle gatherers of vegetable and berry resources. In terms of the caloric contribution of subsistence plants gathered, Hunn (1981) points out that for groups of the Columbia-Fraser Plateau, of which the Nlaka'pamux are a part, roughly 70% of food energy needs came from plant foods harvested by women. This

during the spring in which to recover the storage reserves used during the autumn and winter, Nlaka'pamux timing of harvest coincides with the highest TNC levels.

⁷ Within Portulacaceae, there is citation of the presence of alkaloids (a fairly low measure of 300 ppm) in the leaves of *Portulaca oleracea* <<http://www.ars-grin.gov/duke/highchem.html>>.

finding is quite contrary to most historical ethnographic accounts which have emphasised hunting contributions by men as being most primary.

Teit's (1900) description of girls puberty rites among the Nlaka'pamux also highlights women's integral and assumed role in plant gathering. Girls, at reaching puberty, were separated from other people at which time they would practice various artful and industrial skills that would demonstrate their readiness to contribute to society and provide for a family. The girls undertook some physical feats as well such as gathering wood, running and digging trenches, the last of which might show proficiency at root-digging (p. 313). This division of labour exhibited in Nlaka'pamux culture can be traced back further to mythological beliefs. As noted in Section 2.6 (Digging Implements), the Creator gave specific instruction to the Nlaka'pamux that the digging stick was to be the woman's tool while the bow and arrow was given as the man's. Even the process of pit-cooking vegetables was accomplished by groups of women. Traditionally, no men were even allowed near the pit oven while roots were being cooked (Frye 1993).

The spiritual nature and seriousness with which women approached the procurement of root foods is also mentioned by Teit (Steedman 1930) in reference to face and body painting traditionally practised by the Nlaka'pamux. Painting a portion of ones body or face was common and practised by almost everyone, young and old, of both sexes. Various colours and designs were applied for a multitude of reasons, be it as an offering, to show deference, to obtain success, or for protection. In particular, painting ones entire face red was usually used to ward off danger in correlation to bad dreams or to protect one from harm. It was this painting regime that nearly all women used while

digging roots, as “...it was thought to give them success and protection, help them to find roots, and to dig them more easily; also to preserve them from harm while engaged in their avocations” (p.438).

Specific to bitterroot, the central role women played in gathering is also highlighted in the name of a traditional digging area. “Klootchville” (as noted in Section 3.1) , is a stylised slang form of “woman’s place” by the Nlaka’pamux; “klootch” meaning woman. As Saraphine Kirkpatrick explained, “...they call it Klootchville ‘cause the Indians are digging roots there too much. All the Indians, even from Lytton are digging there, you see nothing but bums [in reference to the stooped harvesting position] digging Indian roots there.” However, the effeminate nature of root digging has been minimised. In recent times, both men and woman commonly dig and clean bitterroot together, albeit the bulk of digging is done by the men while the enterprise of peeling remains to be done mostly by women.

2.3.4 Collection, Preparation and Storage

Collection

“...the Indians never cleaned it all out, just leave some here and there. You know they should leave some so they transplant themselves. They leave some, some small, they leave it; they don’t take it all. They just leave it just to retransplant themselves. But if you take it all, it is all gone.” (Saraphine Kirkpatrick)

As mentioned previously, a portion of the value afforded bitterroot is derived from the large amount of time and effort required for its collection and preparation. Some Nlaka’pamux brought contrast to this fact by mentioning the ease of digging up domestic potatoes that could quickly fill a root cellar, or the gathering of huckleberries or saskatoon berries that would aptly fill a basket in the morning and be dry on mats in the afternoon sun. The harvesting of bitterroot, however, required concerted and planned

effort, having to know exactly where and when to look as well. Nathan Spinks recalled that even after picking all day, "...they picked six or seven sacks and when they peeled them were lucky to get a small little bag out of it when its dry". The Nlaka'pamux also repeatedly mentioned the alertness one needs while digging bitterroot, for it is during the time of year rattlesnakes are out. To them the digging stick can also serve as a probe and for extra safety, some Nlaka'pamux like to bring a dog along while digging.

In selecting which individual bitterroot plants to harvest, besides the physiology already mentioned, the Nlaka'pamux did not have any steadfast rules for digging. Generally, however, the largest to medium-sized individuals were harvested while all the small and seedling-staged specimens were passed over; in a cluster, only the largest individuals would be harvested with the rest being allowed to mature. Although the selection for larger specimens also made for easier and efficient handling and peeling, other Nlaka'pamux gave more attention to the number of individuals harvested. To them, the differences between rosette diameters were perceived as comparatively minuscule and they were not overly specific about specimen size, "...as long as you left some". During the harvest, although focusing on bitterroot, the Nlaka'pamux would also dig other root foods they came across. In particular, the small but tasty bulbs of yellow bells (*Frittilaria pudica*), whose harvesting stage often overlapped, were gathered as they would occasionally be prepared together in a dish with bitterroot.

In digging bitterroot, although there were no obvious and systematic routines found in association to a gathering format, it was selective. Within a locality, Nlaka'pamux would roam randomly throughout and dig where bitterroot seemed to grow thickest, moving on to new areas if evidence of prior digging was visible. The Elder

Maria Minnabarriet also spoke of how at times bitterroot seemed to blend in with the ground and camouflage itself. She recalled how her Grandmother explained that this meant the bitterroot “was hiding from you” and that it did not want to be dug up and picked. It is interesting to note that in areas where bitterroot is marginalised, it often grows scattered or only protected underneath sagebrush. This exhibits an indirect form of conservation and may be an incidental way of giving reason to leave bitterroot alone where it is sparse and to only dig where it is thick and immediately obvious for the gatherer to harvest.

Traditionally, baskets were used in gathering plant resources, the birch-bark variety for berrying, and woven baskets for the collection of roots (Teit 1909). At later times, flour or sugar sacks were used and today plastic buckets and even shopping bags are employed as containers. As a rough indicator of the amount of bitterroot traditionally harvested, the size of the 100 pound white flour sacks are thought to point towards large volumes. With dozens of camps throughout the valley and perhaps hundreds of people digging, the number of these sacks that were filled was significant. Recollections of Mary Sampson also suggest this; “...as kids with our grandmother, picking it by the sackfulls..., you could go out there for days, out on the wagon, sackfulls of *lhQuoopen*. My hands got tired of *lhQuoopen*, fingernails wore out.” Although a qualitative estimate, hundreds of thousands of plants were harvested annually in the early spring by local and touring Nlaka’pamux. These numbers have dwindled in recent years, both in number of people harvesting and volumes harvested, as a parallel to the more incidental use and need of bitterroot.

Preparation

Once bitterroot was dug out of the ground, the thin, brown and somewhat flaky, exfoliated bark of the root was stripped off (see Figure 2-1). Traditionally, after a day gathering the roots, this 'stripping' was done by groups of women in the evening at the camps set up by the harvesting sites. In modern times, after a number of roots have been gathered, most Nlaka'pamux prefer to take them home to be stripped later that day or left to soak in water for a couple days to keep them easy to peel until they were ready to process them. Some elders are even known to bury the roots in sand to keep them fresh until they are ready to peel them, but most Nlaka'pamux peel bitterroot on the day of harvesting.



Figure 2-1 Freshly collected and peeled bitterroot prior to steaming.

If harvested at the right time, the peeling of bitterroot was a relatively quick and easy process, the point when it is just starting to bud being most desirable. At this stage, the periderm peels off with little effort by merely rubbing and rolling the root between the palms of ones hands. If this optimum time is missed slightly, the periderm will still rub off but with more effort required. In this case the Nlaka'pamux will often employ the hard, flat surface of a rock on which to rub and build up considerable friction with their hands or feet. When roots are stripped, the Nlaka'pamux will also remove what they call the plant's 'heart' - a small, orange-red structure in the hypocotyl region that is a bud-like core of the following years growth - as it is said to be too bitter to eat. The 'hearts' of the bitterroot are considered by the Nlaka'pamux to represent the male sex of the plant and it is treated as the male's 'seed'.⁸ When the hearts are removed from the roots they are disposed of inconsequentially, although the Nlaka'pamux say that if planted, the seed will grow into a new plant.

The next processing step of bitterroot, after they had been stripped and 'de-heartened', was to clean them with a light rinse in water. Once clean, the roots were ready to be dried. Although an antiquated practice today, the Nlaka'pamux would traditionally sort the collected roots by size before dehydrating them in the sun. The smaller roots and broken segments were dried collectively and loose on a mat while the larger roots were singled out to be threaded on a string to cure. The mats were positioned on rooftops or out-of-the-way places where the roots would take one to two days to thoroughly dry. In recent times, all the roots are spread out on mats to be dried in the sun.

⁸ Botanically, the seemingly random occurrence of this 'heart' or bud-like core in some specimens (usually of larger size) may be attributed to a developmental stage of growth found in older individuals.

Although today some Nlaka'pamux currently air dry bitterroot indoors, Mary Sampson gave reason as to why bitterroot should be dried in the sun; "when you dry *lhQuoopen* it should be outside, you can't dry them in the house. I tried that once..., but it didn't work up in the rafters, it turned really red; you have to have it outside in the sun." While the manner of drying may seem trivial, recent studies point to the release of otherwise inaccessible nutrients through the process of sun dehydration (Kuhnlein and Turner 1991). This gives further value not only to the consumer, but to traditional food processing knowledge and techniques of the Nlaka'pamux.

Storage

Traditionally, the Nlaka'pamux would store bitterroot, either fresh but most commonly dried, in underground caches. These were pits constructed in dry sandy areas, generally found in the arid plain regions of lower valley elevations but also at times higher in the mountains. The Nlaka'pamux called these caches *sh.EEshtkin*, and they filled them with a variety of food goods for indefinite safekeeping. In locating a site for the construction of a *sh.EEshtkin*, the main features were to find a dry sandy area free of dirt and excessive moisture. Once dug, the pits were lined heavily with dry needles of Ponderosa Pine (*Pinus ponderosa*) upon which the food materials would be stratified and further layered with leaves of other unidentified plants. Occasionally, bitterroot that had been processed into bannock cakes was also stored in the caches.

More recently, the Nlaka'pamux also constructed large, partially subterranean root cellars for storage purposes. Dried roots and berries of all kinds were stowed, with bitterroot being kept in large jars or hanging in flour sacks just below the rafters. These

sacks would be in rows, the main requirement being that they had to be off the ground. The dried roots were reported to never spoil.

With the introduction of modern amenities, Nlaka'pamux storage of bitterroot also makes use of freezers and airtight containers. After the root is washed, it is patted dry and frozen fresh in sealed plastic bags to prevent them from growing too 'mushy'. Or, as is still largely the custom, bitterroot remains to be dried and stored with the only difference being the use of plastic containers. Many Nlaka'pamux continue to keep small portions of dried bitterroot in their cupboards year-round to be accessed and cooked at will.

2.3.5 Digging Implements

To aid in collecting vegetal roots, the Nlaka'pamux made root diggers, known singularly in their language as a *KalAhh*. The root diggers usually took the form of a T-shaped tool that could be fashioned from a number of materials. As a root harvesting technology, this was an implement common to the majority of Indigenous Peoples throughout North America. Teit noted it as the only known implement for digging roots as used by the Nlaka'pamux (Steedman 1930).

The simplest of diggers were nothing more than a section of branch from a birch tree (*Betula* sp.), 60 - 75 cm in length, with its point treated to a slight calcination to ensure toughness (Morice 1893, Teit 1900). Other diggers employed the hard wood of a service-berry (*Amelanchier* sp.) for a shaft and had a birch-wood handle, while some shorter varieties were fashioned from a single piece of caribou, deer, or elk antler (Teit 1909; see Figure 2-2). More recently, some Nlaka'pamux have made use of broken rake prongs from old horse-drawn haying outfits by straightening out the prongs and putting a

T-handle on them. Of late, customised diggers are made out of aluminium pipe or solid iron, of which the latter's strength and weight of shaft made for easy digging even in the toughest of grounds. These are important qualities when considering that bitterroot grows in a variety of ground conditions, a number of which are often rocky.



Figure 2-2 Traditional buckhorn digging stick; digging bitterroot did not require the long shafted sticks used for deeply buried geophytes. Shorter digging sticks like the one displayed sufficed.

To the Nlaka'pamux, a digging stick is a highly personalised tool that customarily holds spiritual and sentimental value for the owner, many of which were often ornately decorated with carved designs symbolic of the use of the implement (Teit 1900, p.137; see Figure 2-3). Digging sticks are used from year to year and are even passed down from generation to generation within a family. They are also commonly given as prized and respected gifts. The personal attachment to ones' digging stick was strong and people could even be identified by their *KalAhh*. This individualised quality and affinity was mentioned by Chief Leslie Edmonds; "...digging sticks are quite personal and when someone else is using someone else's, other people notice it. Everyone has their own."

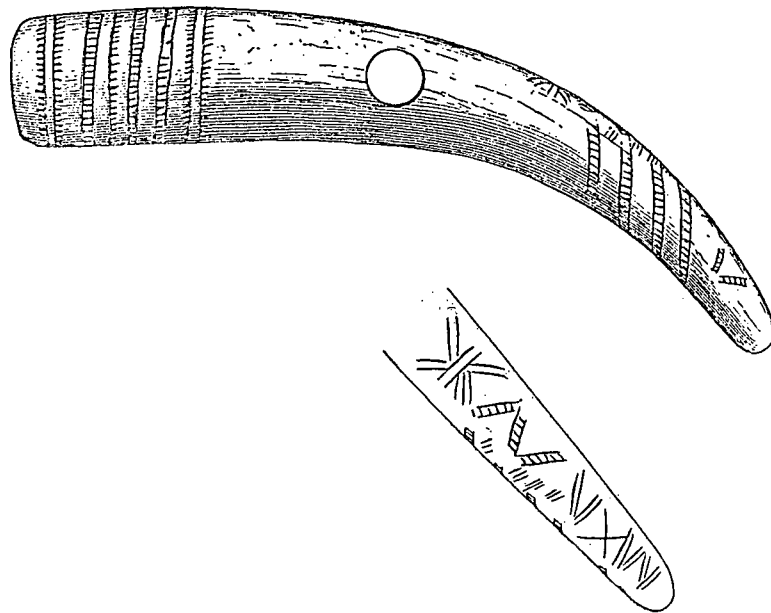


Figure 2-3 Intricately carved designs on handle of digging stick made of antler; reverse side of tip also shown (Teit 1900, p.137)

As will be expanded upon in section 2.6, root digging was seen as a spiritual enterprise. Nlaka’pamux rock writings (especially in the Stein River Valley) illustrate the reverence and seriousness that Nlaka’pamux bestowed upon root resources and their digging sites. Traditionally, when a Nlaka’pamux received a dream about something, they would often consider and record them in the form of a painting sketch on rock surfaces. One such writing (Figure 2-4) was recently located in the Lytton area, and as explained by the late Nlaka’pamux elder Annie York, gives particular reason and respect as to why and what kind of digging stick is used (York et al. 1993):

“These are women’s things here. That’s a digging stick on the left. That Sun Man told them that a woman’s instrument is not going to be the bow and arrow. It’s just a stick like a hoe. That was his design but it wasn’t comfortable to dig with. The next picture is the one designed by *Xwekt’xwektl*, with the hilt on it...

The two little dots below, they’re the stuff that she wants to dig up. The next one to the right is another digging tool. It’s shaped like a letter “P.” Above that is the sign for prayer, like two curlicues, back to back. That *Xwekt’xwektl* told the old lady that she must pray and talk to that tool before she uses it. He says, “You kneel down and talk to it before you start.” Old people do that. I seen them. I saw my grandmother do that...”

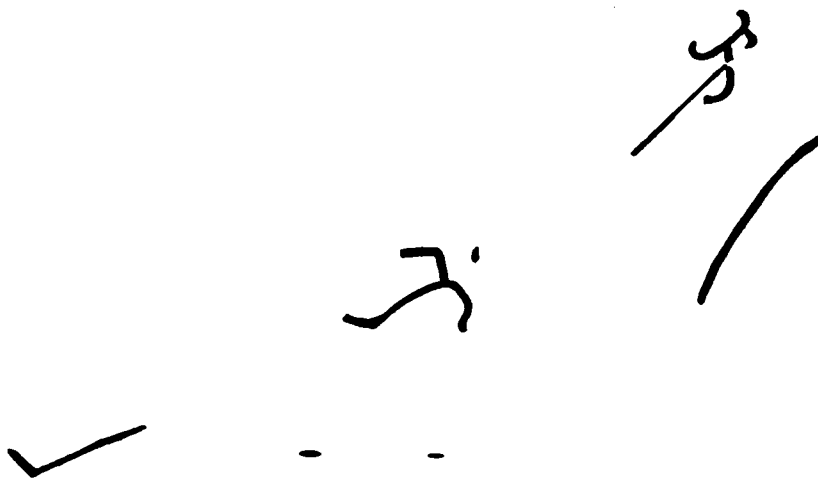


Figure 2-4 Nlaka’pamux rock writing [site EbRk 3] (York et al. 1993)

The use of a digging stick is also integral to helping achieve a sustainable harvest. Firstly, as a harvesting implement, the precision with which a digging stick can unearth a desired root body, even the deepest of tubers, is uncanny. More importantly, the skill and prudence employed by the Nlaka'pamux in digging also exhibits an effort to conserve and care for bitterroot as a resource. Together, these aspects avail themselves to a purposeful and conscious design of stewardship by the Nlaka'pamux. As made clear by Chief Leslie Edmonds:

“...it (digging stick) also helps *lhQuoopen* because shovels tend to dig up too much dirt, where as with the *KalAhh*... its small little point... you just take the one that you want and leave all the little ones around it alone. If you leave the little ones alone you will have some for the years after. You just take the biggest mature looking ones... those are the ones to use, the little ones you leave alone. The way the elders taught me was to not disturb the little ones, you leave them alone, you just take the big ones. So with the shovel, if you had a big one with a bunch of little ones around it, you would disturb all of them just to get the big one.”

