

Cultivating the **təkillak^w**, the ethnoecology of **ləkseḿ**, Pacific silverweed or cinquefoil
[*Argentina egedii* (Wormsk.) Rydb.; Rosaceae]: lessons from K^waxsistalla, Clan Chief Adam
Dick, of the **Qawadiliqəlla** Clan of the **D^zawadaʔənux^w** of Kingcome Inlet
(**K^wak^waka^wwak^w**)

by

T. Abe Lloyd
B.Sc., Northland College, 2002

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

MASTERS OF SCIENCE

in the School of Environmental Studies

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Cultivating the **təkkillak**^w, the ethnoecology of **ləksəm**, Pacific silverweed or cinquefoil
[*Argentina egedii* (Wormsk.) Rydb.; Rosaceae]: lessons from K^waxsistalla, Clan Chief Adam
Dick, of the **Qawadiliqəlla** Clan of the **D^zawadaʔənux**^w of Kingcome Inlet
(K^wak^waka'wak^w)

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T. Abe Lloyd
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Supervisory Committee

Supervisor

Dr. Nancy J. Turner, School of Environmental Studies, University of Victoria

Departmental Member

Dr. Douglas Deur, School of Environmental Studies, University of Victoria

Abstract

Supervisory Committee

Supervisor

Dr. Nancy J. Turner, School of Environmental Studies, University of Victoria

Departmental Member

Dr. Douglas Deur, School of Environmental Studies, University of Victoria

This thesis focuses on the traditional cultivation of an edible root species by K^waxistalla, Clan Chief Adam Dick, of the **Qawadiliqalla** Clan, of the **D^zawada ēnux^w**, a subgroup of K^wak^waka^wak^w, occupying the Kingcome Inlet area on the Central Coast of British Columbia. K^waxistalla is a traditionally trained Clan Chief and potlatch speaker with recognized authority to share his detailed knowledge and experiences of his clan's food production system. This research is centered on his Clan's **təkillak^w** (estuarine salt marsh root garden) root gardens of the Kingcome River estuary, and the long-standing practices associated with the large-scale production of **ləkseḿ**

Pacific silverweed [*Argentina egedii* (Wormsk.) Rydb.; syn. *Potentilla pacifica* (L.) Howell.], is one of the four cultivated root species. K^waxistalla has shared his hands-on knowledge of how root garden cultivation fits into his family's seasonal patterns of food production as well as detailed accounts of how to construct and use tools for cultivating, weeding, harvesting, and cooking estuarine roots. He has also provided information that has been instrumental in developing a model of aboriginal management of estuarine root gardens (Deur 2005). This thesis builds on Deur's model by attempting to experimentally replicate **təkillak^w** management in order to better understand the management effect on the abundance, size, and flavour of *Argentina egedii* roots. Over the course of the 2008 growing season I randomly subjected 60 ¼ square meter patches of K^waxistalla's fallow **təkillak^w** to either a "till" or "till + weed" treatment and allocated 30 similar patches as a control. I applied a roto-tilling treatment just prior to the growing season, a weeding treatment mid-summer, and harvested the roots near the end of the growing season. While the short duration of my study and use of a roto-tiller limit the inferential power of my results, I found that tilling and weeding significantly increased the abundance of *A. egedii* but significantly decreased the root size. Throughout the same 2008 field season I also collected root specimens for analysis of their bitter and sweet constituents and found (bitter) tannins concentrations to be highest in the late summer and lowest in the spring and fall.

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¹**tekillak**: Estuarine salt marsh root garden. Literally "place of manufactured soil." Term provided by AD, orthography by DSS, translation by both AD and DSS.

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Chapter 1. From the Mouth of a Great River

1.1. Background

For over a century, anthropologists struggled to understand the anomalous nature of the Northwest Coast Indigenous “hunter-gatherers,” because these people had socially complex and semi-sedentary societies yet evidently without the benefit of agriculture. Their unique status was commonly rationalized by the apparent abundance of salmon and other marine food resources, which were so prolific that they could be obtained with seemingly little effort. The characterization of these people as hunter-gatherers had significant consequences in terms of the history of settler Canadian-First Peoples relations, primarily in the form of non-treaty land seizures, which were based on the colonial government’s erroneous understanding that the land they were appropriating was not being cultivated or “used” and therefore available for settlement and exploitation (Deur 2000; Deur and Turner 2005).

In light of the growing evidence reflected by K^waxistalla’s *tokkillak* gardens, recent scholarship has challenged the “hunter-gatherer” paradigm by exposing the intensive nature of many Aboriginal resource management systems that are akin to agriculture (Deur 2000; Deur and Turner 2005). K^waxistalla, Clan Chief Adam Dick was kept out of residential school and rigorously trained as a cultural reservoir by his clan and the noble knowledge keepers of the early 1900s. As Clan Chief, he has not only the knowledge and training, but the ancestral authority and responsibility for managing his clan’s territories sustainably. He has served as the primary source in a number of publications highlighting K^wak^waka’wak^w traditional ecological knowledge and stewardship practices (Deur 2000 and 2002; Turner 2005; Turner and Turner 2008; Bouchard and Kennedy 2002; Cullis-Suzuki 2007), including a seminal volume entitled *Keeping it Living*, which compiles numerous case studies and provides a new conceptual framework for understanding Aboriginal plant use and cultivation on the Northwest Coast of North America (Deur and Turner 2005).

K^waxistalla's contribution to the new understanding of intensive resource management on the Northwest Coast of North America is well situated among a growing body of literature classified as *Traditional Resource and Environmental Management* (TREM; Lepofsky 2009). TREM scholars attempt to understand the frequency and intensity of aboriginal management systems at a variety of scales, ranging from the entire landscape down to the individual organism (Anderson 2005), and pay particular attention to how management systems are embedded in each culture's world-view (Lertzman 2009).

1.2. Methods

Food, and the human behaviors involved in attaining it, can be studied from a variety of perspectives. A cultural lens reveals to the anthropologist the connections between food and other facets of culture such as language and religion. An environmental lens shows the ecologist the connections of food systems to the living and nonliving things associated with any particular food item or human management decision. In the study of ethnoecology, these two lenses must be used in tandem, to understand complex cultural and ecological relationships that surround food (Cullis-Suzuki 2007). This thesis embraces the stereoscopic approach of ethnoecology to examine the **D^zawada?enux^w** management of Pacific silverweed. Over the course of my thesis research, I simultaneously endeavored to embrace a participatory, indigenous method of learning about how an estuarine salt marsh root garden was managed, and a western/scientific experimental method to test the effect of indigenous management on the productivity and palatability of Pacific silverweed.

The combination of both Indigenous and scientific modes of inquiry is not novel to this thesis, but has been practiced by many ethnobiologists and ethnoecologists, including a number of Dr. Turner's graduate students (Pukonen 2007, Cullis-Suzuki 2007, and others). One primary example is the work of the Scientific Panel for Sustainable Forest Practices in Clayoquot Sound, whose membership included both Nuu-Chah-Nulth elders and forest scientists (Lertzman 2010). By drawing from the "best of both worlds", the Scientific Panel was able to develop the revolutionary Ecosystem Based Management

silvicultural system (Lertzman 2010). After extensive interviews with the Scientific Panel members, Lertzman and Vrendenburg (2005) identified several critical variables that made the process successful, including: (1) reliance on respected knowledge holders, (2) the use of bi-cultural specialists, or people from one culture that could that communicate meaningfully with the other culture, and (3) the adoption of Nuu-Chah-Nulth cultural protocols by all of the panel members. My study of the **təkkillak**^w mirrored these recommendations.