Despite the Nlaka'pamux's primary use of a *KalAhh*, some Nlaka'pamux presently prefer the ease which a shovel affords the digger as it covers a larger area with more leverage available. However, the use of a shovel is not very common and tends to be used only by Nlaka'pamux who have difficulty getting to remote digging locations (and therefore can wield a shovel because they can drive to the site accessible by road), or those who don't own a digging stick. However, the use of a shovel also carries some social stigmas as disrespecting the earth because it tends to leave hole-like divots in the ground. As put by Evelyn Beckett, there are no written rules of conduct but one must decide for oneself and “...use whatever you think is fair”. Overall, the practicality of a root digger, it's easy carrying and precise extraction capabilities, and its traditional esteem make it an appreciated and the most used harvesting implement.

2.3.6 Transplantation

Cultural dispersal of useful plants through transplanting has been recorded and is thought to have been of occasional occurrence within traditional First Nation living (Compton 1993b, Loewen 1998, Turner et al. 1983). Specific to bitterroot, transplanting is viewed as a highly credible reason behind localised populations of the species within some Native American territories as well as disjunct occurrences in southern Alberta (Wilson et al. 1988). Transplanting useful plants, which included the apt and hardy bitterroot, was also practised by the Nlaka'pamux.

Although most Nlaka'pamux concurred that it was very difficult to know exactly how bitterroot first arrived in their territories, they did imply that it had grown there for a very long time. The elder Saraphine Kirkpatrick on the other hand, while agreeing that there had always been some bitterroot growing in the area, said that the main reason bitterroot proliferated was through transplanting done prior to the turn of the century. In particular, Saraphine's mother-in-law Suzanne Magee, is reported to have transplanted large volumes of bitterroot from Walhachin and other nearby regions in British Columbia's dry belt (possibly Savona) into the Ashcroft area. Other Nlaka'pamux also transplanted bitterroot along with other edible plants like spring beauty (*Claytonia lanceolata*), although the latter species are not known to have survived to the present.

The recorded transplanting seemed to be done out of a sense of urgency in ensuring a future supply. Saraphine mentioned Nlaka'pamux men on horseback having to 'steal' the bitterroot from across the river in Walhachin in order to transplant it in the Ashcroft area; "...if you don't do that, there won't be any around here... but if you transplant it, it flowers and multiply [sic]". It was also an intensive process where

Nlaka'pamux would travel considerable distance (e.g. over 30 km east to Walhachin) on horseback to return with baskets and sacks filled with bitterroot. Saraphine described Suzanne Magee working "...for days and days and days..., transplanting them from way over there across the bridge (Walhachin), ...that is a long ways; she got them in a sack and a basket, a big basket that hangs on the saddle horse."

The transplanting process began by digging up the living plants during the normal spring harvest with the roots being temporarily stored in a pit covered with dry dirt through the summer which coincided with its normal dormancy period. The bitterroot would then be transplanted to the new location in the late fall just after it began to rain or snow; many of the plants were reported to have been transplanted to large areas known as 'Klootchville' (see Figure 3.1). Survival rate is not known, but Saraphine said "...some grow out and some didn't [sic]". The reasons behind transplanting bitterroot also succeeded immediate concerns for food. As made clear by Saraphine's rendering of Suzanne Magee's words, "...I am only doing this for my grandchildren to have something to eat when they grow up; ...when I die Sara[phine], and your children grow up and they will know where to get their Indian roots."

Bitterroot is also transplanted by the Nlaka'pamux in the present-day, but on a much more narrowed scale of personal home gardens. Many Nlaka'pamux referred to the transplanting of bitterroot as a tricky endeavour with whimsical results paralleled to their oft tried but relatively unsuccessful transplanting of edible mushrooms. Nathan Spinks inferred that it seemed just too difficult to grow; "...a lot of people try to transplant that [bitterroot], moving it from here to there, like mushrooms, but it doesn't work". However, other Nlaka'pamux do find success, transplanting bitterroot to their

homes for ornamental as well as practical reasons. Madeline Lanaro noted an Nlaka'pamux elder who transplanted a handful of bitterroot to her personal gardens flower bed. They are said to have grown year after year, and along with wild harvesting, "...she likes to get out and dig some when they are just ready at her house too."

2.4 Social Significance of Harvest Season

"From an examination of several Indian camping-places it was seen that the women evidently collect a supply of roots and return to camp to strip them. One can picture half a dozen Indian women, squatted before the camp-fire at the close of a day's digging, busy peeling the roots preparatory to packing them. The small heaps of skins left at most of the camps indicated that each party returned with many hundreds -perhaps thousands- of roots." -John Davidson (1916)

The harvesting of bitterroot from the sagebrush plains near Ashcroft was a notable and culturally meaningful time for the greater Nlaka'pamux nation. Families and groups of families would camp for weeks at a time throughout the harvesting areas in an atmosphere of festivity amongst the also earnest business of subsistence gathering.

As communities of bitterroot are limited, or at least pocketed and site specific within Nlaka'pamux territory, accessibility was not always an easy endeavour. Other than the Nlaka'pamux whose dwellings juxtaposed the harvest sites, the majority of people had to travel considerable distances in order to dig the root. Nlaka'pamux arrived from all over their territories, representational of present day place names like Merritt, Kamloops, Chase and Lytton. Nathan Spinks recalls that the Nlaka'pamux from the Lytton area "...would go over the mountain pass behind Botanie (Valley) by horse and wagon and come down in front of Basque (Ranch). It was a big trip to get there, two days there and two days back." For the populous who travelled, caravan style entourages were the custom as large groups provided safety and a dynamic of social enjoyment.

Although there were always camps surrounding the major harvesting sites, namely on the flats at 100's (known to the Nlaka'pamux as "*Schuchem-elch*", which means "Root-digging house" [Davidson 1916]), a sprinkling of camps would also be present throughout the greater Lower Thompson River Valley (see Figure 2-5). Nlaka'pamux would generally remain for two or more days and up to a week in one harvesting location, for as some elders shared, there used to be so much bitterroot that moving from place to place too often was unnecessary.



Figure 2-5 Typical traditional camping spot in Venables Valley under a Ponderosa Pine

The spring harvest of bitterroot would bring individuals and families together on an annual basis. The Nlaka'pamux would look forward to the harvest as it allowed for otherwise dispersed family units to be brought together communally in a time when social visiting tended to be a luxury. The harvest period also provided opportunity for the transfer of practical and cultural knowledge in an *in-situ* environment. Young children imitated and helped their parents and grandparents in the bitterroot harvest while many elders also remember countless fabled reminiscings of the Nlaka'pamux arising from camp life during the harvest. In an overall description of the bitterroot harvest, Chief Leslie Edmonds shared:

“There used to be camps set up all over the flats in certain areas. People would be all over gathering it and just having a relaxing time while they did it; ...there used to be camps all over when I was little, all in the hills I used to ride around on saddle horse, ...just anywhere someone might be sitting there cleaning their *lhQuoopen* in the shade of the sagebrush, ...it could spook your horse ‘cause you can’t see them. People from all over used to come, they would camp for about a week or two weeks and just visit around for a while like a social time. When they gathered enough, away they would go.”

Nowadays, harvesting bitterroot is within the context of day trips with small groups and families digging for extended hours instead of days. Nlaka'pamux of all ages still look forward to the chance to dig; bus trips to harvesting sites organised for seniors are especially popular on the May long weekend. Nlaka'pamux have also begun to travel a lot more widely throughout their territories and beyond to harvest bitterroot. Nlaka'pamux members have reported digging not only in the Ashcroft area, but also in Penticton, Keremeos and even across the border near places like Loomis and Omak in the state of Washington.

2.5 Nomenclature and Folk Classification

The Nlaka'pamux named plants through a variety of stimuli, some of which were according to use, size, shape, colour, pubescence, habitat of growth, taste and relationship or resemblance to other plants (Steedman 1930). Evidently, the Nlaka'pamux did not choose to base the name of *Lewisia rediviva* according to the taste of its root, as was the manner imparted in common English. This may appear somewhat quandarical as a number of other plants were named via their bitter taste, as represented by the prefix *tahht*. Examples given by Teit (Steedman 1930) are *taxqai.n*, meaning 'bitter head' (*Leptotaenia dissecta* [modern equivalent is *Lomatium dissectum*]); *taxtaxei'uk*, meaning 'bitter wood' (*Cascara sagrada* [modern equivalent is *Rhamnus purshiana*]); *taxtexo'xsa*, meaning 'little bitter berry' (*Amelanchier alnifolia*). Bitterroot also has many traditional and recent references by the Nlaka'pamux as a plant growing in association with other species as well. For example, companion-type relations with *Montia perfoliata* (Turner et al. 1990 p.241), *Fritillaria pudica* and *Artemisia tridentata* could have also served as the basis for naming.

Similar to the way other First Nations gave a number of names for a variety of different reasons to the species, the Nlaka'pamux naming of bitterroot also varied geographically within their territories. As reported by Turner et al. (1990, p.242), bitterroot was known in the southern regions as *sk-ep-n* in reference to the manner by which it was traditionally prepared; meaning "come to be pierced, impaled, by stick, fork, hook or other sharp instrument". To the north, in and around Ashcroft, bitterroot was known as *s/pi-m*; meaning to "rub bitterroot on rough rock to remove skin (*/pi-m*)" or "skin bitterroot with hands (*/pe-m*)". This varied naming could conceivably be

explained by the fact that the Nlaka'pamux in the southern or 'lower' territories often only received bitterroot in its prepared state through trade while the 'upper' Nlaka'pamux were the ones who actually harvested and stripped the root.

Nlaka'pamux ethnoclassification systems position bitterroot in descending order under the broadly inclusive taxon "ground growth", subclassed within "food ground growth" then further subclassed as a "root food" (Turner 1989). Although the latter class of edible roots (and underground parts) are a major nomenclatural plant category and readily recognised as distinct in utilitarian terms, it is an unnamed class. Whether or not this taxon name has been lost or absorbed into a class of 'weeds' through acculturative perceptions of European culture remains to be seen (Turner 1989). Likely, it was not because the class lacked cultural significance as the Nlaka'pamux did not differentiate between bulbs, rhizomes, corms and tubers, but all underground fleshy structures are traditionally seen as 'roots', the majority of which were utilised as food (Steedman 1930). One possibility speculated by Turner (1987) is that if the Nlaka'pamux language had continued to develop without outside influences, a taxon name for the incipient root category might have evolved through a process of expansion, with perhaps bitterroot or yellow glacier lily (*Erythronium grandiflorum*) serving as the type specimen because of their high cultural salience (p.75).

Within the unnamed taxa of edible roots, bitterroot has been referenced as the dominant member of a restricted mid-range grouping of "bitterroot type" plants (Turner 1989). The criteria for recognition of this mid-range plant grouping was based on a combination of common habitat and morphological similarities that included columbia bitterroot (*Lewisia columbiana*), siberian montia (*Montia sibirica*) and possibly

twayblade (*Listera* sp.) (Turner 1989). In further support of bitterroot as the 'type specimen' of this intermediate folk category, Teit also listed a name of bitterroot as *ilkupeno 'e*, literally meaning "basic bitterroot" (Steedman 1930, p.479). What is interesting to note, however, is that this classification may only be representative on a geographic basis and is not homogenous or universal for all Nlaka'pamux speakers. For members living solely within the dry-belt corridor in and around Ashcroft, bitterroot is independently classed as its own type specimen because the other bitterroot-like plants mentioned above are not ordinarily found in the area. When queried of bitterroot relations to and ordering beside other plants, Saraphine Kirkpatrick said that "...Indian root (bitterroot) hasn't got no friends, they're themselves."

Although there are many associations between plants and animals in Nlaka'pamux culture (Turner 1990), no direct relationships, either observed or perceived, are found specific to bitterroot. However, in more of an indirect manner, some Nlaka'pamux brought forward with consistent repetition a 'folk' connection with rattlesnakes. Many references were made to rattlesnakes and the danger thereof while harvesting bitterroot although this could be seen as more of an environmental hazard of seasonal digging rather than a relationship.

2.6 Mythology, Rituals and Traditional Beliefs

Alongside the utilitarian aspects of bitterroot, socio-cultural and symbolic analyses as to how it is perceived are also important towards understanding its place in Nlaka'pamux culture. Bitterroot, like other significant vegetal resources, carries with it an array of historical, mythological and ceremonial citations that can only be recognised and appreciated within appropriate cultural frameworks. This being said, the

Nlaka'pamux have many creation-type mythologies particular to place and organism within their territories. Notable, but not directly related to bitterroot, a number dealt with the origin and procurement of plants. As recorded by Teit (1912), a portion of one such myth is as follows:

At last Old-One came to the woman, ...He told her to shut her eyes, and, when she opened them again, a large plant had grown up before her. He asked her to go to the birch-tree, and, after saying to it, "O friend! I require you," to strip off its bark. This she did, brought the bark to him, and he rolled the plant in it. Now he told her to travel along that hillside, and throw away pieces of the plant. She did as directed, and, each time she put her hand in the role, she pulled out a different kind of bulb or seed. Thus she sowed all the different kinds of plants used by the Indians for food or medicine; and from these sprang up many, and they spread over the whole country. They grew as soon as they touched the ground. Old-One told her their names, and said, "These only are edible." Thus the Indians learned the edible varieties of roots and the proper kinds of herbs to use. When the plants had all been distributed, Old-One made the role of birch into a basket. He also made a root-digger, and showed the woman how to dig roots (p.326).

As to the abundance and specific distribution of plants throughout Nlaka'pamux territory and beyond, Teit (1912) recorded another variant of the creation myth particular to vegetable root foods (see Appendix I). Aligned with this, Nathan Spinks shared a similar but much abbreviated rendition of this myth in recollection of what was taught to him as a youth by his elders. Interestingly, Nathan's rendering also gives specific reason as to the place of bitterroot and why it grows where it does in the Lower Thompson River Valley:

"Two old people talked to me a long time ago... old, and I was just young; when I lived up at Spences Bridge and one time when I lived down at Siska. They were telling me that story, a long time ago. I listened to that story about when they were making the earth, and he was telling me, he says, 'when the Creator came, He came right through the Stein. He started here, but He didn't dump anything here

from His basket, He went all over, all over North America, dumping a little bit; that's why you see bitterroot only in certain spots, and some trees, and all kinds when they were making it'; this old man was telling me that. And then another old man said the same story, at different times".

Throughout British Columbia, along with stories of the Old One, the Creator, many mythologies also speak of the magical roles Transformer Beings played in the evolution of human, plant and animal life (Teit 1900). Besides helping to separate the first beings into humans and animals, these Transformers also gave instruction to the early people as to how to live and work with one another and the earth (York et al. 1993). This ancient era is what scholars have touted 'The Mythological Age' and the proximity with which the Nlaka'pamux continue to respect and honour these pedagogical understandings remains close and real. For the Nlaka'pamux, Daly (York et al. 1993) points out, "even today it is said that all the flora and fauna retain an elusive, human-like form of consciousness that harks back to the mythological era (p.#xi)".

Besides pointing towards geneses in culture, mythological ancestries can also be indicators of biological organism saliency. As stated by Martin (1995), "by exploring... the symbolic interaction between culture and nature in myth... plants and animals which are considered anomalous -abnormal in their behaviour or morphology- often serve as symbolic mediators in their special ability to cure, nourish or protect people (p.115)." Relating this observation to the knowledge and use of plants by the Nlaka'pamux, bitterroot exemplifies a number of unique attributes, holding mythological and practical values. Many of these beliefs stem from bitterroot's human-like 'transformer' root morphology and the notion that at one time, bitterroot were human themselves.

Although no accounts of bitterroot’s anthropomorphic past are recorded in ethnographic archives, many Nlaka’pamux elders signified that at one time such a myth did exist but had since been lost. Throughout the interview process, many descriptive references of the root were loaded with anthropomorphism’s; ‘the *lhQuoopen* are sitting’, ‘they are holding hands’, ‘they talk to one another’, ‘they are hiding from you’ (see Table 2.3). In fact, aligning bitterroot within a human ancestry remains very real to some Nlaka’pamux. As shared by Saraphine Kirkpatrick, there is even a hesitancy in the present day at digging too many *lhQuoopen*, for her experiences growing up have confirmed for her bitterroot’s humanness:

“I got down on the ground and I was leaning there and I was talking to it (bitterroot). I said to it that ‘my granny said that you could talk and everybody wonders what you are saying’; ...when I heard that talk (gives speaking sounds made) they were talking and looking at each other. The Indian root (bitterroot) seems to come alive, so I don’t like to get them too much, ...the *lhQuoopen* is always alive, I used to talk to them and rub them around my face and talk to them and look at them. My Mother used to tell me you are crazy, I told her they are people, ...I used to talk to them in Indian”

Table 2.3 Anthropomorphic Characteristics of Bitterroot as recognised by the Nlaka’pamux

Noted Attributes	
physical similarities	<ul style="list-style-type: none"> • the red ‘heart’ in what would be the thoracic cavity • the pale skin colour under the outer peridermal layer • the neck-like hypocotyl • the trunk, arm and leg-like appendages common in mature lateral root morphologies
social allusions	<ul style="list-style-type: none"> • often growing in defined, community-type populations • the existence of bitterroot ‘lover’ couplets as representative of the marriage union
spiritual connotations	<ul style="list-style-type: none"> • described as “...a white medicine that looks like a ghost” • regarded and esteemed by some individuals as a guiding spirit

The traditional affinity of the Nlaka’pamux towards bitterroot has also been described in contemporary times as that of a guiding spirit. Particular to married couples, the gendered qualities bestowed upon bitterroot, that being the folk categories of female and male plants (as described in Section 2.9), has been used by the Nlaka’pamux in an amulet-like symbolism. Madeline Lanaro depicts how the more human-like forms of bitterroot are sometimes used (see Figure 2-6):

“...if a couple is going to get married and they don’t ever want to break up, get a male and a female *lhQuopen* and bury them or put them under their pillow, sort of like a wedding ceremony; ...they will never break up cause they are together, those bitterroot is sort of their guiding spirit. If you talk to them and tell for them not to argue, ...that’s the way their life will be. If they don’t grow together or if they can put them together, they can bury them after they prayed to it or talked to it.”