It is important to acknowledge that my research originated from an invitation that K^waxistalla, Clan Chief Adam Dick extended to Dr. Nancy Turner to continue the study of his **təkkillak**^w. K^waxistalla recognized that he was the only person left who was trained as an **ʔuḡ^wamey**² (Clan Chief) to know how the **təkkillak**^w worked and who learned about it firsthand as a child, following the practices and instructions of his grandmother, his Clan Chief mother and the Clan Chiefs who rigourously trained him. When I enrolled as a master's student with Dr. Turner, I took on this project under the direction of K^waxistalla, who is a Clan Chief with ancestral jurisdiction over my study site and has a strong interest in the documentation and potential revitalization of important indigenous food traditions (see Chapter 2).

Much to my delight, I found that I had not only enrolled in the University of Victoria, but also in "Adam's School." As a student of Adam's School, I was supported by the vast knowledge and experience of the "**Ninoḡad** Collective". K^waxistalla, Clan Chief Adam Dick and Mayaniḡ³, Dr. Daisy Sewid Smith who are both recognized **Ninoḡad**³ (knowledgable ones) invited Chief George Shaughnessy, Max^wəd^{zi}; and Og^wilowḡ^wa, Kim Recalma-Clutesi more than 20 years ago to join their specialized team and be trained in

² **ʔuḡ^wamey**: Clan Chief. Term provided by AD, orthography by DSS, translation by both AD and DSS.

³ **Ninoḡad**: Knowledgable ones. This modern working definition was developed by K^waxistalla and Mayaniḡ³ at the request of the Nuyumbalees Society, the first Society formed in Canada to build a Museum to house repatriated artifacts confiscated during the 70 years of anti Potlatch Laws. Prior to K^waxistalla's birth only nobility were allowed to be trained and the term **noḡad** (singular) in times past automatically referred to a person who had been well lectured and trained traditionally and had the nobility right to be trained in all aspects of the culture and TEK. In the late nineteenth century, the Potlatch was banned under law and children removed from families across Canada and placed in residential schools where they were forbidden to speak their language for 3-4 generations. The term "knowledgable ones" took on a new meaning after the anti potlatch laws were lifted with so few trained nobility left. It was necessary to be concise with the meaning since being knowledgable assumed western roles.

gender specific traditional roles. The **Nínogad** Collective supported K^waxistalla as a Clan Chief and were instructed by him to host me, cook for me, translate for me, endlessly explain and demonstrate things to me, and organize for me to be named by his Clan—at his son’s induction as the the Clan Chief of the **Cík^waxallis** Clan in 2008—and to correct me culturally if K^waxistalla felt it was required. Little did I know that after my initial meeting with the **Nínogad** Collective, K^waxistalla had actually organized for the **Nínogad** Collective to be my liaison to the knowledge I sought for this thesis and to him as a Clan Chief (Kim Recalma-Clutesi, pers. comm.), something I have come to understand would have never happened a few decades ago.



Figure 1.4. Two of the **Nínogad** Collective at the Ceremonial Big House at RBCM, Victoria, BC. Left to Right: Sam Dawson in **ʔakéʔeyma**⁴ Grouse Mask; K^waxistalla, Clan Chief Adam Dick; Max^wə dʔI, Clan Chief George Shaughnessy. Photograph taken by Kim Recalma-Clutesi in 2006, and used with her permission.

⁴ **ʔakéʔeyma**: Spirit of the Forest. Term provided by AD, orthography by DSS, translation by both AD and DSS.

I had the honour and privilege of an introduction to an entire community of Kwakwaka'wakw at Kingcome Inlet, but with this came a deep responsibility to learn and understand to the best of my ability the teachings and protocols of Kwaxistalla. I was not alone in Adam's School, but joined a growing group of scholars and students in a number of fields studying other elements of the seasonal round, and a large group of Kwakwaka'wakw people working to learn about and practice their culture.

The School of Adam became the focal point of my ethnographic research, which I have situated within a master-apprentice methodology. The master-apprentice model for learning is as straightforward as the name implies and has been used broadly throughout history as a technique for training new generations of practitioners in a particular skill or suite of skills and the associated protocols and applications. This approach prescribes for the pairing of a master, usually an older person who has perfected a skill and its related knowledge, with an inexperienced, usually younger person, who desires to learn the skill and gain the knowledge, and is willing to offer labour and potentially a period of future labours in exchange for the learning. This model is powerful because it essentially copies innate patterns of experiential learning. For example, children learn to speak by practicing around fluent speakers, and farmers pass on their skills by assigning increasingly difficult chores to their children. The Kwakwaka'wakw similarly embraced master-apprentice learning⁵, as was evident in Kwaxistalla's learning of the seasonal round with his grandparents, learning to fish with his father, and learning to manage the 'tekillak' with his mother (Chapter 2).

When I arrived on Kwaxistalla's doorstep with a list of questions, some of them ridiculously academic, he was quick to say that he couldn't teach me like that. Instead, he would teach me by

⁵ While the master apprentice model was used to transmit knowledge generationally, specialized knowledge like that connected with a Clan Chief's obligations to be a resource steward and cultural specialist, etc., was all passed down in a very strict manner to only those who were chosen by knowledge holders from amongst the nobility. Multifaceted selection criteria were used to choose an appropriate candidate to be trained and few finished the training. For this reason the **Ninoḡad** Collective was called in to monitor, scrutinize and assist Kwaxistalla in sharing knowledge with me, a graduate student who is neither of the nobility or even a commoner in Kwaxistalla's clan, and why decisions were made in a dynamic way about how far to extend the knowledge. While the model can be loosely referred to as a traditional way to learn generationally from Kwaxistalla, he employed traditional techniques to scrutinize and adjust the way I received knowledge (Mayaniŋ?, Dr. Daisy Sewid-Smith, pers. comm.).

showing me—taking me out on the land—and doing it together. With my first attempt at an interview turned on its head, I quickly fell into the role of an apprentice. Following the master-apprentice model, I began to trade my labour for his instruction. As his apprentice, I no longer had absolute control over my own learning, but learned what he thought necessary at a rate he determined appropriate, and was taught using a methodology that he was accustomed to. To that end, I learned about other important stages of the seasonal round, songs, **nuyem**⁶ (mythical stories) and important mores that provided the necessary context for understanding the **təkillak**^w. One of our first master-apprentice tasks was to make a yew wood digging stick so that I could harvest roots from K^waxistalla's **təkillak**^w. This process is covered in more detail in the following chapter on **təkillak**^w tools. After some time comprised of hands-on learning from K^waxistalla, he became more receptive to participating in semi-structured interviews. With his permission, I documented his teachings with field notes, photographs, audio, and occasionally I borrowed ?Og^wilowg^wa's video camera to record in that format.