Figure 2-6 An example of bitterroot "lovers" sometimes used in amulet-like symbolism

The high esteem, identification and relational connection felt by the Nlaka'pamux towards bitterroot also spread beyond mere mythological sentiments. The Nlaka'pamux engaged themselves in a plenitude of rituals surrounding the root and its harvest. A number of these adherences took the form of ceremonially observing the first bitterroot harvested each spring. Teit (Steedman 1930) reported that these First Fruit ceremonies, lesser known as First Root ceremonies, were common to a number of gathered food resources; they "...were observed by the Thompson (Nlaka'pamux) before and after the gathering of roots or fruits... the former were conducted to ensure and increase productivity, the latter as a thanksgiving (p.453)". For many of the Nlaka'pamux of late, the specifics of these prayerful ceremonies have been generally forgotten and their carrying out largely ceased, but their meanings and purposes remain. As Madeline Lanaro explains, "I recall prayers happening when the first *lhQuoopen* of the year was picked when I was a little kid, but I don't remember if anybody does it anymore; ...when we go out now we just do our prayers quietly".

Traditionally, along with ceremonies and a stringent air of reverence during the harvest, personal conduct also played a high role. The Nlaka'pamux took great care in digging and respect in honour of the root itself and where it came from. In modern times, although many of these self readying practices are overlooked if not lost from memory, some elders continue to remind the younger generations of these attitudes. One commentary, in echo of these traditions, says to comb out ones hair thoroughly before taking to dig bitterroot; the connection being that if one had messy hair, they would dig up roots that were matted, bushy and stringy instead of long straight and thick roots that were the preferred norm. Moreover, and not entirely viewed in a disciplinary light, when

children are helping to dig bitterroot, good behaviour is expected and required in edification of the serious and spiritual nature of the enterprise. Madeline Lanaro remembers being taught as a child that if one misbehaved while digging, “you are going to make *lhQuopen* upset”.

2.7 Trade

Bitterroot served as a traditionally important cash crop trade item for the Nlaka’pamux. Roots were traded both intra-tribally to the Lower Nlaka’pamux and to other surrounding Nations for a variety of items, the most common of which was dried salmon (Perry 1952, Turner et al. 1990). Even today, trade remains prevalent though on a far more limited basis than in the past. Nlaka’pamux who attend inter-tribal powwows are frequently approached by members of other nations to exchange or barter for bitterroot.

Bitterroot was traded in a processed condition (i.e. stripped, peeled and dried), either collectively in a sack or bundle, or in the manner upon which its name is derived, that being threaded on a string. Besides making for ease in curing and light handling, the threaded and dried segments of roots were used in order that trade value and market worth could be determined and accounted for in a uniform manner.

Teit (1900) gives reference to bitterroot as a commonly traded item though he did not list it as a ‘principle commodity of trade’ like the status given dried salmon, dressed skins and woven baskets. As enumerated, 10 bundles of bitterroot were considered to be of equitable exchange for one large dressed buckskin (p.261). Elsewhere, it was even reported by an early explorer that a sack of its roots could buy a good horse (Lyons 1952). Although the amounts of ‘bundle’ and ‘sack’ are unquantified, it can be granted

that these were dry amounts representing considerable energy and effort to collect and prepare.

The Nlaka'pamux consider bitterroot and the trade thereof a sacred overture to its stewardship. The Elder Nathan Spinks shared in a vein of reverence and concern that natural resources of the Nlaka'pamux are a gift of the Creator and should be regarded as such:

The Creator gave *lhQuoopen* to the Nlaka'pamux for a reason and that's why it only grows in certain spots, to trade and share; ...trade it with people who don't have it for other things like salmon. Or what is good is to give it away to someone who is travelling. If you don't treat things with respect they will disappear like when the people who started to sell salmon...; now the salmon doesn't come back the way they used to because they took too much and didn't treat salmon with respect. And that is like *lhQuoopen*...; you must treat it with respect and not sell it for money. White people would call *lhQuoopen* a commodity because it is important and it only grows in some spots and only some people can get it. In Indian we don't have a word like that cause we all share and trade, but that is like what it is.

2.8 Similar Ethnobotanical Species

Within Portulacaceae, only one other species matches the prolific use and importance attained by bitterroot. *Claytonia lanceolata*, commonly known as 'Western Spring Beauty' or 'Indian Potato' is also a highly salient root food of many interior First Nations; a mountain range, the 'Potato Mountains', is even named after this plant in the territories of the nearby Tsilhqot'in First Nation. Other notable but not as heavily used species include *Montia perfoliata*, or 'Miner's-Lettuce', used by the Nlaka'pamux as a medicine for sore eyes (Turner et al. 1990) and as the common name implies, also used as a salad green by early prospectors. Other species used by the Nlaka'pamux includes *Lewisia columbiana* and *Lewisia pygmaea*, both of which were used as sources of food,

the latter of which was sometimes thought to cause insanity (Steedman 1930, Turner et al. 1990). In identifying *Lewisia pygmaea*, which can be quite similar to *Lewisia rediviva*, any misgivings can be resolved in recognising that it only has two sepals, much fewer petals, its narrow leaves are usually a great deal longer than the stalks and it has a higher elevation habitat (Parish, Coupé and Lloyd 1996).

Modern ornamental use of Portulacaceae also includes species of more than usual horticultural interest and application (Hitchcock and Cronquist 1973, Mathew 1989, Zomlefer 1994). For obvious reasons, the genera *Talinum*, *Claytonia* and *Lewisia* are sought for their stunning, delicate and often opulent nature of flower. In regards to bitterroot, though a desirable species for the rock gardens of desert plants enthusiasts, when transplanted to the more temperate climates found west of the Cascades, it does not do well without careful care and attention in as it is overly prone to root rot.

2.9 Traditional Ecological Knowledge

For thousands of years, aboriginal peoples around the world have used knowledge of their local environment to sustain themselves and to maintain their cultural identity. Only in the past decade, however, has this knowledge been recognised by the scientific community as a valuable source of ecological information (Johnson 1992).

Nlaka'pamux traditional knowledge of bitterroot and other natural resources is in effect an overflow to the deep-seated, locally inherent understandings they hold as an indigenous people.⁹ This has resulted in appropriate, working knowledge systems of flora, fauna and overall ecology in the area. Aspects of this indigenous knowledge are

⁹ As such, indigenous is in dynamic reference to "...early peoples of an area whose traditional cultures are rooted in particular landscapes with which they are essentially and specifically identified." (Elder and Wong 1994, p.7).

often lumped under the phrase Traditional Ecological Knowledge (abbreviated TEK) and as stressed in The Brundtland Commission's report, *Our Common Future* (1987), there associated with the concept of 'sustainability'. The sustainable use and awareness of how, where and when to harvest bitterroot grew from familiarity with habitat requirements as well as physiological understandings of the species.

While Nlaka'pamux TEK of bitterroot is not entirely obvious as to habitational reasons why it grows where it does (locally around Ashcroft), there was consensus as to what ideal growing situations are. Climatic conditions stated to bring about large, favourable roots are dependant upon the winter months. If there was little or no snow or rain, bitterroot was said to have abnormally small roots in the spring. However, if the winter did provide enough moisture in the ground and it was not too cold, "...they will grow big". Edaphic requirements are seen as equally important. Many Nlaka'pamux conveyed that bitterroot grows better in sandy soils, where it is generally hot and dry, but where the soil is still able to retain some moisture. Furthermore, where the soil is soft it tends to grow bigger and they are easier to dig. As Saraphine Kirkpatrick states, "when it rains it (bitterroot) grows, but when its no rain it dries up just like a stick. When it is too rocky and dry they don't come out right [sic]."

In regards to physiological differences between bitterroot populations, it has been reported that some First Nation groups recognise varying degrees of astringency, believing that only certain populations produce palatable roots (Hitchcock et al. 1964); the Nlaka'pamux do not fully concur. While they recognise that environmental factors may bring about certain nutritional or physiological differences, the variations are noted as being on a year to year basis, not changing greatly over time. The Nlaka'pamux

interpret physiological variations as arising from environmental or climatic factors. As Ruth Peters shared, "...in different parts of the country they come in different sizes", however, "...they are the same kind".

TEK of the Nlaka'pamux also accounts for the reproductive dynamics of bitterroot, influencing and contributing greatly to the species' propagation as well. In general, traditional terms, Teit reported that although it may have not been entirely accurate scientifically, the Nlaka'pamux did have concepts of sex in plants; this being explainable through greater plant size usually attributed to that of the male (Steedman 1930, p.453-4). In regards to bitterroot, morphological size remains to have sway over plant engenderment, that is, along with the presence or absence of 'hearts' as previously mentioned. However, Ruth Peters shares that one can locate female individuals without digging to compare root size or the presence of a heart; "...just like everything, there is female and male. Vegetables, everything, even the lilac bush (*Syringa vulgaris*) out in front [of her home] is a female because it has saplings underneath it. The females are the ones who have all the little ones around, ...it is the same with the flowers".

Relating these understandings to the propagation of bitterroot, the Nlaka'pamux recognise the male 'heart' of the root as also being the male 'seed'. Further, mentionings from various Elders correspond to the fact that "...you can go and plant the male seed and it will grow", or "...the one with the heart is the male and that seed is to grow more [plants]". While all Nlaka'pamux interviewed confirmed that the 'hearts' were removed from the edible portion of the root due to its bitter taste, no one gave reference to replanting it as a fertile propagule once it was removed. From what was shared, any replanting of the root or its propagule was incidental as the male 'seeds' were cast away

indiscriminately without any formal thought to where it landed. However, because of many references to the 'seeds' self reproductive abilities, it is foreseeable that at one time, a replanting process may have been on a much more intentional, outright basis.¹⁰

Nlaka'pamux management strategies surrounding bitterroot and other plant food resources are many. It should be mentioned, however, that one of the most prominent examples in illustration of the comprehensive nature of their TEK is the use of fire. Periodic controlled burning of resource sites was a prominent factor in maintaining and enhancing floral resources by keeping competitive species at bay and releasing nutrients into the soil. In fact, the persistence with which Interior First Nations have used burning (Lewis 1973, 1982, Turner 1995, 1997) has allowed fire to be the dominant force in selecting for fire-resistant species.

As a grassland geophyte, it can be ascertained that bitterroot is a species potentially enhanced through burning although few referrals were given by the Nlaka'patmux attributing or connecting this process specifically to the bitterroot harvest. Traditional burning is a well recognised management tool throughout Nlaka'pamux territory though it has evolved into a rare safety practice in prevention of large, unintentional fires since governmental repression earlier this century. To many Nlaka'pamux, fire was known to have been used moderately throughout the Ashcroft area; modern ecological interpretations of the landscape in many ways attributes change to the present lack of burning.

Landscape and habitat degradation in the area is also addressed and interpreted through TEK and other recollections made by Nlaka'pamux Elders. Many times,

¹⁰ Further quantitative study as to the ability of bitterroots 'heart' to act as a propagule is needed for verification.

remarks as to the fact bitterroot roots were getting smaller were charged to the introduction of cattle. Madeline Lanaro recognised this; "...they grew nice and big but the cows have all trampled them... they are little now, ...it is not as good as it used to [be]". So noticeable has the introduction of cattle been that in digging areas where grazing is heavy, the Nlaka'pamux have identified a loose relationship between bitterroot and sagebrush (*Artemisia tridentata*). It seems that through trampling and grazing and the effects of soil compaction and erosion¹¹, bitterroot is conscripted to grow most favourably under the shelter and protection of sagebrush. Consequently, although not mentioned as a traditional exercise, probing and digging underneath sagebrush is now a common spot to harvest bitterroot.

Along with traditional observation of bitterroot's interactions with indigenous mammals, that is, the leaf herbivory of small rodents (various species) and mule deer, domestic livestock have also entered the scene although on a much more detrimental level. Saraphine Kirkpatrick distinguishes that cattle not only trample bitterroot, they consume flowers before the plant can set seed:

"...the cows eat all the flowers and that's what kills them. They are eating the seeds, you know the flowers, and they are eating the seeds and that's why it won't transplant. That is not nice. It isn't nice to have cows in there cause they are eating the seeds too. I wonder if it grows now, cause a long time ago they [bitterroot] were just riding each other, you know on top of each other; you dig anywhere and you see lots of roots coming up."

Through the above information presented on the ethnobotany and TEK of the Nlaka'pamux, humans are, of course, prominent users of bitterroot as well. It is strongly evident that they were not merely passive gatherers of such natural resources. Much of

¹¹ This is thought to be due in part to the loss of microbiotic crust (that is the vegetative layer made up predominately of byrophytes) and the protective role it plays in relation to substrate conditions; e.g.

the knowledge surrounding bitterroot and its procurement stemmed from a deep appreciation for and understanding of intricate ecological systems. In all, the Nlaka'pamux were acutely aware and active in the sustainable management of bitterroot.

helping to retain soil moisture or in prevention of wind erosion (Cannings and Cannings 1996).

3.0 Autecology of *Lewisia rediviva* in the Lower Thompson River Valley

As outlined in the previous chapter, Nlaka'pamux ethnobotany of *Lewisia rediviva* is a complex and integrated text that manifests a clear and purposeful sense of stewardship. While the cultural salience of the species is implicit and obvious as to reasons why and factors of how it has been maintained, ecological characteristics and inquiry as to the reciprocal effects management activities have wrought are much more abstruse and locally unknown. The historical and contemporary place of the plant among the Nlaka'pamux incurs the need to view *Lewisia rediviva*'s status on an autecological basis in order to understand or even approach a balanced consensus of the structure and dynamics of its populations.

The ecological component of this research employed an inductive approach to describe vegetation rather than using experimental, hypothesis testing methodologies. With the objective to document habitat requirements and to develop a preliminary baseline survey of the species' local distribution and abundance for future reference and comparison, data sets related to ecosystem properties were collected through a variety of environmental (essentially abiotic) and species (biotic) site parameters. Vegetation description was at the floristic level with *Lewisia rediviva* and associated plant species valued through cover estimations respective to seven anthropogenic communities spread throughout the Lower Thompson River Valley.

3.1 Methodology

3.1.1 Study Sites

The most recognised and still existent bitterroot harvesting sites of the Nlaka'pamux were selected in which to conduct ecological surveying. Seven locations were chosen to give an even and complete cross-section of traditional sites based upon historical records and contemporary mentionings delineating them as such. All surveying took place during one field season (in the spring of 1999) at a time when bitterroot is customarily harvested, that is just prior to flowering, between late April to early June. None of the study areas exhibited the prolific bitterroot populations as documented earlier this century (Davidson 1916), but they did represent the most productive, present-day populations found in the Lower Thompson River Valley. Figure 3-1 displays the seven site locations, with Table 3.1 containing general descriptions of the sites.

Of the seven sites selected, all were located within the Thompson 'Bunchgrass' biogeoclimatic zone. Within this zone, sites were divided between Very Dry Hot (BGxh2) and Very Dry Warm (BGxw) subzone variants, representing the hottest, driest biogeoclimatic zones in British Columbia. Overall, observed vegetation was dominated by big sagebrush (*Artemisia tridentata*) and bluebunch wheatgrass (*Agropyron spicatum*), with pasture sage (*Artemisia frigida*), rabbit-brush (*Chrysothamnus nauseosus*), and Kentucky bluegrass (*Poa pratensis*) as co-dominants.

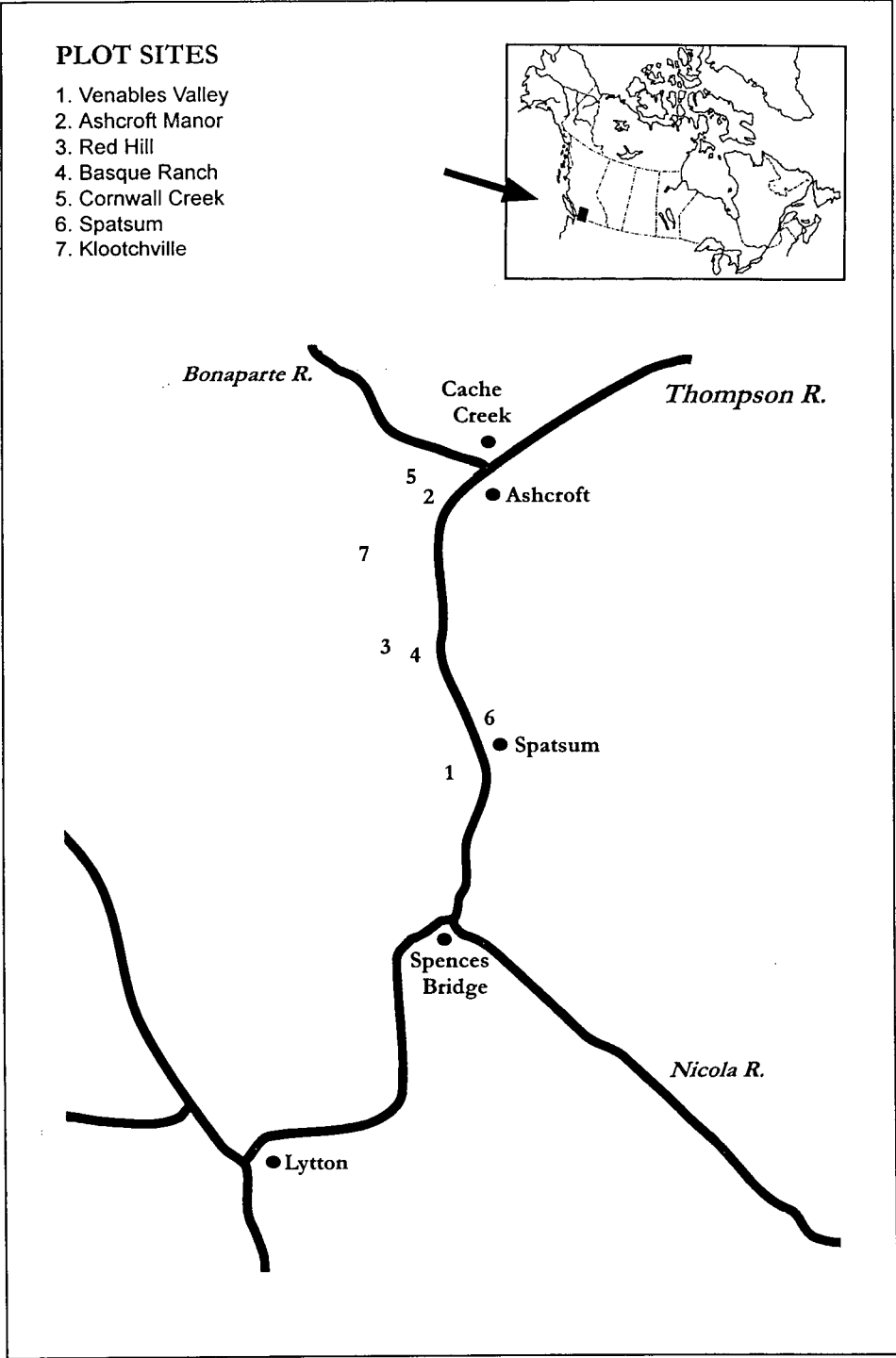


Figure 3-1 Survey site locations of traditional bitterroot harvesting grounds in the Lower Thompson River Valley; see Table 3.1 for corresponding descriptions.