The methods that I used for the western scientific side of my research attempted to experimentally replicate a simplified version of traditional **təkillak**^w management in order to quantitatively test a model of intensive management proposed by Deur (2000, 2002, 2005; Deur and Turner 2005) and Nancy Turner (2005). Deur and Turner worked closely with K^waxistalla to more fully understand the intensive use of the **təkillak**^w through analysis of ethnological accounts, physical evidence of estuarine gardens – including soil characteristics – preserved in the archaeological record, and specialized terminology associated with these gardens and their management. My goal was to build on that work by investigating in more detail, through experimental means, the relationships between the **təkillak**^w management practices and the growth patterns and seasonal development of the edible root species, particularly **ləksem**,⁷ Pacific silverweed. My hypothesis was that intensive

⁶ **Nuyem**: Mythical stories. Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁷ **ləksem**: Pacific silverweed (*Argentina egedii*; syn. *Potentilla pacifica*). Term provided by AD, orthography by DSS, translation by both AD and DSS.

management, particularly tilling and weeding, would increase the productivity of *A. egedii* roots, which I tested with replicated and randomized “till” and “till + weed” treatments in a portion of K^waxistalla’s long fallow ^{tekkillak} over the course of just one growing season. Unfortunately the long fallow period prior to my experimentation was a major confounding variable in the research, and the only practical way to break the dense turf and to restart the ^{tekkillak} management process, was to use a rototiller. This presented complications which will be explained in more detail later in this thesis.

1.3. Organization and Scope of this Thesis

In the remainder of this chapter, I define some important terminology that is used throughout this thesis, and provide an overview of the people and plants relevant to this thesis, as well as the ethnological accounts of the ^{tekkillak}. Chapter 2 presents key aspects of the life-story of K^waxistalla, Clan Chief Adam Dick, whose knowledge and support have been fundamental to my work. K^waxistalla’s life-story is inextricably connected to K^wak^waka’wak^w resource management practices. K^waxistalla’s protection from western schooling at a time when most of his contemporaries were forced to attend residential school, and his unique training as a Clan Chief and caretaker of his clan’s lands and waters, have made him especially knowledgeable about the ^{tekkillak}. Because of his unique history and position, he has become a “cultural refugium” (Garibaldi and Turner 2004); his expertise, authority, and commitment to maintaining his cultural traditions and fulfilling his obligations to his people and his territory have resulted in an ongoing revitalization of interest in the ^{tekkillak} and other traditional management systems such as the ^{lux̄ xiwēy},⁸ or clam gardens, and native berry gardens (Szimanski 2005; Deur and Turner 2005). I also use K^waxistalla’s biography as a means of demonstrating how

⁸ ^{lux̄ xiwēy}: A clam garden, or culturally modified beach, where rocks were rolled down the beach to the low water line and carefully engineered into a back-filled terrace that improved clam habitat and enhanced clam productivity. Term provided by AD, orthography by DSS, translation by both AD and DSS.

K^wak^waka'wak^w resource management practices were situated in time, space, culture, and the environment—a phenomenon described concisely by anthropologists as “the seasonal round.”⁹

Next, in Chapter 3, I explore the tools used in association with the **təkillak^w** as a means to understand their cultural value and illustrate how the **təkillak^w** was managed. Then, in Chapter 4, I describe my use of a quantitative experimental method to test a simplified model of **təkillak^w** management and discuss how I have come to understand the ecological mechanisms of garden management and how they are important to sustaining healthy yields of one of the edible estuarine salt marsh roots: Pacific silverweed (*Argentina egedii*; syn. *Potentilla pacifica*), called **ləksəm** in the **K^wak'wala** language of the K^wak^waka'wak^w. Finally, in Chapter 5, I examine factors that influence taste, with the goal of ensuring that people involved in revitalizing the **təkillak^w** are able to taste the roots as they were originally produced.

While the inferential power of my experiments may be limited due to the short-term nature of the study, and the use of some modern tools—rather than traditional tools—my experiment was able to tentatively identify several autecological factors of *A. egedii* that influenced cultural practices including: (1) the ability of *A. egedii* to vigorously regenerate from root fragments; (2) the ability of weeding to increase *A. egedii* root abundance, length and thickness; (3) the seasonal fluctuations of bitter-tasting tannins in *A. egedii* that influence its palatability; and (4) the ability of storage to further decrease tannin levels in *A. egedii* roots. Many of these findings warrant longer-term study, and in the few instances where my limited results appear to contradict K^waxistalla's traditional ecological knowledge, his rigorous training as a Clan Chief and resource steward, which draws on countless generations of first-hand experience, should by all means trump my single growing season of scientific research.

⁹ The seasonal round is a major element of the lifeways of the K^wak^waka'wak^w and other Indigenous Peoples of northwestern North America, in which people travel through their territories throughout the spring, summer and fall to access and process the different resources – clams, oulachens, salmon, berries, and roots – as these become available for harvesting at particular sites.

1.4. Terms Used in this Thesis

Traditional Ecological Knowledge (TEK)

Throughout this thesis I rely on the phrase traditional ecological knowledge (TEK), which can be defined as “a cumulative body of knowledge, practice and belief evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment (Berkes 2008, p. 7).” While I use Berkes’s definition, he illustrates in his earlier work that there is no consensus on the definition of the term (Berkes 1993). Some aboriginal scholars believe that the very need to define TEK is rooted in a colonial need to categorize and control (Lertzman 2010), but many aboriginal scholars find the term empowers and gives authority to their ways of knowing (Turner *et al.* 2000). Berkes’ definition of TEK works well within the context of the **D’awada?ēnux^w** clans, with the caveat that their traditional hierarchical social structure privileged the transmission of some TEK exclusively upon apprentices within a variety of cultural institutions such as the clan, secret society, **pessa** investment society (see chapter 2), and in the case of this thesis, potlatch speaker and Clan Chief (Mayaniŋ?, Dr. Daisy Sewid-Smith, pers. comm.). In this thesis the estuarine salt marsh serves as the nexus point for TEK, ranging from the spheres of the natural environment (such as where, when, and which edible roots were managed and harvested) to the cultural environment (such as **nuyem** and songs about edible salt marsh roots and the cultural, spiritual, and ceremonial aspects of their use).

The D’awada?ēnux^w of the K^wak^waka’wak^w

The **D’awada?ēnux^w** are one of approximately 20 tribes. These tribes are recently known collectively as the K^wak^waka’wak^w (formerly Kwagiulth),¹⁰ and located on the north end of Vancouver Island, the Broughton Archipelago, and the surrounding coast of mainland British Columbia (Figure 1.1.

¹⁰ Many early scholars and government officials erroneously used the term for the village site in Fort Rupert, the Kwagiulth (or Kwakiutl) as the term for the entire Nation (Duff 1965).

The K^wak^waka'wak^w people share the common language of K^wak'wala/ Lig^wala (Wakashan language family), with nine regional dialects (Sewid-Smith 1992, p. 8). Other universal features of K^wak^waka'wak^w culture include large dugout cedar travelling canoes, extended family “bighouse” wintertime residences of cedar, a complex marine based economy, and a clan social structure organized around the Potlatch (see chapter 2; Boas 1966; Suttles 1990; Lertman, D. pers. comm.). The **D^zawada?ēnux^w** tribe was originally made up of an alliance of five Clans whose first ancestors and place of descent were different. The first Clan was **Qawadiliqalla** or Wolf Clan whose place of descent after the flood was **ʔug^wwxtollis** (Mountain) and first ancestor was **Qawadiliqalla**. The current Clan Chief is K^waxistalla, Adam Dick. The other Clans that still have living decendents today are the **Cik^ʔk^waʔallis** or Bird Clan, whose place of descent after the flood was **Galudda** (Mountain) and first ancestor was named **Qix^ʔallaʔallis**. The **Lillawagilla** or Raven Clan’s First Ancestor, **Lawagilla**, came down at **Homsdamma** Mountain in the Kingcome Valley after the flood waters receded. The **Nin^ʔkinux^w** or the Mountain Goat Clan’s place of descent after the flood for its first ancestor, **Wiq^ʔellasug^wilak^w**, was **Ləʔlaq**. The fifth Clan, **Həlxaboy**, has no living descendants, so the Clan no longer exists (K^waxistalla, Clan Chief Adam Dick pers. comm.).

The Clan Alliance of the **D^zawada?ēnux^w** tribe’s historic territory is located in what is now known as the central mainland coast of British Columbia, including all of the Kingcome River watershed and much of the Kingcome Inlet, and parts of the Broughton Islands (Figure 1.1). Today, although four of the original Clans of the **D^zawada?ēnux^w** still exist and two have seated Clan Chiefs¹¹ and the other two have heirs identified to the Clan seat, the Federal Government gazetted Indian Reserves under the name Tsawataineuk in the mid nineteenth century. Only about 5% of the original territory of the **D^zawada?ēnux^w** is held under the elected Band Council of the Tsawataineuk First Nation. As a result of the imposition of Indian Reserves and Indian Bands to all Aboriginal Tribes in British Columbia under the

¹¹ Both K^waxistalla and Walas Gyumd^ʔi, were left title to their Clan seats in a **lawikilla** (living will) witnessed at Potlatch given by their predcessors, both have potlatched and affirmed these titles culturally (K^waxistalla, Clan Chief Adam Dick, Mayaniʔ?, Dr. Daisy Sewid Smith, and Max^wə d^ʔi, Chief George Shaughnessy 2009)

Federal Government's Indian Act (1876),¹² the original **D^zawada?ēnux^w** Clan members now live on various Indian Reserves in the K^wak^waka'wak^w Nation and the Tsawataineuk (Indian Band) First Nation's membership is comprised of people who originated from several other Tribes. All of the field work for this thesis was undertaken within the **D^zawada?ēnux^w** traditional territory with K^waxistalla's permission and under his ancestral authority over his Clan's traditional resources and territory. K^waxistalla not only gave his permission for me to undertake the work, but also monitored the progress of my research in a manner according to the ancestral laws of the original clans of the **D^zawada?ēnux^w**. As I mentioned elsewhere, I also conducted interviews, with the written permission from the elected Band Council of the Tsawataineuk (Indian Band) First Nation,¹³ with six band members. Parts of this thesis reflect generalized knowledge of other Peoples because literary sources often do not specify or distinguish among the tribes, and cultural practices and language can, at time, be similar across the different tribes of the K^wak^waka'wak^w.

¹² The gazetting of **D^zawada?ēnux^w** reserves is convoluted and confusing. It began with six provisional allotments by Sprout in 1879, five of which belonged to other tribes. In 1886 O'reilly visited the area and formalized the **D^zawada?ēnux^w** reserves suggested by Sprout but under the new name of the Gilford Island Natives, and allocated to the Gilford Island Natives five additional reserves. O'reilly recognized that the Gilford Island Natives were made up of the **D^zawada?ēnux^w** and remnants of the **G^wawēnuk** and the **Huhuamis**. Oddly, by 1901, the Department of Indian Affairs, Annual Report listed the **D^zawada?ēnux^w** as having retained only a single reserve on Gilford Island (IR #1); their winter village at the mouth of the Kingcome River (IR #7) was allotted to the **G^wawēnuk** (Galois 1994, p. 97-98). The **D^zawada?ēnux^w** made ten additional claims at the McKenna-McBride Royal Commission in 1913-16, four of which were accepted (Galois 1994, p. 125-131).

¹³ While these two terms are strikingly similar, they have disparate meanings relating to the jurisdictional provenance of each term: **D^zawada?ēnux^w** is the name of the Tribe of the Allied Clans that formed the foundation of the original traditional governance structure; while the second term, Tsawataineuk is the name of the Indian Band or more recently known as First Nation, and whose governance structure is derived from the Canadian Federal Government's Indian Act (1876).