Table 3.1 Survey site descriptions of traditional bitterroot harvesting grounds in the Lower Thompson River Valley.

No.	Name (common name)	Site Locality and Description (Date surveyed; latitude - longitude; elevation; slope angle; slope aspect as from true north; biogeoclimatic subzone variant [explanation]; land title and use [disturbance]; location and directions; population area <i>Lewisia rediviva</i> in hectares [phenological state]; principal associated co-occurring species [alphabetical]; comments)
1	Venables Valley	08 May 1999; 50° 34'N - 121° 19'W; 511m; 4°; 327°; BG xh2 (very dry hot bunchgrass); crown land being leased by the Oregon Jack Creek Band and used for cattle grazing (heavy); 1 km south up Venables Valley Rd. (gravel), plot is 50 m east of road near barbwire fence (transecting north to south); 2-3 ha (only rosettes, no buds); <i>Agropyron cristatum</i> , <i>Androsace occidentalis</i> , <i>Antennaria dimorpha</i> , <i>Arabis holboellii</i> , <i>Artemisia tridentata</i> , <i>Poa pratensis</i> ; old flat-topped <i>Pinus ponderosa</i> found nearby is where Percy Minnabarriet's Grandma used to camp for weeks at a time while harvesting <i>Lewisia rediviva</i> .
2	Ashcroft Manor	12 May 1999; 50° 43'N - 121° 19'W; 481m; 1°; 352°; BG xh2 (very dry hot bunchgrass); Ashcroft Reserve (IR 4) land laying vacant with no grazing; directly east off Highway 1, 20m in on the left side of entrance road (gravel) to NI' Akapmx Eagle Motorplex; 0.5 -1 ha (small buds showing); <i>Antennaria dimorpha</i> , <i>Artemisia tridentata</i> , <i>Frittilaria pudica</i> , <i>Lomatium macrocarpum</i> , <i>Poa pratensis</i> ; <i>Lewisia rediviva</i> grew in intensive clump-like pockets, this is a well known and easily accessible harvesting area.
3	Red Hill	13 May 1999; 50° 38'N - 121 ° 21'W; 465m; 6°; 72°; BG xw (very dry warm Bunchgrass); private land (Ashcroft Ranch) being used for cattle grazing (heavy); 50m west off Highway 1 directly across from Red Hill Reststop area; 0.5 ha (buds well developed); <i>Agropyron spicatum</i> , <i>Androsace occidentalis</i> , <i>Antennaria dimorpha</i> , <i>Arabis holboellii</i> , <i>Artemisia frigida</i> , <i>Opuntia fragilis</i> , <i>Phacelia linearis</i> ; traditional camp sites were very common here while harvesting <i>Lewisia rediviva</i> , evidence of 'discing' near plot site.
4	Basque Ranch	14 May 1999; 50° 38'N - 121° 19'W; 373m; 18°; 108°; BG xh2 (very dry hot bunchgrass); Basque Ranch Reserve land (IR 18), Cooks Ferry Band, used for cattle grazing (light); on the northwestern perimeter of middle field adjacent to dry creekbed and barbwire fence (east to west); 0.5 - 1.0 ha (majority in full flower); <i>Agropyron spicatum</i> , <i>Artemisia tridentata</i> , <i>Delphinium nuttallianum</i> , <i>Opuntia fragilis</i> , <i>Poa pratensis</i> , <i>Sporobolus cryptandrus</i> ; last grazed in 1996.

5	Cornwall Creek	16 May 1999; 50° 44'N - 121° 19'W; 610 m; 24°; 328°; BG xw (very dry warm bunchgrass); 105 Mile Post Reserve (IR 2), Ashcroft Band, used for cattle grazing (heavy); on the south side, 400m west up unmarked road (dirt) west off Highway 1 across from NI' Akapmx Eagle Motorplex; 1 ha (few rosettes, small buds showing); <i>Antennaria dimorpha</i> , <i>Arabis holboellii</i> , <i>Artemisia tridentata</i> , <i>Lomatium macrocarpum</i> , <i>Poa pratensis</i> , <i>Tragopogon dubius</i> ; <i>Lewisia rediviva</i> was not found on slopes > 30°, evidence of herbivory on some rosettes. Area traditionally known as <i>nKa.chEEn</i> , meaning 'dry place'.
6	Spatsum	17 May 1999; 50° 32'N - 121° 17'W; 320m; 9°; 218°; BG xh2 (very dry hot bunchgrass); Shpazchinh Reserve (IR 20), Cooks Ferry Band, used for occasional grazing (light); 100m east off road (dirt) 2 km north of Spatsum near large scree slope; 10 ha (majority in flower, some in bud); <i>Agropyron spicatum</i> , <i>Androsace occidentalis</i> , <i>Arabis holboellii</i> , <i>Opuntia fragilis</i> , <i>Phacelia linearis</i> , <i>Poa pratensis</i> ; 2-3km's of sparse <i>Lewisia rediviva</i> with punctuated pockets throughout.
7	Kloutchville	18 May 1999; 50° 42'N - 121° 22'W; 709m; 8°; 97°; BG xw (very dry warm bunchgrass); private land (Ashcroft Ranch) used for cattle grazing (heavy); upper meadows of Ashcroft Ranch, 400m down slope (east) of thinly forested area, 600m northwest of the older southern-most corral, 20 east off unmarked road (dirt); 1 - 2 ha (rosettes still present, majority in beginning to bud); <i>Agropyron spicatum</i> , <i>Artemisia frigida</i> , <i>Fritillaria pudica</i> , <i>Lappula redowskii</i> , <i>Poa pratensis</i> , <i>Tragopogon dubius</i> ; traditionally important harvesting site with access now extremely limited.

The sites varied in size from < 1 hectare (Red Hill) to nearly 10 hectares (Spatsum). In all, the region of study constituted an area of roughly 250 square kilometres along the western and eastern flanks of the lower Thompson River, from north beyond Spences Bridge to the southern perimeter of Cache Creek (Spences Bridge to Cache Creek=42km).

As mentioned, survey sites were selected for their historical and contemporary significance as a bitterroot digging area. Specific sampling locations within sites were subjectively chosen based upon culturally guided factors rather than chance or pure randomness. After a brief scouting of each locale, one plot of 100m² was demarcated at each site in an area that represented general physiognomic uniformity as well as fair portrayal of an anthropogenic bitterroot population. In order to conduct floristic

description at each site, plot layout was that of a 10 X 10m transect grid with set sampling placements throughout (see Figure 3-2). Hence, sampling within each plot was objective and fixed, being carried out in a structured, predetermined manner.

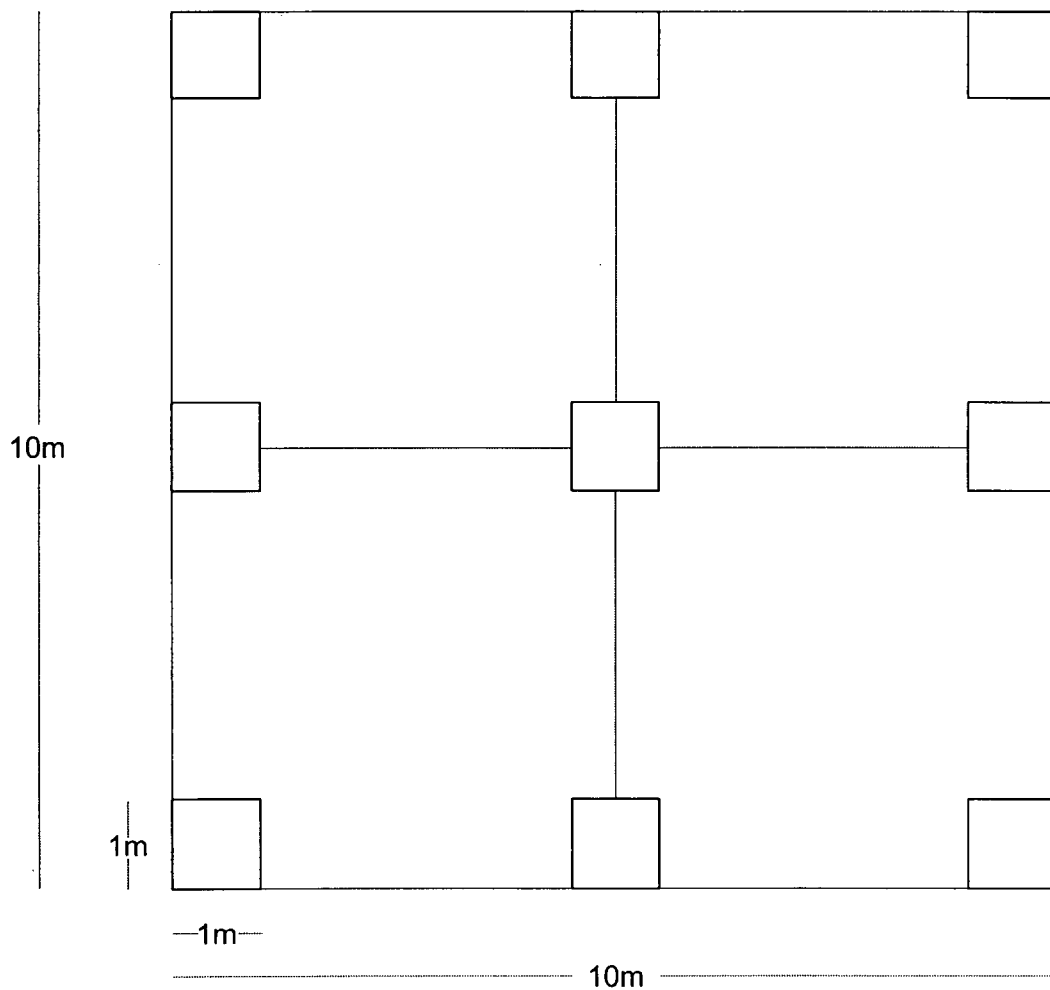


Figure 3-2 Grid format of plots used in survey sampling. The nine squares represent quadrat placements; drawn to scale (0.9cm = 1.0m)

3.1.2 Vegetation Description

The 10 X 10m transect grid system, made up of nine 1 X 1m quadrats was set up in order to record species abundance by way of estimating percent cover values. These quadrats were evenly spaced and sampled at the corners, meridians and central points of each plot using a portable 1 X 1m quadrat frame. The data collected was subjective in nature as cover estimates were made by eye using a modified Braun-Blanquet scale methodology (Kent and Coker 1992). Cover value percentages used were augmented from 0.25, 0.5, 1.0, 1.5, 2.0, 2.5 and continuing on in whole percentages from 3.0 and greater. All herbaceous plants and shrubs in the quadrats at the time of surveying were recorded and their percent cover estimated.¹² Larger woody bushes and trees were uncommon at the sites and did not occur in any of the grid plots. Bryophytes were amalgamated under the heading 'microbiotic crust', and were treated as a single species, being given appropriate percent cover values per quadrat. Except for the most common and dominant plant species in the area, collections were made of species within the quadrats to aid in identification and to serve as herbarium vouchers for the study.

Species Identification

Nomenclature for the vascular plants identified in plot surveys followed the four volume series by Douglas, Straley and Meidinger (1989, 1990, 1991, 1994). For instances where species identification proved difficult in the field, collections were made for closer examination and comparison at the University of British Columbia's Herbarium. These specimens were collected in duplicates on a random basis among the plot sites and have been deposited in the herbarium at the University of British Columbia

¹² It is recognised that some species in the plots were overlooked because they were not yet visible above ground.

and the repositorial facilities of the Nlaka'pamux Nation Tribal Council. Occasionally, triplicate specimens were also collected to be sent to the Royal Provincial Museum Herbarium in Victoria or other appropriate herbaria.

3.1.3 Environmental Parameters

Overall site descriptions, both quantitative and qualitative, were carried out at each of the seven plot areas under the following domains: landforms (aspect, slope, latitude & longitude), climate (elevation, exposure), vegetation (physiognomical and floristic features,¹³ biogeoclimatic zone and variants), soils (compaction, rockiness, pH, texture, colour) and disturbance (grazing). Table 3.2 outlines the environmental variables derived from these domains and how their respective values were calculated to be adopted into analyses.

Soil compaction and rockiness were amalgamated into a single category. Measurements were taken with a makeshift aluminium soil probe and gauged through taking the average depth (cm) of ten random probes within each grid area. Other substrate variables were evaluated off site. Three samples from the uppermost soil horizon¹⁴ were collected randomly from each of the seven plots in order to determine average pH, colour and texture qualities (these samples were composed primarily of organic rather than mineral matter). Soil pH was measured by diluting approximately 4 grams of roughly sifted soil in 20 ml of distilled water. The mixture was stirred for 30 minutes and left to settle for another 60 minutes before being assayed with an electrometric meter (Orion pH meter - model 420A) at an ambient temperature of 25.0° C; the meter was first calibrated with pH 4.0 and 7.0 buffering solutions. Soil colour

¹³ Considered here as an environmental parameter in characterising habitat type.

¹⁴ Ranging from a depth of 3 - 10 cm, in representation of the region of bitterroot growth.

qualities were gauged using the Munsell Soil Colour Chart while soil texture was valued by applying a standardised hand Texture By Feel Guide test.¹⁵

Table 3.2 Environmental variables used in habitat analysis

Variable	Definition
aspect	Slope aspect, transformed as $\cos(A_{\max} - A) + 1$, where $A_{\max} = 202.5$ (S-SW), and A is azimuth from true north; S-SW=2, N-NE=0
slope	Slope angle in degrees
elevation	Elevation in metres above sea level (ASL)
lat	Latitude (converted to a decimal number)
long	Longitude (converted to a decimal number)
exposure	Categorical variable, 3 levels: full direct sun(3); sloped, direct sun(2); partial shade(1)
comp-rock	Compaction and rockiness index, values from 0 to 30 cm (high numbers = more compaction and greater rockiness)
pH	Upper substrate pH (to one decimetre equating with root depth)
texture	Substrate texture index calculated on a 1-10 scale, where 1=clay, 5=silt and 10=sand
colour	Substrate colour calculated using Hurst Colour Index ($[\text{Hue} \times \text{Chroma}] / \text{Value}$)
microcrust	Microbiotic crust percent cover values (means for 9 quadrats per site)
barerock	Percent cover values for bare soil and rock (means for 9 quadrats per site)
shrub	Categorical variable, 3 levels: large sagebrush(3); low sagebrush(2); bunchgrass(1)
herbcover	Sum of average percent cover values (means for 9 quadrats per site) for all associated vascular species
alphadiv	Representative of the mean number of vascular species present within the 9 quadrats per site; used as an index of species richness and biodiversity
betadiv	Calculated here as the total number of species recorded at a site divided by the average number of species per quadrat; used as a measure of the degree of floristic change within a site (higher numbers = greater variance)
intro-spp	Number of introduced vascular species present at each site
native-spp	Number of native vascular species present at each site
grazing	Categorical variable, 3 levels: no grazing(1); light grazing(2); heavy grazing(3)

¹⁵ as found at <<http://ltpwww.gsfc.nasa.gov/globe/tbf/tbfguide.htm>>

3.1.4 *Lewisia rediviva* Population Characteristics

Data specific to *Lewisia rediviva* were collected to further understand the nature of environmental controls on plant growth. In addition to an estimation of the population area of the species at each site (as mentioned in the original site descriptions; see Table 3.1), quantification of harvestable root bodies was also made. For this purpose, a 1 X 1m quadrat was subjectively positioned within the plot in an area that contained the most prominent, aboveground growth of bitterroot (regardless of whether or not it fell along grid transects). The aim was to characterise the maximum harvestable growth output for the various bitterroot populations in terms of numbers and biomass that could also be applied in estimation of species health and vigour.

Species variables enumerated for each plot area are outlined in Table 3.3. The net dry weight of harvested root material was determined after preparing the roots in the traditional fashion of stripping off the outer periderm, rinsing in water and setting to cure in the sun (in this case, bitterroot 'hearts' were not removed). The processed root bodies were then dried further in an oven (Fisher Scientific Isotemp Oven model-655F) at 60° C for 72 hours before being weighed on a microscale (AND HF-400).

Table 3.3 Variables used in enumeration of *Lewisia rediviva*

Variable	Definition
lewisiamax	Maximum number of harvestable <i>Lewisia rediviva</i> in a 1X1 meter quadrat at each site (excludes seedlings)
total-weight	Total dry weight of roots (in grams) taken from lewisiamax; used as a measurement of biomass
indiv-weight	Average individual dry weight of roots (in grams) taken from lewisiamax; used as a measurement of biomass

3.2 Data Analysis

Vegetation data used in analyses consisted of cover values for a total of 38 species¹⁶ in 63 quadrats¹⁷ from the seven plots. Environmental data and the growth characteristics of *Lewisia rediviva* corresponded to the seven plots, thus avoiding grid redundancy in treating each quadrat on an individual basis. Analyses used to examine the above data involved indirect ordination methods to assess vegetation and environmental properties. The growth data on *Lewisia rediviva* were incorporated in a subsequent step to examine possible relationships between population characteristics and vegetation / site features.