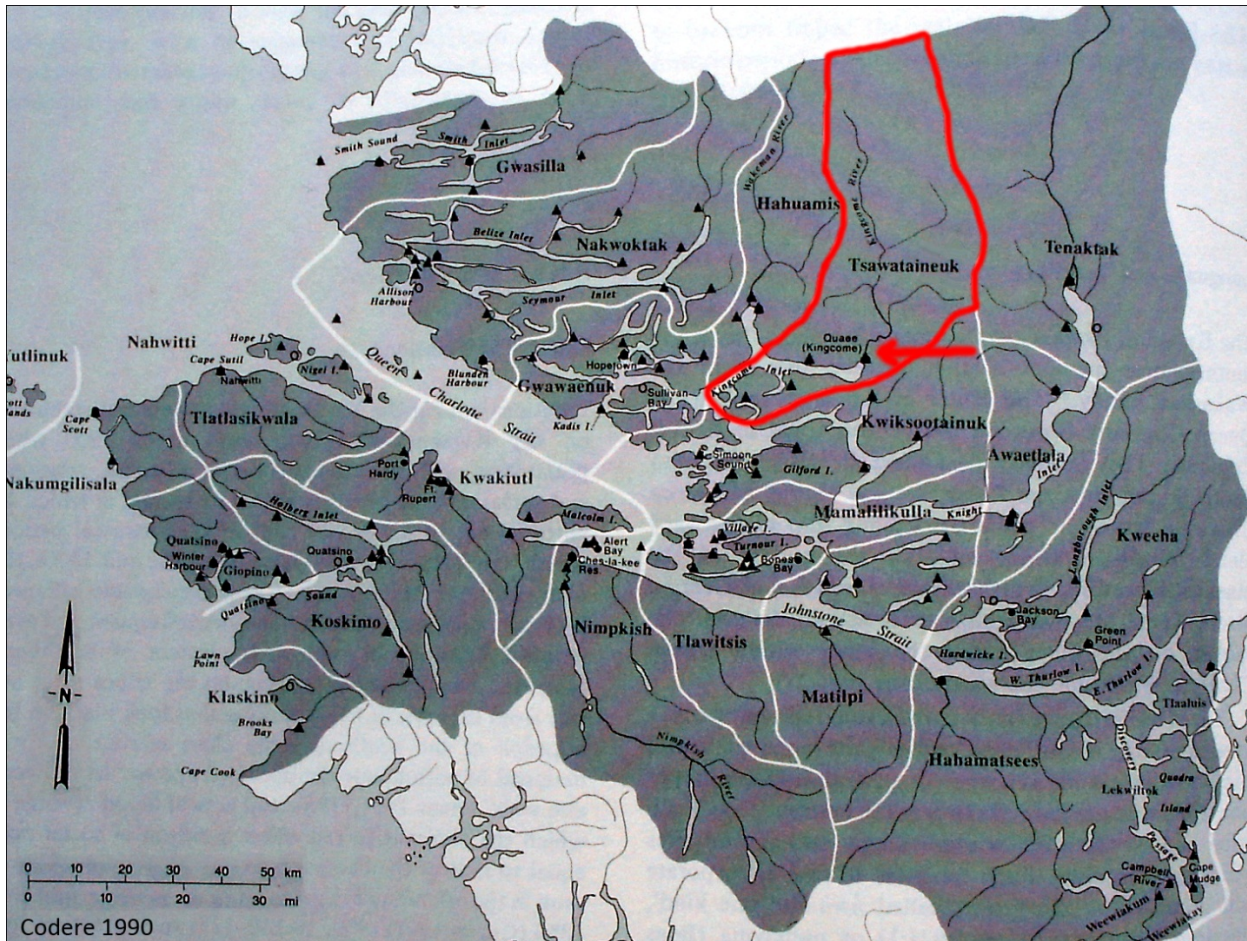


Figure 1.1. Kwakwaka'wakw territories and settlements in the early 19th century (from Codere 1990, p. 360) with the Dzawadaʔenux territory outlined in bold (red) and an arrow pointing at the village at Kingcome Inlet).

ʔuḡʷamēy, Clan Chief

Prior to Colonial and Canadian Government interference, the Kwakwaka'wakw intricately intertwined their social, governance, economic, cultural, and natural resource structures in a hierarchical manner with a Clan system serving as the principal unit for understanding Kwakwaka'wakw resource management systems. Within each Clan there were social classes including commoners, slaves, and ranks within a nobility structure based on one's birth place; the highest rank being the *ʔuḡʷamēy* who had to trace their ancestry in an unbroken line to the First Ancestor. Greater detail on the specific Dzawadaʔenux Clans system is provided in section 2.1.

Among other responsibilities, the **ʔuǵ̃^wameȳ** was head of the **ᵑessa**, the investment society and economic and governance base of the Clan. There he controlled up to 50 investment seats that were named and ranked and filled only by the aristocracy of the Clan. Highly trained noble men named **Gigigameȳ** (**Gigameȳ**, singular) worked the **ᵑessa** to advance the economic well being of the entire clan under their **ʔuǵ̃^wameȳ**. A **Gigameȳ** could not advance to **ʔuǵ̃^wameȳ**; the position was based on a strict set of inheritance laws. However an **ʔuǵ̃^wameȳ** could hold **ᵑessa** seats in other Clans' and Tribes' **ᵑessa** systems.¹⁴ Essentially the **Gigigameȳ** worked for the Clan Chief to advance the economic position of the clan through a dividend-based system of investments (Mayaniᵑ̃?, Dr. Daisy Sewid-Smith in Recalma-Clutesi 2007).

Only the Clan Chief oversaw and was trained in the stewardship obligations of his Clan's territory and resources. The Clan Chief was the closed living relative of the First Ancestor, whose title to the land was conferred by the Creator after the flood. Through the rights of inheritance, the **ʔuǵ̃^wameȳ** was therefore responsible for the stewardship of his clan's territory and the wellbeing of his clansmen, a task that required rigorous training and specialized knowledge (K^waxistalla, Clan Chief Adam Dick, Max^wə d̃i, Clan Chief George Shaughnessy, and Mayaniᵑ̃?, Dr. Daisy Sewid-Smith pers. comm.). **ʔuǵ̃^wameȳ** are therefore the principal conduits and arbiters of certain vast categories of intellectual property. K^waxistalla's training as a **Dzawada?ənuᵑ^w** Clan Chief gives him immense credibility as a key research informant. For me it was a great privilege to be given access to his knowledge and perspectives, which provide the primary research findings.

¹⁴ K^waxistalla is the last living Clan Chief to have been initiated into this **ᵑessa** system in his youth (Mayaniᵑ̃?, Dr. Daisy Sewid Smith, and Max^wə d̃i, Chief George Shaughnessy 2009).

łəksəm (*Argentina egedii*)

Of the four major edible estuarine salt marsh species eaten by the K^wak^waka'wak^w, special attention is given to *Argentina egedii*. *Argentina egedii* is a member of the Rose Family (Rosaceae) and is commonly known as Pacific silverweed or cinquefoil. It was formerly known by the scientific names *Potentilla pacifica* Howell and *Potentilla anserina* L. ssp. *pacifica* (Howell) Rousi, and is known by the K^wak^waka'wak^w as **łəksəm** (Turner and Bell 1973 p. 289; Compton 1988, p. 23-24). *Argentina egedii* is an herbaceous perennial with erect, pinnately compound leaves 10-40 cm long, and recumbent stolons (Figure 1.2). Leaflets alternate between larger (1-3.5 cm) oblong to obovate, sharply serrated leaflets, and smaller entire to toothed leaflets. Flowers are borne on long stalks emerging from the stolon nodes. Petals are yellow, 5 per flower, and resemble those of the “buttercup” (*Ranunculus* spp.) (Hitchcock and Cronquist 1961).

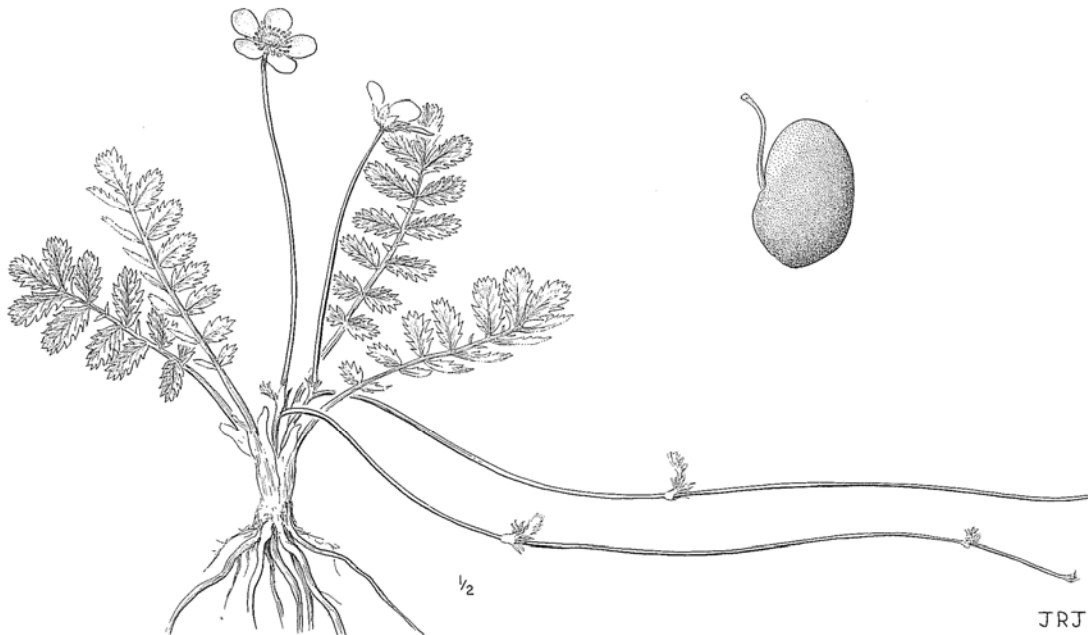


Figure 1.2. Line drawing of Pacific silverweed (Hitchcock and Cronquist 1961, V3 p. 153).

Argentina egedii is salt tolerant and abounds in coastal and estuarine salt marshes on the Pacific coast from California to Alaska across the Arctic, and Hudson's Bay in the North Atlantic south to New

York (Hitchcock and Cronquist 1973 p. 216; USDA Plants 2010). It is also found less commonly on riversides, dunes, and beaches from low to middle elevations (Pojar and Mackinnon 1994). Two subspecies (*A. egedii* (Wormsk.) Rydb. ssp. *egedii* and *A. egedii* (Wormsk.) Rydb ssp. *groenlandica* (Tratt.) A. Löve) with overlapping ranges are recognized, but are not discussed in this thesis. Descriptions of *A. egedii* habitat and its use by the K^wak^waka'wak^w are discussed in further detail throughout this thesis.

ᑕᑦᓃᓂᓂᓂ,¹⁵ Springbank clover (*Trifolium wormskioldii* Lehm.), **ᓂᓂᓂᓂᓂ**,¹⁶ Northern rice root (*Fritillaria camschatcensis* (L.) Ker Gawl), and **ᑕᑦᓂᓂᓂ**,¹⁷ Nootka Lupine (*Lupinus nootkatensis* Donn ex Sims) are three other **ᑕᓂᓂᓂᓂ** species also valued by the K^wak^waka'wak^w for their edible roots (Deur and Turner 2005; Turner and Bell 1973) and while discussed in this thesis, are not the primary focus. Hemlock parsley [*Conioselinum gmelinii* (Cham. & Schltld.) Steud.] is another edible root-producing plant found in salt marshes and historically eaten by some K^wak^waka'wak^w (Compton 1993), but it will not be discussed in this thesis because it was not one of the species used by K^waxistalla and his clan (Pers. comm. to N. Turner 2009). Figure 1.3 shows the roots of **ᓂᓂᓂᓂᓂ**, rhizomes of **ᑕᓂᓂᓂᓂ**, and bulbs of **ᓂᓂᓂᓂᓂ**, which all grow naturally in the Kingcome River high estuarine salt marsh.¹⁸

¹⁵ **ᑕᓂᓂᓂᓂ**: Springbank clover (*Trifolium wormskioldii* Lehm.). Term provided by AD, orthography by DSS, translation by both AD and DSS.

¹⁶ **ᓂᓂᓂᓂᓂ**: Northern rice root (*Fritillaria camschatcensis* (L.) Ker Gawl). Term provided by AD, orthography by DSS, translation by both AD and DSS.

¹⁷ **ᑕᓂᓂᓂᓂ**: Nootka Lupine (*Lupinus nootkatensis* Donn ex Sims). Term provided by AD, orthography by DSS, translation by both AD and DSS.

¹⁸ K^waxistalla provided the names **ᓂᓂᓂᓂᓂ** and **ᓂᓂᓂᓂᓂ** for the terrestrial features of the Kingcome River estuary. **ᓂᓂᓂᓂᓂ** is the name for the sandbar below the salt marsh and **ᓂᓂᓂᓂᓂ** is the name of the estuarine salt marsh (Pers. comm., 20 Feb. 2008). He also used the name **ᑕᓂᓂᓂᓂ** to describe the estuarine island near the mouth of the Kingcome River (Nancy Turner Field Notes, 27 Jan. 2007). For a comprehensive list of general root garden names, see Appendix 3.

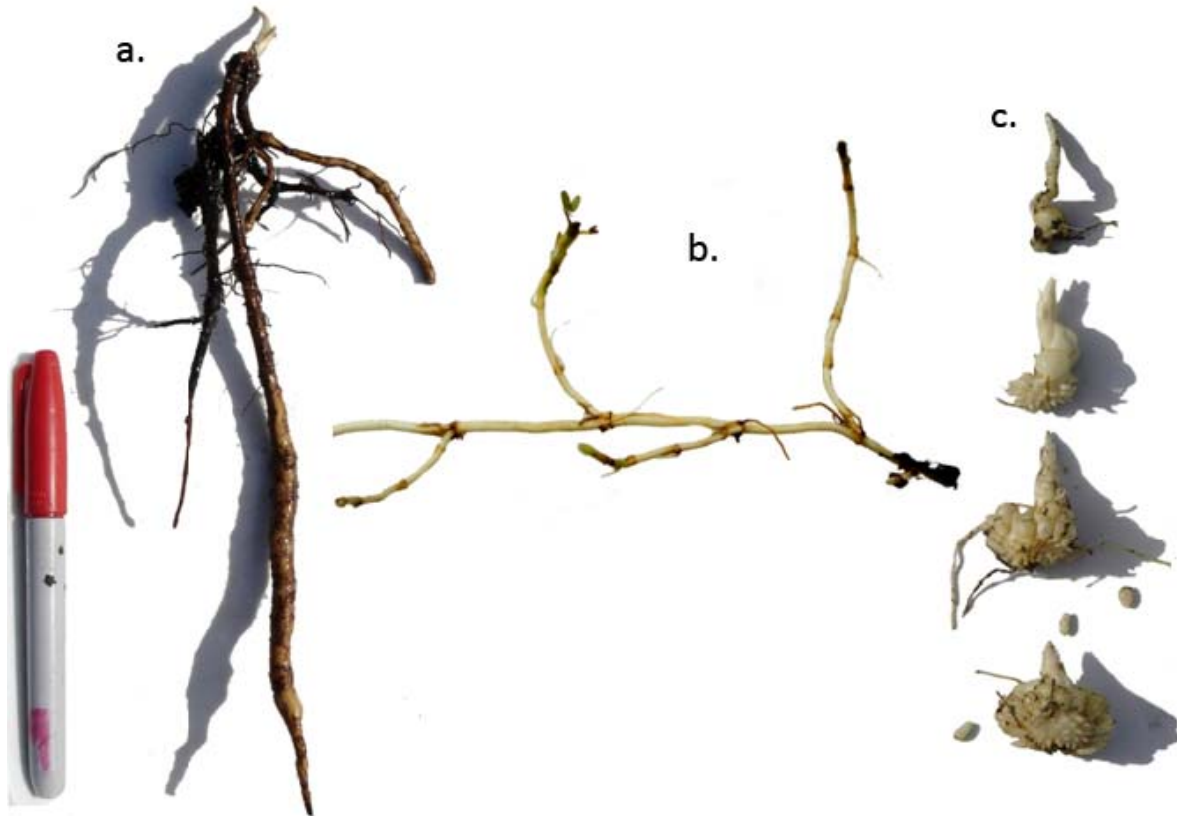


Figure 1.3. Three of the edible “roots” of the **tekillak**; *Argentina egedii* (a), *Trifolium wormskioldii* (b), and *Fritillaria camschatcensis* (c).