Examination of the species data (n=63 quadrats) collected was carried out independently of the environmental data (n=7 plots) because the low number of plots surveyed (limited by few local traditional harvesting sites) was unsuited for the complexities of reciprocal averaging techniques found in direct or canonical analyses (i.e. meanings could potentially be lost in the stabilising process because of the differences in sample size between the species and environmental data). Therefore, the species data were analysed using Detrended Correspondence Analysis (DCA), a widely used and well accepted methodology since the early 1980's, and cited as the overall preferred indirect ordination technique for practical and descriptive ecology very much similar to the concerned survey (pers. comm. Bradfield 1999, Kent and Coker 1992). No downweighting of rare species (those being scarce to the quadrats) was instituted as the breadth of the data set proved relatively trim; regardless, instalment of the

¹⁶ For inclusion and simplicity in analysis, the species represented were reduced to an eight character code, that being a combination of the number of its alphabetical position along with the first three letters of the genus and the first three letters of the specific epithet (e.g. *Lewisia rediviva* Pursh became 28lewred)

downweighting option produced differences perceived as insignificant between ordinations . Axes were rescaled according to the default settings (number of segments = 26; threshold = .00) in the programme used (PC-ORD for Windows, Version 3.17). No additional data transformations were performed on the species cover values.

In a separate analysis of the environmental data, a total of 19 variables were selected and used (on the basis of the parameter having a numerical value) in forming a plot matrix preparatory to ordination. Using methodologies available on PC-ORD, ordination was carried out through Non-metric Multidimensional Scaling (NMDS). This methodology was chosen due to the limited sample size and non-parametric nature of some of the environmental variables. As sampling sites fell within the confines of a single watershed and were not spread out on a wide biogeoclimatic basis, NMDS was used because of its overall strengths in treating small test groups that are similar on a local scale (pers. comm. Bradfield 1999). For useful comparison, Principal Component Analysis (PCA) was also run on the environmental data, however, the results were perceived as differing little and offered no additional insights than those gathered from NMDS. The NMDS options used included the use of Euclidean distance as a measure of interplot similarity, with starting coordinates selected on a random basis particular to two axes.

The harvestable growth outputs recorded for *Lewisia rediviva* were in regards to the maximum number of individuals and their biomass weights specific to the seven plots. This data was analysed separately from the above ordinations using a logarithmic graphing option in Microsoft Excel (Version 5.0).

¹⁷ Quadrats were numbered 1 through 63 as they were distributed evenly in groups of nine among seven plots (e.g. numbers 10 through 18 equated to the nine quadrats from plot number two)

3.3 Results

Vegetation Analysis

The DCA ordination of the sixty-three quadrats at the seven sites based on species cover data is shown in Figure 3-3 (see Appendix II for the raw scores of species cover; plant stratification was minimal and did not result in cover values of over 100%). No distinct groups are apparent among the quadrats corporately other than an ill-defined clumping of quadrats near the middle of Axis 2. However, sites 2, 3, 5, 6 and 7 do show obvious clustering among quadrats indicating greater vegetation homogeneity than at sites 1 and 4. The positions of outlying quadrats in the ordination are attributable to abnormally high percent cover values of certain species within the plots. For example, the bottom right outlier in plot 2 was pulled askew by an 8% cover of *Agropyron spicatum* in quadrat number 15, while the upper right outlier in plot number 6 was pulled askew by a 20% cover of *Chyrsothamnus nauseosus* in quadrat number 48. This interpretation was based on inspection of the raw cover data (Appendix II) in combination with the species ordination shown in Figure 3-4.

Figure 3-4 was generated simultaneously with the quadrat ordination but displays the relative similarities among the species based on their patterns of distribution and abundance at the seven sites. Again, no highly distinctive groups are apparent other than the nestling of species towards the centre of both axes. Viewed beside Figure 3-3, the pull of some quadrats towards the lower and upper right corners of the graph is clearly seen by way of directional groups of species gravitating towards the same two corners in Figure 3-4. The slight intersection of quadrats and species that occurs in both these

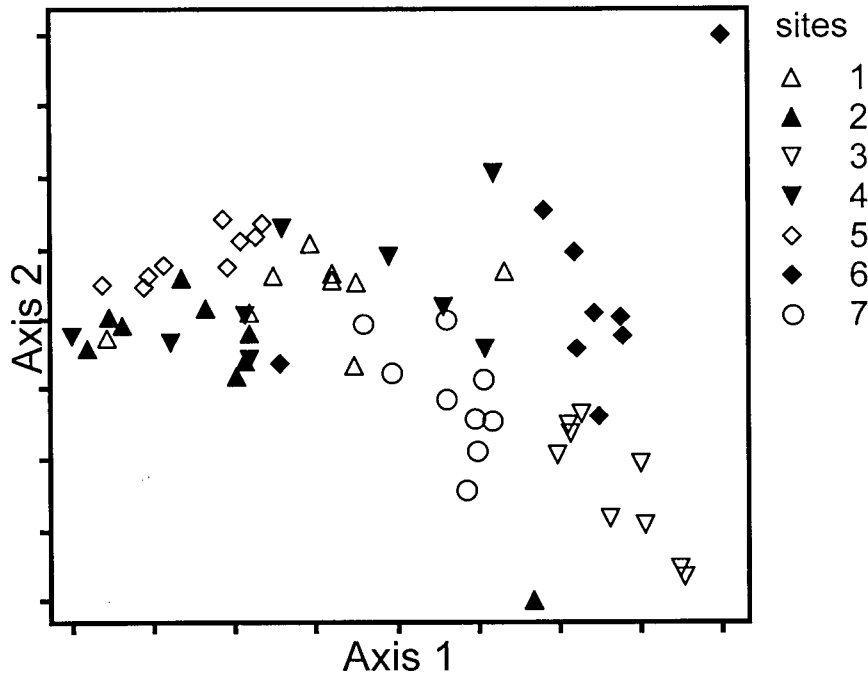


Figure 3-3 Quadrat (Site) ordination from DCA of cover data. Site names: 1 (Venables Valley), 2 (Ashcroft Manor), 3 (Red Hill), 4 (Basque Ranch), 5 (Cornwall Creek), 6 (Spatsum), 7 (Klootchville).

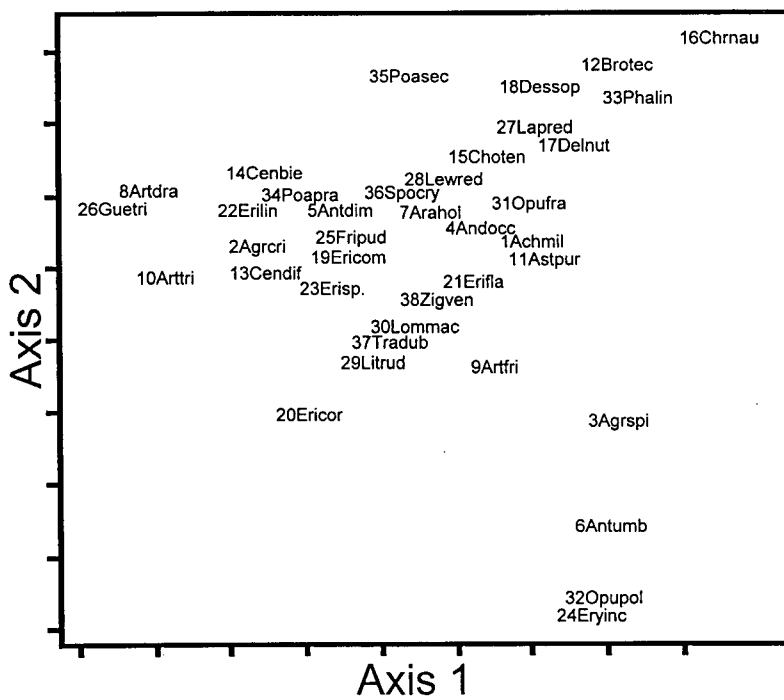


Figure 3-4 Species ordination from DCA of cover data

figures can be interpreted as representing an average plot area with its corresponding plant associations common to all the survey sites.

Although the majority of species present in the quadrats can be equated as loose associates of *Lewisia rediviva* throughout the study area, the centrally positioned grouping of species in Figure 3-4 represents the most common associates. Species commonly associated with grazing disturbances, such as *Opuntia fragilis*, *Antennaria dimorpha*, *Poa pratensis*, *Achillea millifolium*, *Lappula redowskii*, *Centaurea diffusa*, *Tragopogon dubius* and *Erigeron compositus* are highly evident in this central group, suggesting that *Lewisia rediviva* could be suffering from grazing effects throughout the valley. As seeded for fodder, the proximity of *Agropyron cristatum* adds further complication to the effects of grazing despite its presence in only in one of the seven plots (Venables Valley). Also notable in the central grouping of species is the traditionally recognised association between *Lewisia rediviva* and *Fritillaria pudica*, evidence that this historical linkage between populations is still intact.

Table 3.4 lists the species correlations with the first two DCA axes. By viewing this table in combination with the previous two figures, additional explanations for the overall form of the ordination can be explored. Most of the correlations are weak (i.e. between -0.3 and +0.3) indicating that the majority of species are randomly distributed. Of particular interest are the strong correlations shown by *Agropyron spicatum*, *Artemisia tridentata*, *Phacelia linearis*, and *Poa pratensis*, suggesting that these species are responding to the dominant environmental gradients within the *Lewisia rediviva* vegetation. Correlation values with opposite signs indicate an opposite response by the corresponding species to the gradient in question. It is no surprise that this “gradient-

indicating”, species association is also representative of the greater biogeoclimatic zone in the area, the ‘bunchgrass - sagebrush’ community type.

Table 3.4 DCA species output from graph; Pearson (parametric coefficients of r and r-sq) and Kendall (nonparametric tau) correlations with ordination axes (N= 63). Large values of r and tau, indicating species with significant effects on the ordination axes, have been boldfaced.

Species	Axis 1			Axis 2		
	r	r-sq	tau	r	r-sq	tau
1Achmil	.175	.031	.216	.036	.001	-.034
2Agrcri	-.220	.048	-.147	.118	.014	.140
3Agspi	.670	.449	.613	-.681	.464	-.495
4Andocc	.216	.046	.177	-.011	.000	-.009
5Antdim	-.171	.029	-.225	.225	.051	.174
6Antumb	.177	.031	.156	-.340	.115	-.256
7Arahol	.070	.005	.122	.155	.024	.134
8Artdra	-.153	.023	-.132	.096	.009	.115
9Artfri	.264	.070	.199	-.387	.150	-.380
10Arttri	-.670	.448	-.676	.110	.012	.144
11Astpur	.271	.073	.248	-.078	.006	-.108
12Brotec	.287	.083	.361	.228	.052	.078
13Cendif	-.199	.040	-.148	-.021	.000	-.045
14Cenbie	-.231	.053	-.215	.234	.055	.256
15Choten	.044	.002	.023	.028	.001	.011
16Chrnu	.259	.067	.158	.388	.151	-.017
17Delnut	.284	.080	.205	.025	.001	.012
18Dessop	.175	.031	.138	.237	.056	.197
19Ericom	-.061	.004	-.039	.092	.008	.104
20Ericor	-.072	.005	-.040	-.032	.001	-.063
21Erifla	.064	.004	.012	-.087	.008	-.029
22Erilin	-.212	.045	-.189	.262	.069	.315
23Erisp.	-.106	.011	-.124	-.007	.000	-.004
24Eryinc	.105	.011	.080	-.331	.110	-.178
25Fripud	-.171	.029	-.127	.065	.004	-.009
26Guetri	-.210	.044	-.198	.089	.008	.157
27Lapred	.217	.047	.209	.042	.002	-.139
28Lewred	.103	.011	.106	.190	.036	.167
29Litrud	-.048	.002	-.098	-.104	.011	.033
30Lommac	-.063	.004	-.190	-.259	.067	-.131
31Opufra	.256	.066	.334	-.017	.000	-.115
32Opupol	.105	.011	.080	-.331	.110	-.178
33Phalin	.463	.215	.475	.045	.002	-.175
34Poapra	-.467	.218	-.310	.385	.148	.349
35Poasec	-.036	.001	.015	.268	.072	.222
36Spocry	-.067	.004	-.121	.069	.005	.044
37Tradub	-.103	.011	-.098	-.103	.011	-.035
38Zigven	.029	.001	.010	-.087	.008	-.070

Environmental Analysis

The NMDS ordination of plots based on the environmental parameters is shown in Figure 3-5 (see Appendix III for the raw scores of these environmental values).

Overall, no strong groupings of plots are noticeable along either axis other than some similarities among plots 1, 2 and 3; plots 6 and 7 are plausible outliers. Interpretation of the environmental gradients represented by the two ordination axes was facilitated by using the overlay option available in PC-ORD (i.e. by varying the symbol sizes in the plot points), and by examining the correlations of environmental variables with the ordination axes as listed in Table 3.5.

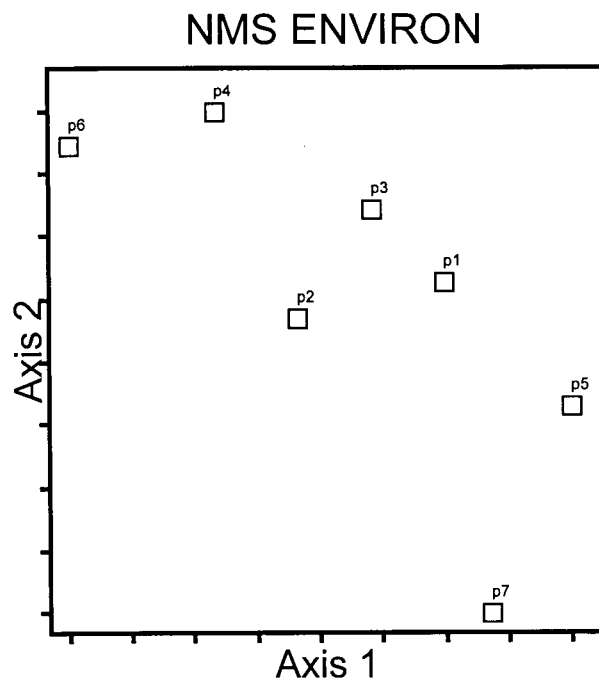


Figure 3-5 Plot Ordination from NMDS of environmental parameters. Plot numbers designate study sites: p1 (Venables Valley), p2 (Ashcroft Manor), p3 (Red Hill), p4 (Basque Ranch), p5 (Cornwall Creek), p6 (Spatsum), p7 (Kloutchville).

The majority of the variables were factors (however superfluously) to the gradients of both axes. High positive values were given to comp-rock and barerock on Axis 1 with comparably high values given to elevation, latitude, longitude, exposure, herbcover and introduced spp. on Axis 2 (refer to bolded values in Table 3.5). Nevertheless, even though these gradients are strong, definition of the gradient's make-up gives reason for their high values. In illustration of the association between elevation, latitude and longitude on both axes, plot 6 has the lowest elevation (320 m), and is one of the most southern study areas (32'N), while plot 7 has the highest elevation (709 m), and is one of the most northern study areas (44' N); all other plots were somewhere in-between these two poles. As the study area was located along a short stretch of river running north to south and represented an overall limited landbase (see Figure 3-1), this association of variables is conceivably unavailing if not effectively neutralised.

The positive correlation on both axes between bare-rock (representative of unvegetated soil) and compaction-rock (an index of soil compaction and rockiness) is also of interest. With greater amounts of bare soil, sites tend to have greater soil compaction. This relationship hints at the negative effects cattle ranching has on the area with grazing and trampling compounding each others' disturbance. However, there is a negative correlation on both axes as well; sites with lower herb cover tend to be found at lower elevations along with having reduced microbiotic crusts. This also points to conceivably heavier grazing in the more accessible regions of the lower plains.

In regards to the centrality of plots 1, 2 and 3, the grouping is moderately diffused with plot 2 being the most central of the points. As the distance between points represents an approximate measure of the degree of similarity or difference to each other

(closer points = greater environmental homogeneity), plot 2 serves as an average plot or provisional centroid for the 7 plots in the study; with perhaps plots 4 and 5 being transitional between this central grouping and the previously described, dis-similarities of plots 6 and 7. What is overwhelmingly the most noteworthy manner in which to separate this plot from the others is via the microbiotic crust, bare rock and grazing variables. Although plot 2 cannot be classified as totally undisturbed, being that it is adjacent to a high traffic area (see Table 3.1), it was the only site surveyed that was not currently used for or had a detectable history of grazing. Plot 2 also had by far the highest percent cover of intact microbiotic crust (an average of 70%) as well as the lowest percent cover of bare rock / soil (an average of 9%), which again gives indirect implication as to the possible effects of grazing.

The centrality of plot 2 along with the moderate to high correlation values registered by grazing could be explained in that the grazing variable was categorically and subjectively valued but more likely because grazing was widespread throughout the entire valley, albeit with varying intensity. This leads to the fact that although the other variables mentioned are congruent with the gradient given, the most functional premise to draw out and separate the plots on an environmental basis seems to be in reference to the surrounding effects of grazing.

Table 3.5 NMDS Environmental Output from Graph; Pearson (parametric coefficients of r and r-sq) and Kendall (nonparametric tau) Correlations with Ordination Axes (N= 7); significant rankings have been boldfaced.

Domains	Axis 1			Axis 2		
	r	r-sq	tau	r	r-sq	tau
aspect	.267	.071	.238	-.533	.284	-.238
slope	-.287	.082	-.143	.045	.002	-.048
elevation	-.354	.125	-.238	.998	.997	1.000
lat	-.787	.620	-.586	.654	.427	.488
long	.035	.001	.056	.762	.581	.507
exposure	-.429	.184	-.436	.579	.336	.546
comp-rock	.595	.354	.429	-.265	.070	-.238
pH	-.431	.186	-.048	-.359	.129	-.333
texture	.160	.025	.206	-.066	.004	-.206
colour	.013	.000	-.056	-.253	.064	.282
microcrust	-.705	.496	-.048	.059	.003	.048
barerock	.831	.690	.810	-.593	.352	-.429
shrub	-.229	.052	-.109	.087	.008	.218
herbcover	-.792	.628	-.714	.389	.151	.333
alphadiv	.241	.058	.098	.292	.085	.293
betadiv	-.134	.018	-.195	-.182	.033	-.098
intro-spp	.243	.059	.233	.662	.438	.467
native-spp	.230	.053	.098	.187	.035	.293
grazing	.461	.213	.350	.544	.296	.467

Analysis of *Lewisia rediviva*

The third step in analysis involved quantifying characteristics of *Lewisia rediviva* for each of the seven plots. Figure 3-6 displays the values obtained from the quadrats with maximum *Lewisia rediviva* growth at each plot. As the intention of this analysis was geared towards measuring the harvestable numbers and biomass of the species, seedlings and immature individuals were not included. However, on a purely subjective level, seedlings appeared to be present in equal numbers throughout all the plots. Conversely, among the quadrats within each plot, seedling numbers were more variable because of their tendency to grow in tight clumps.