K^wak’wala terminology

I have included **K^wak’wala** translations for many of the words related to the **tekillak**. Unless otherwise noted, these terms were provided by Clan Chief K^waxistalla, Adam Dick (AD), transcribed by linguist Mayaniṭ?, Dr. Daisy Sewid-Smith (DSS), and translated by both Mayaniṭ? and K^waxistalla. In most cases I have also included a definition of the **K^wak’wala** term in a footnote as a means of crediting the knowledge and work of K^waxistalla and Mayaniṭ?. All **K^wak’wala** terminology in this thesis is shown in boldface type.

1.5. The Working of the **təkkillak**^w: Traditional Ecological Knowledge of K^waxistalla, Clan Chief Adam Dick

The **təkkillak**^w is part of a much bigger system, also part of K^waxistalla's world, encompassing the entire Kingcome watershed and beyond, which influences the estuarine salt marsh root gardens both ecologically and culturally. The seasonal fluctuations in the river combined with the rising and lowering of the tides create a unique environment at the estuary, where literally, "not one square inch" was not part of the **təkkillak**^w garden system, as stated emphatically by K^waxistalla (Pers. comm., 2008). There have been a number of studies focused on how these plots were managed by a number of strategies including site ownership^{19, 20}, marking (Deur 2000, 2005; K^waxistalla, Clan Chief Adam Dick pers. comm., 2008; Ford 1941 p. 51; McKenna-McBride Royal Commission, 1914 p. 207) naming (Reid and Sewid-Smith 2004 p.71), modifications to the salt marsh to expand the natural range of the edible root-producing plants (Deur 2000, 2005), soil tilling²¹ and modification,²² regular weeding²³ (Deur 2000,

¹⁹ Lagius (n.d.), whose account appears to have been the primary source for Edward Curtis's (1915) description of harvesting clover and silverweed, emphasized the significance of garden ownership: "...the women owned plots of ground which had been in the family for many generations. If a woman did not choose to work her ground in a certain season, nobody else would touch it unless she gave permission.... These 'gardens' could not be sold but descended in the family exactly like a crest. To have sold them would have been robbing the generation's unborn (quotations in original)."

²⁰ Charles Nowell (Ford 1941 p. 51) explained the consequences of harvesting from someone else's **təkkillak**^w, "...if one woman gets into another's patch, they fight over it."

²¹ There have been numerous ethnographic references to tilling (see Deur 2000). Boas (1966, p. 17) observed "the clearing of grounds in which clover and [silverweed] grow," and Menzies noted the importance of soil disturbance in Nuu-chah-nulth clover gardens: "Wherever this *Trifolium* abounds the ground is regularly turned over in quest of its roots every year" (Menzies 1923, p. 116-117). Edwards provides a similar account of Nuxalk clover management noting the need to loosen the garden soil in the spring (Edwards 1979, p. 6). The practice of tilling to achieve "soft" soil was emphasized by K^waxistalla as an important means of getting the garden to "grow better every year" (in Deur 2005, p. 313). Soil disturbance or tilling appears to be an important part of **təkkillak**^w management, as the English translation of the word **təkkillak**^w, "place of manufactured soil," implies (Mayaniŋ?, in Deur 2005, p. 315).

²² The composition of the soil was evidently important to the growth of estuarine salt marsh roots. K^waxistalla said that the soil needed to have "a little bit of everything" (in Deur 2005, p. 314), including organics, sand, and silt – a mixture enhanced by tilling. This was also suggested by the work of Franz Boas, who reported that the mixed sand and clay soils in the estuarine salt marshes at Gwayee (the Kingcome River) and the Klinaklini River produced the longest clover roots, whereas the pebbly Nimpkish River estuarine salt marsh produced only short roots (Boas 1921, p. 190). Deur (2000) observed garden rockworks trapping soil improving sediments and detritus and noted the rich soils still present in fallow **təkkillak**^w sites.

²³ On weeding, see Edwards 1979; Deur 2000; Turner and Peacock 2005). K^waxistalla recalled making several trips to his family's **təkkillak**^w throughout the growing season for the sole purpose of **cʔikʷa** [weeding] out grasses and

2005; K^waxistalla, Clan Chief Adam Dick pers. comm.), predator control (Deur 2000, Deur and Turner 2005; Edwards 1979; Turner 2004), selective harvesting, and replanting of root fragments.²⁴

These activities together resulted in enhanced productivity of edible root-producing plants (Pukonen 2008). In my many conversations with K^waxistalla, he has reconfirmed that each of these management techniques were used traditionally to enhance the productivity of the **tekillak^w** and to provide a stable and abundant food source for his clan; he was instructed in these practices as part of his own training with his grandfather and others as they prepared him for his role as Clan Chief. Moreover, in my communication with residents of Kingcome Inlet, many individuals have affirmed that these practices were referred to by their grandparents.

1.6. Historical Context of the Use of **laksem**

Argentina egedii was once an important root food for the K^wak^waka^wak^w that was relished as a wintertime feast food and after-dinner dessert (Boas 1921; Nowell in Ford 1941). Early in the era of first contact with Europeans (and in some cases slightly before this time), coastal First Peoples adopted the use of potatoes (*Solanum tuberosum*) and slowly began relying less on native sources of carbohydrates (Suttles 1951; Beckwith 2004 p. 212). Colonial assimilation policies and legislation posed additional challenges to *A. egedii* consumption, and today few people are aware of its former use, and nobody eats

non edible leafy plants, especially a type of grass with long thick rhizomes called **kakikama** (Adam Dick in Deur 2005; Pers. comm., 2008).

²⁴ One of the most intriguing components of root garden management is the practice of replanting portions of the harvested estuarine salt marsh roots (see Deur 2000, 2005; Edwards 1979; Turner and Peacock 2005). K^waxistalla said that riceroor fragments were carefully replanted and reported that when he was young, he was responsible for replanting a portion of the riceroor called the **galemp**, or “grandfather.” Historical accounts of replanting estuarine salt marsh roots are scattered, but Lagius said of clover that “The roots just below the main plants were never taken out, and such pieces as were not deemed good for food were carefully put back into the ground.” According to the late Hesquiaht elder Alice Paul, the ends of the roots of silverweed and clover were placed back in the ground so they would grow the following year (in Turner and Efrat 1983, p. 68, 73). Edwards noted that Nuxalk clover harvesters returned “immature white roots” to the earth (1979, p. 5). According to plant taxonomist Dr. John Gillett (Turner and Kuhnlein 1982, p. 429), rhizome and vegetative cuttings of springbank clover are easily propagated in damp sand. Considered together, the scattered references to silverweed, clover, and riceroor replanting suggest a widespread practice of deliberately replanting edible estuarine salt marsh roots. Each of these roots are also evolutionarily adapted to asexual reproduction from root fragments.

it regularly. I suggest that traditional knowledge of the 'təkkilak' food system shadowed the decline in use of *A. egedii* by about two generations (Figure 1.5 b). When use of this plant dipped below a threshold that supported critical infrastructure, the rate of decline accelerated rapidly (Turner and Turner 2008; Figure 1.5 a).