In general, as with the seedlings, mature *Lewisia rediviva* plants often occurred in clumps. This was especially true in sites that were heavily grazed, as individuals that reached maturity usually did so in clumps under the protection of sagebrush (*Artemisia tridentata*). At times, the more matted of the clumps constituted strikingly large, intertwined growths of two to four, thin individuals.

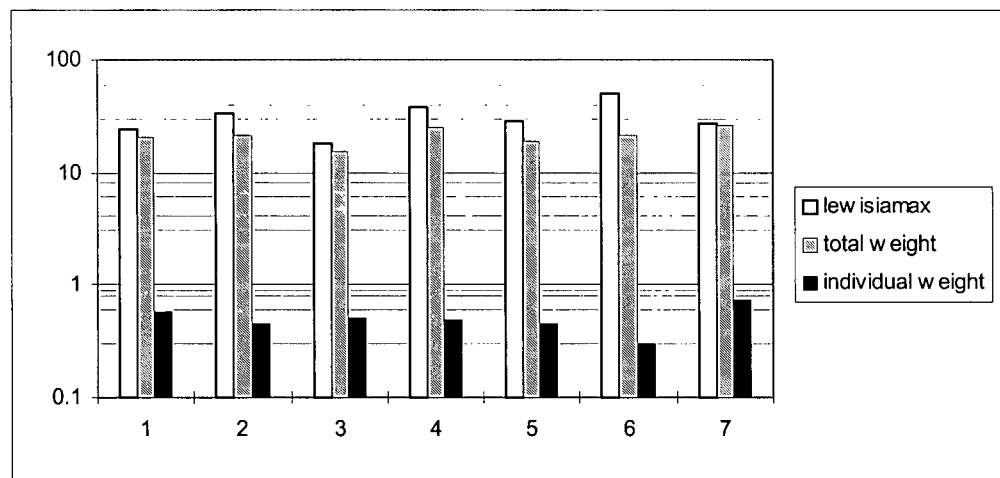


Figure 3-6 Characteristics of *Lewisia rediviva* measured at the seven plots; Y axis is on a logarithmic scaling with weight categories in grams.

Recorded biomass weights among the plots were, on the whole, consistent and evenly proportioned. However, some of the sites did exhibit irregularities, the most noteworthy of which were in plots 6 and 7. These two plots, which were also on opposite poles from each other concerning environmental variables, differed the most in total numbers and individual weights of roots. The differences in root size could be attributed to temperature and moisture conditions during the autumnal growth phase of the plant in the same manner that rosette diameter is dependent (Marvel 1986).¹⁸ Alternatively, root size could be affected by higher light and moisture levels in the vernal season when maximum carbohydrate storage capacities are realised (Marvel 1986). Likewise, in

either case for plots 6 and 7, biomass variability could be induced through a variety of environmental conditions along an elevation gradient; higher elevation being equated to larger root size through greater moisture levels. Apart from the foregoing speculations, there appeared to be little difference in *Lewisia rediviva* characteristics among the seven plots.

3.4 Discussion

The complex structure and dynamics of plant communities, combined with a highly variable 'environmental complex', places very real limitations on any conclusiveness in plant ecology. Despite these limitations, however, this study has identified what may be some of the contributing factors as to the status of bitterroot in the Lower Thompson River Valley. By concentrating on conditions where bitterroot occurred, that is through culturally guided means, a comparative description of population structure and associated habitat features was attained.

It can be expected that with a narrow data set, any ordination method would be constrained drawing out gradients in a manner accurate and meaningful to all the sites, as was particularly true for this information gathered. However, the data gathered at the seven sites were in-depth, and in all probability, may be representative of bitterroot throughout its range. While no strong ecophysiological trends were detected to suggest what optimal growth and reproduction requirements might be for the species at large, the fact that bitterroot grew in highly site specific areas throughout the Valley does point to both micro- and macro-scale limitations to its distribution and abundance. This is also seen in the narrow range of environmental conditions represented, indicating at least an appearance of the species being confined to a particular type of habitat.

¹⁸ Overall, climatic differences between the plots are perceived as slight.

What brought complementary expression to the status of bitterroot was species composition and associations throughout the seven sites. To further these findings and to serve as an intriguing diachronic comparison, Davidson (1916) made some poignant observations of bitterroot populations in the Ashcroft area earlier this century. Although presumably made on a descriptive level, the principal plant species associated with bitterroot were listed as the following (modern binomial equivalents given in brackets were applicable): *Phacelia menziesii* (*P. linearis*), *Triticum glaucum occidentale* (*Agropyron spicatum*), *Erigeron peucophyllus* (*E. linearis*), *Opuntia polycantha borealis* (*O. fragilis*), *Artemisia tridentata* and *Artemisia frigida* (p.135). While all the species listed occurred within quadrats of the present survey (offering some continuity), their overall weight in ordination appeared minimal as compared to species commonly associated with overgrazing (that is, as previously mentioned: *Antennaria dimorpha*, *Poa pratensis*, *Achillea millifolium*, *Lappula redowskii*, *Centaurea diffusa*, *Tragopogon dubius* and *Erigeron compositus*, excluding *Opuntia fragilis* and the association of *Agropyron spicatum* - *Artemisia tridentata*). This leads to an inference that the change in environmental conditions seemingly brought on from continued grazing (in addition to introduced seeding of *Agropyron cristatum*) have altered plant population structure, resulting in a substantially changed vegetation from that described by Davidson nearly 100 years ago.

In summary of variation in the vegetation data, ordination revealed a strong representation of species commonly associated with disturbance and overgrazing; the majority of other species had weak correlations. Comparatively, ordination of the environmental data identified gradients which separated the seven sites primarily by way

of substrate conditions, which may be associated with disturbance and overgrazing (e.g. soil compaction, low microbiotic crust cover). Through indirect means, these two ordinations were linked to the extent that they meshed through gradients thought to be attributed to disturbance. However, in analysis of bitterroot numbers and biomass, the effects of disturbance, and thus overgrazing, did not prove as critical as temperature and moisture requirements found to be related in some degree to local elevation.

Overall, the results of this analysis point to the indication that bitterroot populations in the Lower Thompson River Valley are contained in, and adapted to, a disturbance regime. Species composition, while having some variability within sites, was found to be highly variable between sites. The weak relationship of vegetation and environmental variation found between sites is most likely a direct consequence of historical anthropogenic influences; i.e. bitterroot and its associated vegetation was not able to establish a 'natural', stable order because of sustained human manipulation and intervention. Thus, enduring and identifiable connections could not develop, offering explanation as to why no obvious plant community or environmental gradients could be seen. If associative relationships did occur at one time, they have been severely masked by various kinds and levels of disturbance, be it root harvesting, grazing, or combinations of both.

4.0 Overall Discussion and Conclusions

"God creates. People rearrange"

-Joseph Casey

The relationship between ethnobotany and ecology, or more befitting, the Nlaka'pamux people and bitterroot, is a closely knit but blurred weave of agency and adaptation. The Lower Thompson River Valley is host to an extensive and intensive history of anthropogenic association, making it conceptually difficult if not impossible to differentiate between what are natural and what are humanly engineered environments; locally, they are one and the same. Moreover, philosophical rhetoric may not even allow for a distinction to be made, after all, the centricism of believing humankind is not a part of nature is obvious and myopic. All told, the Lower Thompson River Valley is seen by the Nlaka'pamux as possessing a unique vegetal richness. As contributory to bitterroot, these anthropogenic populations should be seen and approached in the light of co-evolution; this being an evolution articulated in the reciprocal relationship between plants and the people who manage them.

Ethnobotanical Aspects

Anthropogenic plant communities arise near human populations, both in proximity and persuasion. In part, they are ecological niches that show evidence of human involvement and manipulation, being created through these disturbances. In broad terms, tracing the perpetuity of the form and function of plants and their use, Ford (1978) maintains that the theoretical road to domestication is often abbreviated by not recognising the place of anthropogenic plant communities:

“Adherence by a culture to general principle for manipulating vegetation does not preclude the creation of new plant forms or communities. In fact, following rules like ‘take only the part you will

use' is precisely the process which leads to selection for larger leaves or seeds characteristic of domesticated plants (p.251)".

Recent theories as to the origins of proto-agricultural traditions stem from a continuum of people and plant interactions; from simple collecting, to cultivation and modification of plant growth, to full-scale domestication where plant survival is entirely dependant on human input (Cotton 1996). Although conventional agriculture was not traditionally practised by the Nlaka'pamux, modes of plant-food production once perceived as limited to wild foraging are in fact much more complex. In regards to bitterroot, the Nlaka'pamux were not passive and indifferent to its procurement as a plant resource but employed many practices (essentially horticultural) to secure and be active in its maintenance and development. In this manner, the Nlaka'pamux were able to obtain substantial benefit and yield while keeping the intensity of their repair (upkeep contributions) to a minimum. By taking advantage of the combination of natural and artificial selection techniques, bitterroot communities were strengthened and enhanced. Sustainability was achieved by allowing for genetic diversity to be maintained while still acquiring desirable phenotypes.

Although it may be controvertible whether or not aspects of this management were incidental or highly controlled and deliberate, the main point is that it was directed and purposeful. The sustainability of bitterroot and their harvesting sites throughout the Lower Thompson River Valley over hundreds, perhaps thousands of years, denotes that a management system was in place. The bitterroot harvest carried design on both cultural and cultivational fronts. Mythological and ritualistic beliefs as well as traditional concepts of ownership infused a conscience of accountability and responsibility on a personal and corporate level. In many ways this intimacy was crafted and required by the

Nlaka'pamux to ensure not only the species' survival but its long-term prolificacy as well. Timing and scheduling of the harvest was also important and was arranged and established according to a specific stage of bitterroot growth. Harvesting sites at lower elevations along the river contained plants that reached anthesis sooner than those at higher and thus cooler elevations which allowed roughly a two-week window of optimum digging for each site. This harvest practice was low in impact and prevented site over-harvesting while in turn stretching the seasonal harvest over a period of up to eight weeks from population to population.

The physical manner and criteria by which bitterroot was harvested also played a pivotal role in its sustainability. As compared to the harvesting of renewable plant parts (e.g. bark, stems, leaves), roots require special attention because in strict utilitarian terms their harvesting usually requires that the individual plant be destroyed. This presents a danger that over-utilisation could lead to site depletion or even species extinction if conservation measures are not in place (Turner 1981). Although the 'digging' of bitterroot is destructive in nature, it proved to be restorative and even productive in practice. The Nlaka'pamux maintained and enhanced bitterroot populations through harvest techniques that included selective digging (leaving seedlings and immature specimens to continue to grow), tilling of the soil (the use of a digging stick aerated and loosened the soil) and periodic transplantation of root bodies (instituting or enhancing populations at desirable sites).

Ecological Considerations

While the prevalence and richness of ethnobotanical species such as *Erythronium grandiflorum* has in itself contributed to their favourable use among many northern First Nations (Loewen 1998),¹⁹ the local distribution and abundance of bitterroot in the Lower Thompson River Valley may be a direct response to it first being valued as a food. Wide ethnobotanical use of bitterroot is well documented throughout arid regions of western North America -being a much sought after and heavily traded species- and may have propelled the Nlaka'pamux to bolster already occurring populations and possibly adding expediency to the creation of new ones through transplantation.

Within the continental distribution of bitterroot, there seems to be a trend of recession from the southern areas of California combined with a northward-spreading range into the valleys of southern British Columbia. Nlaka'pamux Elders speak of the Lower Thompson River Valley becoming drier all the time, as evidenced by now dry channels that are still named on maps as remnants of creeks and streams. While there is no denying a natural shift of the species into the southern valleys of British Columbia that are slowly becoming warmer and drier, it is arguable as to whether this extension northward was also encouraged by cultural rather than solely environmental, climatic or other natural means.

Phytogeographic change is troublesome to delineate, especially in regards to a heavily used species such as bitterroot. As reported by Wilson et al. (1988), this is the case for many ethnobotanical species, citing Reeve (1980), as encountering "...similar difficulties in assessing cultural vs. natural dispersal in terms of the modern flora of the

¹⁹ See Loewen (1998); ecological research done on the comparably harvested root food, the 'Yellow glacier lily', in many ways confers to the same disturbance regimes as that of bitterroot.

Yellowstone National Park area of Wyoming” (p.521). Although there are no pronounced discontinuities in the local distribution of bitterroot that would suggest human intervention outright, the empirical record of First Nation skill in plant dispersal and transplantation (Compton 1993b) does furnish evidence that what is accepted as the common range of the species may more correctly be its extended range.

Among the Nlaka’pamux, transplanting appears to have been a common practice with a number root foods although maybe not on as an extensive a level as bitterroot. With transplantation being known to have occurred over distances of at least 30 km’s (from Walhachin west to Ashcroft), expertise needed for successful transplantation is explicit; i.e. familiarity with ideal growing conditions and localities as well as phenological development. This can be seen through a variety of comments like, “...it is too rocky and dry and they don’t come out right”, “...they grow best here, but over there it is dry”, or “...now they are growing good because it is damp”. Moreover, incidental means of distribution should also be considered. Saraphine Kirkpatrick shared how Suzanne Magee, while transporting large baskets of bitterroot for transplantation by horse and cart, “...said she was coming across the river (Thompson) and she needed help and it was deep and the horse needed help and it all spilled over, the cart and everything was into the river [laughing].”

Overall, occurrence of bitterroot in the Lower Thompson River Valley is pocketed and site-specific which does coincide with human agency as a possible mode of introduction. Nonetheless, in light of the continental distribution of the species, these pocketed occurrences cannot be considered disjunct; they may be better seen as exemplifying a kind of range extension or ‘pushed dispersal’ at the hands of the

Nlaka'pamux. Adding to the plants conspicuity in the region, cultural dispersal may, in the end, prove to offer more answers than first anticipated. In light of only wind aided dissemination, Daubenmire (1975) states:

“How effective dissemination is accomplished across tracts of inimical habitats can only be judged by the widespread occurrence of the species. A breeze barely strong enough to pick up an average dry leaf would carry a disseminule easily. However, only a rather violent wind could result in dissemination across land supporting an abundance of plants even a decimetre in height, for such vegetation lifts breezes sufficiently above the ground to leave the disseminule trapped indefinitely (p.21).”

Obviously there is no end to possibilities and reasons as to how bitterroot reached its present distribution. As explained by Wilson et al. (1988), “clearly, these questions are of more than local interest, and their ultimate resolution will be of great significance in terms of the phytogeography of western North America” (p.521).

Abundance of bitterroot in the Lower Thompson River Valley is also notable in relation to anthropogenic influences of the Nlaka'pamux. While there are no non-human examples of direct disturbances on bitterroot (such as the case with other root vegetables being dug up by bears for example), there was repeated large-scale disturbance by the Nlaka'pamux through harvesting. Although this did not imitate any known natural disturbances, harvesting may have inadvertently accustomed if not enhanced the species.

It is not hard to see how upturned soil from digging had a positive effect on seed germination especially considering that selective harvesting left some specimens in clumped areas juxtaposed to freshly disturbed substrate; and this was immediately prior to anthesis. Moreover, wind is seen to be the main dissemination agent on local scales for bitterroot, particularly as disseminules can be caught on even the smallest of ridges

(Daubenmire 1975). Upon examination of one harvesting site well into the month of August, disseminules were located on the ground with seeds and calyptra laying beside obvious and recent evidences of digging. For the Nlaka'pamux, as shared by Madeline Lanaro, the exact process is not always known, but the persistence of bitterroot is undeniable; "I don't know how *lhQuoopen* propagates, but I imagine like any other plant, by the seeds. The *lhQuoopen*... seed themselves and just keep growing."

Enhancement of vegetative means of propagation is also highly probable through the harvesting process. Although no studies have been done to quantify the extent of vegetative propagation in bitterroot, it is often the case that the root bodies of fleshy, tuberous geophytes can spread by way of propagules. Moreover, horticultural literature notes bitterroot as the easiest 'lewisia' to grow (provided certain conditions are met) and outlines the relative ease of increasing bitterroot vegetatively through 'notching' and splitting the root-stock and caudex (Mathew 1989). In traditional harvesting methods, root breakage is common as a result of manually using a digging stick; rarely is a bitterroot removed without a lateral or taproot appendage being left in the ground. The viability of plant multiplication through root breakage is also backed by natural, undisturbed multiplication processes. One growth formation found by Daubenmire (1975) exhibited below ground root grafting, while many other specimens were located with lateral roots producing caudices through a manner of sympodial branching:

"Although a plant may continue to have but one caudex as it ages, adventitious buds arising well below the soil surface on thick lateral roots may produce additional caudices that rise to the surface, each bearing a rosette of leaves, with the plant eventually exhibiting several orders of branching (p.15)".

Although untested, another more coincidental means of vegetative propagation may have arisen through the traditional processing of bitterroot. Traditionally, after a days harvest, the 'male' roots were 'de-hearted' on site at the same time as all the roots were peeled. As the 'hearts' of bitterroot are bud-like cores of the following years new growth and traditionally recognised as male 'seeds' capable of propagation, it can be seen that even though these 'hearts' were reportedly disposed of in haphazard fashion, the chance of some of these 'seeds' inadvertently taking root must also be considered.

Assessment of the environmental impacts of long-term root extraction and surrounding maintenance activities are difficult to measure. Ultimately, human induced effects on bitterroot in the Lower Thompson can only be measured and determined by comparing the diachronic behaviour of those populations which are harvested with those that are not. This is because any human influence on a natural environment (in this case root harvesting, their cultivation and propagation) is superimposed upon the natural population dynamics of an area. As Cotton (1996) points out, "...comparative sampling of natural populations and populations which are subject to varying degrees of harvesting intensities must be undertaken in order to investigate the sustainability of different harvesting regimes" (p.361/62). It is recognised that without more systematic research, all environmental change and impact reporting of anthropogenic influences is limited if not speculative.

Developmental Pressures

Since the introduction of cattle ranching in Ashcroft and surrounding areas during the mid 1800's (Wier 1964), substantial disturbances to the vegetation of the Lower Thompson River Valley has taken place. Although the physiognomic appearance of the

rangeland has been retained through grazing, the floristic make-up of the species has been greatly affected. As a traditional management technique, periodic landscape burning selected for and was a benefit to root foods by keeping weedy species at bay. However, with the introduction of cattle ranching, these competing species were now allowed the chance to survive and establish themselves.

This botanical transpiration can in some ways be accounted for morphologically; harvestable 'root foods' were largely geophytic, that is having an energy storing body and shoot apices located below ground. Competing therophytic plants (i.e. grasses) also grow in meadowlands but have their apical meristem tissue above ground where fire can destroy them but where grazing disturbance encourages them. Thus, a lack of burning allowed less palatable grasses and other weedy species a chance to increase or invade at the expense of geophytes and preferred, native, grazing plants such as Bluebunch Wheatgrass. The physiognomy of the Lower Thompson River Valley has remained a grassland primarily because larger plant morphologies have not had an opportunity to establish themselves because of grazing.

However, it is not merely the presence of cattle that concerns the Nlaka'pamux, for as Ruth Peters recalled, "there used to be thousands a head of cattle in Ashcroft, now they don't have as many anymore, not like during the war". Not only is herbivory an issue, but the main concern lies in the effects of localised trampling and overgrazing caused by some ranchers. As related to bitterroot the loss of microbiotic crusts and the compaction of soil is severely damaging. Chief Lesley Edmonds explained:

"*LhQuoopen* is harmed by cattle if they hang out in one area. Years ago the old time ranchers used to move their cattle around everyday so that they don't overgraze. Now people in 4x4's do it but

from a much more casual way; the cattle stay in one area and they trample the ground until it is packed rock hard.”

Compounding the effects of grazing, seeding of the fodder Crested Wheatgrass through the process of discing destroys natural plant communities of which bitterroot can often be apart (and in so doing, appears to be the distinguishing factor that separates the seemingly positive effects of traditional digging disturbance from the seemingly destructive effects of discing, not to mention that discing is only instituted in areas of which the natural plant community is already severely eroded through grazing). The only retribution offered through discing is alleviating future pressure off certain bitterroot harvesting sites. As shared by Chief Robert Pasco, “...it has become a lot better now where the *lhQuoopen* is growing and now doing well; the animals aren’t out there because they are in the seeded area.”

In measuring the detrimental effects of grazing on bitterroot, many Nlaka’pamux have given reference to ‘the way things were’; the roots were bigger and more of them. In the words of Saraphine Kirkpatrick, “...it was not very much long ago and you walk all over and you got to watch where you step cause you might step on it (bitterroot)”. In casual comparison of root body sizes, a voucher specimen collected by Davidson in 1915 from *Schuchem-elch* (U.B.C. Accn #063207), did not visually differ in any way from specimens collected for present vouchers; likely, small differences in size could be recorded from year to year or locality to locality. However, graphic accounts by the Nlaka’pamux as well as Davidson (1916) of past bitterroot abundance is irrefutable and dumbfounding:

“The bitter-root region covers several square miles of open undulating country. The plants are present in the millions; at one point twenty-two plants were counted on one square foot of ground.

Over large areas one finds an average of twelve plants per square foot...(p.135).”

These numbers are not even approached anywhere in the valley at present. The small, localised harvesting areas that remain are few and even they are becoming eroded to the point that many Nlaka’pamux view bitterroot as now locally threatened if not endangered. This erosion has serious implications for continuance of the species throughout the Lower Thompson River Valley. Not only is the environment being slowly degraded and altered, but the cultural fixations upon which it adapted to is also eroding. This could be said of other traditional foods as well.

It should also be mentioned that through traditional territories being pre-empted earlier this century, many harvesting sites, some of the best included, have become the private property of non-Nlaka’pamux people. In one case, the most prominent of areas, commonly referred to as “100-Mile Flats” and known to the Nlaka’pamux as “*Schuchemelch*”, which means “Root-digging house” (Davidson 1916), is now privately owned in its entirety by Ashcroft Ranch; the main digging area is now a winter holding pen for cattle that has utterly destroyed the bitterroot that used to be found there. In other cases, land holders do not allow Nlaka’pamux access to their traditional harvesting sites purportedly for fear that it will provide more incentive and momentum for reclamation of the land. Given the situation, some Nlaka’pamux have resorted to harvesting bitterroot in relatively secret digging sites where they can actively and responsibly conserve the plant along with aspects of culture and tradition surrounding its use.

Ultimately, the threat to bitterroot and other vegetation of the Lower Thompson River Valley is not found solely in ranching nor in its array of cumulative maintenance hazards that include discing. The real threat is in ‘habitat loss’ through development

pressures brought on through urban sprawl such as the 'Wastech' garbage dump, a wood-chip mill, irrigated hayfields or the expansion of tarpaulined ginseng monoculture.

Bitterroot is not an alpine meadow plant that may enjoy temporary isolation from development pressures at least by distance; the localised micro-environments in which bitterroot is found lays close to human habitation and may have been the one of the reasons why humans gathered there in the first place. For the future, bitterroot must be purposefully insulated and accounted for in all natural resource management decisions.

In beholding a population of these plants in flower, one is drawn to the tension found in the delicateness of light pink petals against the often rocky and arduous landscape. For the Nlaka'pamux, it is a picture of balance, a sense of place drawn out like a dance over time. They are the ones who have partaken of the valley's rich volcanic soils a plant whose root body incarnates past generations. How different would bitterroot and surrounding ecologies be valued if everyone affirmed this heritage rather than the pursuit of a narrowly defined sense of wealth? As Chief Leslie Edmonds shared, "if the mighty big wheel of progress doesn't take these things into consideration, it will all be lost...". Bitterroot's long-term sustainability resonates in the fertile traditions of the Nlaka'pamux. Their stewardship will continue to be a rich and innovative source of vegetal and natural resource management for years to come. Living up to the more recent, western scientific name of 'rediviva', it is hoped that with some attentiveness and respect, populations of bitterroot that were once so profound can satisfy its spirited name and 'live again'.

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Appendix I Nli'kesentem, as recorded by Teit (1912, p.297); "obtained from *Nkamtci'nemux*"

When *Nli'kesentem* was ready to be lowered down by the spider and his wife, the latter put four stones in the basket, saying, "Throw one of these stones overboard when you reach each of the four obstacles." She also gave him a present of four articles of clothing, a coat, shirt, leggings, and moccasins of buckskin, and some food to eat on the way, consisting of four bundles of roots which grew plentifully in the upper world. Each bundle was of a different variety (see below).

When *Nli'kesentem* reached the earth, he ran four times with the slack of rope, - twice to the east and twice to the west. He tugged the rope four times, -twice at each quarter; then the spider pulled the basket up. He cached his present of clothes at Lytton, but carried the roots on his back to *Beta'ni* (Botanie). Although he ate of them, they did not decrease in number.

He overtook four old women on the trail, -the Ant, Beetle, etc., and learned from them that his wife, *Lqo'qena* (the teal duck), had been taken by his father. He overtook his other wife, and where he told her to camp, he created a spring which runs at the present day.

When out hunting one day, he was carrying his lunch of roots, as usual, and he felt them heavy. He thought to himself, "These roots are heavy, and do not decrease when I eat them. What shall I do with them?" Then the spiders wife called from the sky, saying, "Throw them on the earth to the people." *Nli'kesentem* took some roots from the bundle containing *tatu'en*, and threw some to the east, saying, "You shall hence forth live on the earth, and grow plentifully in that direction. People will dig you and eat you in great numbers." Then he threw some to each of the other quarters, addressing the roots

in the same fashion. Taking some roots from each of the other bundles, he did the same thing with them. Thus these roots from the sky became plentiful all over the mountains of the earth. Still most of the roots remained in the bundles, so *Nli'kesentem* emptied them out in the *Beta'ni* valley, saying, "You will become very plentiful here, and this place will become a noted root-digging resort." Therefore the *Beta'ni* valleys are celebrated for the great quantity and variety of roots to be found there.

[note: one bundle contained *tatu'en*-roots (Wild Potato or Indian Potato, likely *Claytonia lanceolata*); another bundle consisted of *skametc*-roots (Yellow Adder Tongue Lily, likely *Erythronium grandiflorum*). The roots in the other two bundles are uncertain.]

Appendix II Raw scores of the species matrix; percent cover values of the 38 species in the seven plots used for the ordination

		Venables Valley								
		Quadrats (% cover)								
Species		1a	1b	1c	1d	1e	1f	1g	1h	1i
1) <i>Achillea millefolium</i>		8			3			1.5		
2) <i>Agropyron cristatum</i>				1.5	1.5	2	4.5		4.5	2
3) <i>Agropyron spicatum</i>		2	4							
4) <i>Androsace occidentalis</i>			0.5	0.5	0.5		0.5	0.5		0.5
5) <i>Antennaria dimorpha</i>		0.5	2.5	2	2.5	2	3	35	5	1.5
6) <i>Antennaria umbrinnella</i>										
7) <i>Arabis holboellii</i>		0.5		0.5	0.5	1		1	1.5	0.5
8) <i>Artemisia dracunculus</i>										
9) <i>Artemisia frigida</i>				1	1		1	1	2	2
10) <i>Artemisia tridentata</i>			4	1	1	1	30	1	3	6
11) <i>Astragalus purshii</i>				1		1				1
12) <i>Bromus tectorum</i>										
13) <i>Centaurea diffusa</i>										
14) <i>Centaurea maculosa</i>										
15) <i>Chorisporea tenella</i>										
16) <i>Chrysothamnus nauseosus</i>										
17) <i>Delphinium nuttallianum</i>										
18) <i>Descuriana sophia</i>										
19) <i>Erigeron compositus</i>										
20) <i>Erigeron corymbosus</i>										
21) <i>Erigeron flagellaris</i>		0.5								
22) <i>Erigeron linearis</i>										
23) <i>Erigeron sp.</i>										
24) <i>Erysimum inconspicuum</i>										
25) <i>Fritillaria pudica</i>								1		
26) <i>Guem triflorum</i>										
27) <i>Lappula redowskii</i>										
28) <i>Lewisia rediviva</i>		2	1.5	1.5	0.5	1.5	1	1	1.5	1
29) <i>Lithospermum ruderale</i>							1			
30) <i>Lomatium macrocarpum</i>			0.5		1	2		2.5		
31) <i>Opuntia fragilis</i>		1				1				
32) <i>Opuntia polyocantha</i>										
33) <i>Phacelia linearis</i>										
34) <i>Poa pratensis</i>		3	1.5	1.5	2	1.5	1	2.5	1	1.5
35) <i>Poa secunda</i>								1	1	0.5
36) <i>Sporobolus cryptandrus</i>										
37) <i>Tragopogon dubius</i>							1.5	1		0.5
38) <i>Zigadenus venenosus</i>										
Bare rock/earth		40	30	35	20	50	3	7	40	50
Microbiotic crust		3	17	5	20	1	7	40	15	5
Total herb cover		17.5	14.5	10.5	13.5	13	43.5	49	19.5	17
Number of species		8	7	9	10	9	9	12	8	11
<i>Lewisia rediviva</i> (individuals)		26	17	21	4	19	9	19	17	7

Species	Ashcroft Manor									
	Quadrats (% cover)									
	2a	2b	2c	2d	2e	2f	2g	2h	2i	
1) <i>Achillea millefolium</i>										
2) <i>Agropyron cristatum</i>										
3) <i>Agropyron spicatum</i>			1	1	2.5	8	1			
4) <i>Androsace occidentalis</i>										
5) <i>Antennaria dimorpha</i>	1.5	1	2	0.5	0.5		2.5	1.5	1.5	
6) <i>Antennaria umbrinnella</i>										
7) <i>Arabis holboellii</i>		0.5								
8) <i>Artemisia dracunculus</i>										
9) <i>Artemisia frigida</i>	1	1	1.5	0.5	3					
10) <i>Artemisia tridentata</i>	6	5	4	4.5	14	2	35	20	35	
11) <i>Astragalus purshii</i>										
12) <i>Bromus tectorum</i>										
13) <i>Centaurea diffusa</i>	0.5		0.5					1		
14) <i>Centaurea maculosa</i>										
15) <i>Chorisporea tenella</i>										
16) <i>Chrysothamnus nauseosus</i>					0.5			1		
17) <i>Delphinium nuttallianum</i>										
18) <i>Descuriania sophia</i>										
19) <i>Erigeron compositus</i>										
20) <i>Erigeron corymbosus</i>										
21) <i>Erigeron flagellaris</i>										
22) <i>Erigeron linearis</i>										
23) <i>Erigeron sp.</i>										
24) <i>Erysimum inconspicuum</i>						1.5				
25) <i>Fritillaria pudica</i>				0.5	0.5		0.5	1	1.5	
26) <i>Guem triflorum</i>										
27) <i>Lappula redowskii</i>										
28) <i>Lewisia rediviva</i>	2	0	0.25	0	0.25	0.5	0	0	0.5	
29) <i>Lithospurmum ruderales</i>										
30) <i>Lomatium macrocarpum</i>	1			2.5	3	4	3	2.5	4	
31) <i>Opuntia fragilis</i>										
32) <i>Opuntia polyocantha</i>						3				
33) <i>Phacelia linearis</i>										
34) <i>Poa pratensis</i>	2	6	2.5	2	2	1.5	1.5	1.5	12	
35) <i>Poa secunda</i>										
36) <i>Sporobolus cryptandrus</i>				0.5	0.5					
37) <i>Tragopogon dubius</i>										
38) <i>Zigadenus venenosus</i>										
Bare rock/earth	7	8	15	15	5	2	20	3	7	
Microbiotic crust	75	60	65	70	45	90	60	85	80	
Total herb cover	14	13.5	11.75	12	26.75	20.5	43.5	28.5	54.5	
Number of species	7	5	7	8	10	7	6	7	6	
<i>Lewisia rediviva</i> (individuals)	45	0	3	0	1	2	0	0	3	

Species	Red Hill								
	Quadrats (% cover)								
	3a	3b	3c	3d	3e	3f	3g	3h	3i
1) <i>Achillea millefolium</i>			1		0.5	1.5		2.5	
2) <i>Agropyron cristatum</i>									
3) <i>Agropyron spicatum</i>	7	4	12	17	6	35	27	10	35
4) <i>Androsace occidentalis</i>	0.5	0.5		0.5		0.5			0.5
5) <i>Antennaria dimorpha</i>	2	0.5		1	1.5		3.5	1.5	1
6) <i>Antennaria umbrinnella</i>									2
7) <i>Arabis holboellii</i>	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
8) <i>Artemisia dracunculus</i>									
9) <i>Artemisia frigida</i>	6	3.5	1.5	1	4	1	4	4	2
10) <i>Artemisia tridentata</i>						1	2	1.5	
11) <i>Astragalus purshii</i>	0.5		1	0.5					
12) <i>Bromus tectorum</i>			1					1	
13) <i>Centaurea diffusa</i>									
14) <i>Centaurea maculosa</i>									
15) <i>Chorisporea tenella</i>									
16) <i>Chrysothamnus nauseosus</i>		0.5					0.5		
17) <i>Delphinium nuttallianum</i>									1.5
18) <i>Descuriania sophia</i>									
19) <i>Erigeron compositus</i>									
20) <i>Erigeron corymbosus</i>									
21) <i>Erigeron flagellaris</i>									
22) <i>Erigeron linearis</i>									
23) <i>Erigeron sp.</i>									
24) <i>Erysimum inconspicuum</i>									
25) <i>Fritillaria pudica</i>									
26) <i>Guem triflorum</i>									
27) <i>Lappula redowskii</i>									
28) <i>Lewisia rediviva</i>	1	1	1.5	1	0.5	0.5	1	1	0.5
29) <i>Lithospermum ruderale</i>									
30) <i>Lomatium macrocarpum</i>			1				1		
31) <i>Opuntia fragilis</i>	0.5		1	0.5	1.5			3	
32) <i>Opuntia polyocantha</i>									
33) <i>Phacelia linearis</i>	0.5	0.5	0.5		0.5	0.5	0.5	0.5	
34) <i>Poa pratensis</i>	0.5	0.5		1	1		0.5		
35) <i>Poa secunda</i>									
36) <i>Sporobolus cryptandrus</i>									
37) <i>Tragopogon dubius</i>	1.5	1	0.5				1		1
38) <i>Zigadenus venenosus</i>									
Bare rock/earth	55	60	65	65	4	40	20	55	15
Microbiotic crust	5	4.5	1.5	1	80	4	4	10	8
Total herb cover	20.5	12.5	21.5	23	16	41.5	40.5	25.5	44
Number of species	11	10	11	9	9	9	10	10	9
<i>Lewisia rediviva</i> (individuals)	7	8	17	14	6	10	8	10	4

		Basque Ranch								
		Quadrats (% cover)								
Species		4a	4b	4c	4d	4e	4f	4g	4h	4i
1)	<i>Achillea millefolium</i>									
2)	<i>Agropyron cristatum</i>									
3)	<i>Agropyron spicatum</i>		3	6.5	3	1.5	1.5	2	3.5	2.5
4)	<i>Androsace occidentalis</i>									
5)	<i>Antennaria dimorpha</i>								2	
6)	<i>Antennaria umbrinnella</i>									
7)	<i>Arabis holboellii</i>									
8)	<i>Artemisia dracunculus</i>									
9)	<i>Artemisia frigida</i>									
10)	<i>Artemisia tridentata</i>	1.5	4	3	8	70	5	3	40	3
11)	<i>Astragalus purshii</i>									
12)	<i>Bromus tectorum</i>	0.5		1				6		
13)	<i>Centaurea diffusa</i>									
14)	<i>Centaurea maculosa</i>									
15)	<i>Chorispora tenella</i>									
16)	<i>Chrysothamnus nauseosus</i>									
17)	<i>Delphinium nuttallianum</i>	0.5	1	1.5						1.5
18)	<i>Descuriania sophia</i>		0.5					0.5	0.5	0.5
19)	<i>Erigeron compositus</i>									
20)	<i>Erigeron corymbosus</i>									
21)	<i>Erigeron flagellaris</i>									
22)	<i>Erigeron linearis</i>									
23)	<i>Erigeron sp.</i>									
24)	<i>Erysimum inconspicuum</i>									
25)	<i>Fritillaria pudica</i>		1							0.5
26)	<i>Guem triflorum</i>									
27)	<i>Lappula redowskii</i>									
28)	<i>Lewisia rediviva</i>	0.5	11	1	1	2.5	1	0.5	0.5	0.5
29)	<i>Lithospermum ruderae</i>									
30)	<i>Lomatium macrocarpum</i>	1							3.5	
31)	<i>Opuntia fragilis</i>		1	1	0.5	1.5	0.5		6	3
32)	<i>Opuntia polyocantha</i>									
33)	<i>Phacelia linearis</i>									
34)	<i>Poa pratensis</i>	4.5	3.5	0.5	1.5	3	2.5	1.5	0.5	
35)	<i>Poa secunda</i>									
36)	<i>Sporobolus cryptandrus</i>	1.5		4	1	1.5	1		1.5	1.5
37)	<i>Tragopogon dubius</i>									
38)	<i>Zigadenus venenosus</i>		0.5							1
	Bare rock/earth	55	15	40	65	4	40	60	2.5	30
	Microbiotic crust	3.5	3	2.5	5	1	2	4	1	1
	Total herb cover	10	25.5	18.5	15	80	11.5	13.5	58	14
	Number of species	7	9	8	6	6	6	6	9	9
	<i>Lewisia rediviva</i> (individuals)	5	42	7	7	26	4	1	1	1

		Cornwall Creek								
		Quadrats (% cover)								
Species	5a	5b	5c	5d	5e	5f	5g	5h	5i	
1) <i>Achillea millefolium</i>			1							
2) <i>Agropyron cristatum</i>										
3) <i>Agropyron spicatum</i>				0.5			0.5	2		
4) <i>Androsace occidentalis</i>		0.5	0.5				0.5			
5) <i>Antennaria dimorpha</i>	4	1	1.5	1	1.5	15	2	6	10	
6) <i>Antennaria umbrinnella</i>										
7) <i>Arabis holboellii</i>	0.5	0.5	0.5	1	1	1	0.5	1	0.5	
8) <i>Artemisia dracunculus</i>	0.5									
9) <i>Artemisia frigida</i>										
10) <i>Artemisia tridentata</i>	20	2	35	40	20		3	10	2	
11) <i>Astragalus purshii</i>										
12) <i>Bromus tectorum</i>										
13) <i>Centaurea diffusa</i>										
14) <i>Centaurea maculosa</i>		0.5		0.5			1		0.5	
15) <i>Chorispura tenella</i>										
16) <i>Chrysothamnus nauseosus</i>										
17) <i>Delphinium nuttallianum</i>										
18) <i>Descuriana sophia</i>										
19) <i>Erigeron compositus</i>									1	
20) <i>Erigeron corymbosus</i>										
21) <i>Erigeron flagellaris</i>			0.5							
22) <i>Erigeron linearis</i>		0.5				1	1	1.5	0.5	
23) <i>Erigeron sp.</i>	0.5			0.5						
24) <i>Erysimum inconspicuum</i>										
25) <i>Fritillaria pudica</i>										
26) <i>Guem triflorum</i>		1.5		12						
27) <i>Lappula redowskii</i>										
28) <i>Lewisia rediviva</i>	2	1	1	1.5	1	1.5	2	2	2	
29) <i>Lithospermum ruderale</i>		0.5					0.5			
30) <i>Lomatium macrocarpum</i>	0.5		2	2	1	2	0.5	1	1.5	
31) <i>Opuntia fragilis</i>										
32) <i>Opuntia polyocantha</i>										
33) <i>Phacelia linearis</i>										
34) <i>Poa pratensis</i>	25	20	30	25	20	25	20	20	15	
35) <i>Poa secunda</i>										
36) <i>Sporobolus cryptandrus</i>										
37) <i>Tragopogon dubius</i>	1.5	0.5	1.5	1.5	1	1.5	2	1.5	1	
38) <i>Zigadenus venenosus</i>			1						0.5	
Bare rock/earth	15	15	6	5	15	70	30	10	25	
Microbiotic crust	35	45	70	35	40	20	20	30	20	
Total herb cover	54.5	29.5	73.5	85.5	45.5	47	33.5	45	34.5	
Number of species	9	12	10	11	7	7	12	9	11	
<i>Lewisia rediviva</i> (individuals)	27	23	18	24	12	26	34	37	33	

		Spatsum								
		Quadrats (% cover)								
Species	6a	6b	6c	6d	6e	6f	6g	6h	6i	
1) <i>Achillea millefolium</i>					0.5					
2) <i>Agropyron cristatum</i>										
3) <i>Agropyron spicatum</i>	9	4	3	6	8	10	10	12	3.5	
4) <i>Androsace occidentalis</i>	0.5	0.5	0.5				0.5	0.5	0.5	
5) <i>Antennaria dimorpha</i>		1	1	3	0.5			1.5		
6) <i>Antennaria umbrinnella</i>										
7) <i>Arabis holboellii</i>	0.5	0.5	0.5	0.5	0.5			1	0.5	
8) <i>Artemisia dracunculul</i>										
9) <i>Artemisia frigida</i>										
10) <i>Artemisia tridentata</i>		10								
11) <i>Astragalus purshii</i>	1	0.5				1	1		1	
12) <i>Bromus tectorum</i>			1		1.5	1	1.5	1.5		
13) <i>Centaurea diffusa</i>										
14) <i>Centaurea maculosa</i>										
15) <i>Chorispura tenella</i>										
16) <i>Chrysothamnus nauseosus</i>			20	3				1		
17) <i>Delphinium nuttallianum</i>		1	1				2			
18) <i>Descuriania sophia</i>					0.5		0.5		1.5	
19) <i>Erigeron compositus</i>										
20) <i>Erigeron corymbosus</i>		1								
21) <i>Erigeron flagellaris</i>										
22) <i>Erigeron linearis</i>										
23) <i>Erigeron sp.</i>										
24) <i>Erysimum inconspicuum</i>										
25) <i>Fritillaria pudica</i>									0.5	
26) <i>Guem triflorum</i>										
27) <i>Lappula redowskii</i>				0.5			0.5	0.5	4	
28) <i>Lewisia rediviva</i>	1	0	1	1.5	2	1	3	2.5	4	
29) <i>Lithospurmm ruderale</i>								0.5		
30) <i>Lomatium macrocarpum</i>				1						
31) <i>Opuntia fragilis</i>	1.5				1	1.5	10	4	0.5	
32) <i>Opuntia polyocantha</i>										
33) <i>Phacelia linearis</i>	1	0.5		3.5	3	2	2	1.5	2.5	
34) <i>Poa pratensis</i>	2.5	2	3.5	3	1.5	4	1.5	3.5	2	
35) <i>Poa secunda</i>			0.5							
36) <i>Sporobolus cryptandrus</i>								1	1	
37) <i>Tragopogon dubius</i>										
38) <i>Zigadenus venenosus</i>										
Bare rock/earth	70	25	65	60	40	20	20	40	20	
Microbiotic crust	5	30	5	4	2	4	2	3	4	
Total herb cover	17	21	32	23	20.5	31	23.5	28.5	21.5	
Number of species	8	10	10	10	11	8	9	14	11	
<i>Lewisia rediviva</i> (individuals)	10	0	13	21	25	6	46	39	79	

		Klootchville								
		Quadrats (% cover)								
Species	7a	7b	7c	7d	7e	7f	7g	7h	7i	
1) <i>Achillea millefolium</i>							1.5		1.5	
2) <i>Agropyron cristatum</i>										
3) <i>Agropyron spicatum</i>	7	3	4	6		9	5	8	3	
4) <i>Androsace occidentalis</i>										
5) <i>Antennaria dimorpha</i>	4		1	2	1		1			
6) <i>Antennaria umbrinnella</i>		3						0.5		
7) <i>Arabis holboellii</i>	0.5			0.5			0.5	0.5		
8) <i>Artemisia dracunculus</i>										
9) <i>Artemisia frigida</i>	1		3	10	7	2	4	4	2.5	
10) <i>Artemisia tridentata</i>										
11) <i>Astragalus purshii</i>										
12) <i>Bromus tectorum</i>										
13) <i>Centaurea diffusa</i>						0.5				
14) <i>Centaurea maculosa</i>										
15) <i>Chorisporea tenella</i>									1	
16) <i>Chrysothamnus nauseosus</i>										
17) <i>Delphinium nuttallianum</i>						0.5		0.5	0.5	
18) <i>Descuriana sophia</i>										
19) <i>Erigeron compositus</i>			1.5							
20) <i>Erigeron corymbosus</i>										
21) <i>Erigeron flagellaris</i>	1.5							1.5		
22) <i>Erigeron linearis</i>										
23) <i>Erigeron sp.</i>				0.5	1					
24) <i>Erysimum inconspicuum</i>										
25) <i>Fritillaria pudica</i>		0.5	1	0.5			0.5	0.5	1	
26) <i>Guem triflorum</i>										
27) <i>Lappula redowskii</i>	0.5	0.5	1.5	1	1	1	1	1	1	
28) <i>Lewisia rediviva</i>	1.5	1	0.5	2	2.5	0.5	3	2.5	1	
29) <i>Lithospermum ruderales</i>		2								
30) <i>Lomatium macrocarpum</i>	7	5	4	7	8	10	5	8		
31) <i>Opuntia fragilis</i>	1			1			1.5	1.5	0.5	
32) <i>Opuntia polyocantha</i>										
33) <i>Phacelia linearis</i>										
34) <i>Poa pratensis</i>	4	2	15	4	6	4	3	4	6	
35) <i>Poa secunda</i>										
36) <i>Sporobolus cryptandrus</i>										
37) <i>Tragopogon dubius</i>	3	2	1		2	2		1	1.5	
38) <i>Zigadenus venenosus</i>		0.5			1.5	1.5	1	0.5		
Bare rock/earth	45	20	10	5	10	5	6	10	6	
Microbiotic crust	1	3	2	1	1	1	1	0.5	2	
Total herb cover	31	19.5	32.5	34.5	30	31	27	34	19.5	
Number of species	11	10	10	11	9	10	12	14	11	
<i>Lewisia rediviva</i> (individuals)	12	6	5	26	29	5	34	33	9	

Appendix III Raw scores of the environmental matrix; not all values were used for the ordination

Environmental Domains	Plot Sites						
	Venables Valley	Ashcroft Manor	Red Hill	Basque Ranch	Cornwall Creek	Spatsum	Klootchville
landforms							
aspect (degrees)	327	352	72	108	328	218	97
slope angle (degrees)	4	1	6	18	24	9	8
Lat(50) & Long.(121)	34°N - 19°W	43°N - 19°W	38°N - 21°W	38°N - 19°W	44°N - 19°W	32°N - 17°W	42°N - 22°W
climate							
elevation (m)	511	481	465	373	610	320	709
exposure	full direct sun	full direct sun	partial shade	sloped; full sun	stp. slope; full sun	partial shade	full direct sun
vegetation types							
height of vegetation	large sagebrush	low sagebrush	bunchgrass	bunchgrass	large sagebrush	low sagebrush	bunchgrass
biogeoclimatic zone	BG xh2	BG xh2	BG xw	BG xh2	BG xw	BG xh2	BG xw
subzone variant	very dry hot	very dry hot	very dry warm	very dry hot	very dry warm	very dry hot	very dry warm
soils							
depth (10 probe average)	8.8 cm	9.25 cm	5.3 cm	11.2 cm	18.5 cm	3.95 cm	6.1 cm
pH #1	6.93	8.15	7.12	7.71	6.64	7.02	7.16
pH #2	6.96	7.76	7.1	7.75	6.82	7.11	6.98
pH #3	7.06	7.6	7.16	7.37	7.44	7.05	7.03
pH average	6.99	7.84	7.13	7.61	6.97	7.06	7.06
texture	sandy loam	loamy sand	loamy sand	clay loam	sandy clay loam	sandy loam	sandy clay loam
colour	dk. grayish brown	grayish brown	grayish brown	dark brown	dk. grayish brown	grayish brown	dk. grayish brown
hue	10YR	10 YR	10 YR	10 YR	10 YR	10 YR	10 YR
value	value 4	value 5	value 5	value 3	value 4	value 5	value 4
chroma	chroma 2	chroma 2	chroma 2	chroma 3	chroma 2	chroma 2	chroma 2
<i>Lewisia rediviva</i>							
population area	2-3 ha	0.5-1 ha	0.5 ha	0.5-1.0 ha	1 ha	10 ha	1-2 ha
max. number in 1X1m.	24	34	18	38	28	51	27
total dry weight (roots)	20.169g	21.652g	15.431g	24.747g	18.580g	21.697g	25.922g
net dry weight (roots)	0.5824 g	0.4547g	0.5133 g	0.4883g	0.4425g	0.3041g	0.7307g
human management							
title	crown	reserve	private	reserve	reserve	reserve	private
use/disturbance	heavy grazing	vacant	heavy grazing	light grazing	heavy grazing	light grazing	heavy grazing

Appendix IV List of all taxa discussed in the text or present in one of the seven survey sites of *Lewisia rediviva*; left column gives scientific binomial (alphabetically arranged) and author, right column gives common English name as well as previously referenced Nlaka'pamux names in italics

Scientific name	Common name
<i>Achillea millefolium</i> L.	Yarrow
<i>Agropyron cristatum</i> (L.) Gaertn.	Crested Wheat Grass
<i>Agropyron spicatum</i> (Pursh) Scribn. & Smith	Bluebunch Wheat Grass
<i>Amelanchier alnifolia</i> Nutt.	Saskatoon, Serviceberry
<i>Androsace occidentalis</i> Pursh	Western Fairy-candelabra
<i>Antennaria dimorpha</i> (Nutt.) T. & G.	Low Pussy-toes
<i>Antennaria umbrinella</i> Rydb.	Umber Pussy-toes
<i>Arabis holboellii</i> Hornem.	Holboell's Rockcress
<i>Artemisia dracunculus</i> L.	Tarragon
<i>Artemisia frigida</i> Willd.	Pasture Sage
<i>Artemisia tridentata</i> Nutt.	Big Sagebrush
<i>Astragalus purshii</i> Dougl.	Woollypod Milk-vetch
<i>Betula</i> L.	Birch
<i>Bromus tectorum</i> L.	Cheat Grass
<i>Balsamorhiza sagittata</i> (Pursh) Nutt.	Balsamroot; <i>shchAquem</i>
<i>Centaurea diffusa</i> Lam.	Tumble Knapweed
<i>Centaurea maculosa</i> Lam.	Spotted Knapweed
<i>Chorispora tenella</i> (Pall.) DC.	Chorispora, Blue Mustard
<i>Claytonia lanceolata</i> Pursh	Western Spring Beauty
<i>Chrysothamnus nauseosus</i> (Pall.) Britt.	Common Rabbitbrush
<i>Delphinium nuttallianum</i> Pritz.	Upland Larkspur
<i>Descuriana sophia</i> (L.) Webb	Flixweed
<i>Erigeron compositus</i> Pursh	Cut-leaved Daisy
<i>Erigeron corymbosus</i> Nutt.	Long-leaved Daisy
<i>Erigeron flagellaris</i> Gray	Trailing Daisy
<i>Erigeron linearis</i> (Hook.) Piper	Fine-leaved Daisy
<i>Erysimum inconspicuum</i> (Wats.) MacM.	Small Wallflower
<i>Erythronium grandiflorum</i> Pursh	Yellow Glacier Lily
<i>Frittilaria pudica</i> (Pursh) Spreng.	Yellow Bells
<i>Geum triflorum</i> Pursh	Old Man's Whiskers
<i>Lappula redowskii</i> (Hornem.) Greene	Western Stickseed
<i>Lewisia columbiana</i> (Howell) Robins.	Columbia Lewisia
<i>Lewisia pygmaea</i> (Gray) Robins.	Alpine Lewisia
<i>Lewisia rediviva</i> Pursh	Bitterroot; <i>lhQuoopen</i>
<i>Listera</i> R. Br.	Twayblade
<i>Lithospermum ruderale</i> Dougl.	Lemonweed
<i>Lomatium dissectum</i> (Nutt.) Math. & Const.	Fern-leaved Desert-parsley
<i>Lomatium macrocarpum</i> (Nutt.) Coult. & Rose	Large-fruited Desert-parsley

<i>Montia perfoliata</i> (Donn) Howell	Miner's-lettuce
<i>Montia sibirica</i> (L.) Howell	Siberian Miner's-lettuce
<i>Opuntia fragilis</i> (Nutt.) Haw.	Brittle Prickly-pear Cactus
<i>Opuntia polyocantha</i> Haw.	Plains Prickly-pear Cactus
<i>Panax</i> L.	Ginseng
<i>Phacelia linearis</i> (Pursh) Holz.	Threadleaf Phacelia
<i>Pinus ponderosa</i> Dougl.	Ponderosa Pine
<i>Poa pratensis</i> L.	Kentucky Bluegrass
<i>Poa secunda</i> J.S. Presl in C.B. Presl	Sandberg Bluegrass
<i>Prunus virginiana</i> L.	Comon Chokecherry
<i>Rhamnus purshiana</i> DC.	Cascara
<i>Sporobolus cryptandrus</i> (Torr.) Gray	Sand Dropseed
<i>Syringa vulgaris</i> L.	Common Lilac
<i>Talinum</i> Adans.	Fameflower
<i>Tragopogon dubius</i> Scop.	Yellow Salsify
<i>Zigadenus venenosus</i> Wats.	Death-camas