For the purpose of understanding, one might think of two levels of infrastructure operating in the management of estuarine salt marsh root gardens as described by Kwaxistalla. First, material infrastructure, like female-owned canoes, harvesting tools (see Chapter 3), and harvesting shelters, allowed women—who were the primary managers of 'təkkilak' plots—to travel and work independently of their husbands. Secondly, cultural structures, such as a seasonal round, access to a youthful labor pool, and a demand for indigenous root foods for feasting and daily meals allowed managers to harvest the roots efficiently and realize their cultural value. The introduction of the potato was only one of many factors that led to the decline of λəksəm use. Participation in cash economies, changing patterns of boat ownership, forced enrolment of children in residential school, decreased access to harvesting sites, from the imposition of Indian reserves and anti-potlatch legislation were also significant (Lutz 2008; Kuhlein 1995; Kuhnlein and Receveur 1996; Turner and Turner 2008).

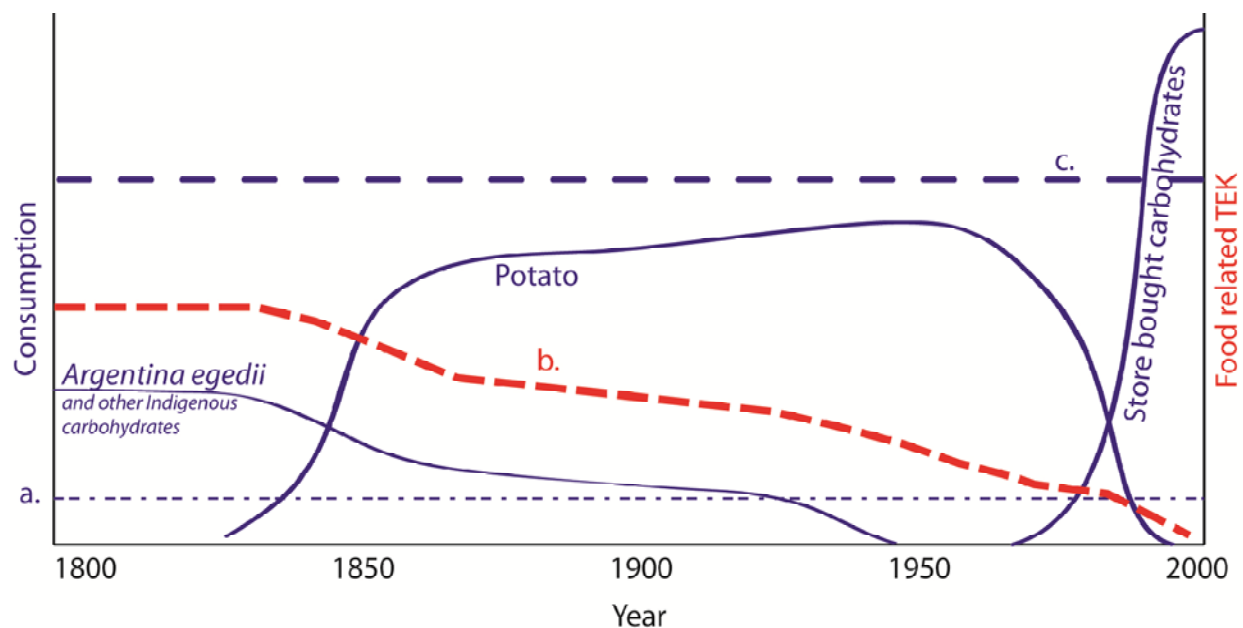


Figure 1.5. Schematic diagram showing trends in historical consumption of carbohydrates by the Kwakwaka'wakw over the last 200 years. The dotted line (a) represents critical use level, below which use is likely to decline rapidly and desist. The thick dashed line (b) represents TEK, suggesting TEK shadows use. The thin dashed line (c) represents a hypothetical carbohydrate consumption threshold, over which the risk of disease increases dramatically (See Chapter 5).

1.7. Pertinence

K^waxistalla has always maintained that **laksem** and the other roots and indigenous foods his ancestors relied on were healthy and culturally important and that restoring their uses and management is not only desirable but a necessary part of restoring a vibrant and healthy relationship with the environment. While conditions will never again be as they were prior to European contact, K^waxistalla's call to restore the **tekillak**™ is well timed within a period of greater global market uncertainty, residential school settlements, treaty negotiations, and increasing awareness of the health benefits of traditional foods. Food can serve as a poignant example of many of these forces. For instance, the people currently living in Kingcome Inlet pay shipping costs of up to one dollar a pound for mostly high-carbohydrate western foods which may pose a risk of type two diabetes (Figure 1.5 c). Meanwhile, **tekillak**™ plots lay fallow on proximal "Crown lands" that were historically owned by the original five

clans of the **D^zawada?ēnux^w**. By documenting K^waxistalla's knowledge and experiences of his Clan's **'təkillak^w** and attempting to implement some of the original cultivation practices in an experimental way under K^waxistalla's guidance, I hope to contribute information in this thesis that will not only support the efforts of K^waxistalla and the Tsawataineuk First Nation to renew the **'təkillak^w** gardens and the culturally and nutritionally valuable roots they provide, but also support a wider understanding of the importance of this resource management system.

Chapter 2. K^waxistalla, a Traditionally Trained Clan Chief and Knowledge Keeper

This chapter pays tribute to the cultural authority and primary knowledge source under which my thesis research at Kingcome Inlet was conducted. As noted in Chapter 1, K^waxistalla's detailed knowledge of the 'təkillak^w and his stewardship obligations as a Clan Chief, have been instrumental to my understanding of both the practical elements, such as tool-making and use, as well as the cultural protocols that have guided and directed my understanding of 'təkillak^w cultivation.

2.1. Introduction to the K^wak^waka'wak^w Cultural Landscape

Although my research focuses on only one edible root species, **ləksem**, Pacific silverweed [*Argentina egedii* (Wormsk.) Rydb.], this plant cannot be taken out of context of the entire K^wak^waka'wak^w food system. Ownership, weeding, harvesting and feasting traditions of the 'təkillak^w or estuarine salt marsh root garden, are components of a larger, more complex system of food production and resource use that extends over the entire year and across an the ecologically diverse territory of the original clans of the D^zawada?ənu^w of Kingcome Inlet, as for other Northwest Coast First Peoples (Deur and Turner 2005). This food system was mediated by ancestral practices that were adapted and were carefully passed down from generation to generation through cultural transmission and maintained by strictly trained ʔuḡ^wamēy (Clan Chiefs) for the benefit of the people of their clan until about the middle of the twentieth century. K^waxistalla is the last Clan Chief, who was strickly and traditionally trained to be entrusted with the knowledge of how to sustain the natural and cultural obligations of his Clan.

Prior to European contact, K^wak^waka'wak^w social organization and its governance, economic, cultural and natural resource use stuctures were inextricably intertwined. The clan²⁵ system that was in place in the past (Mayaniḡ, Dr. Daisy Sewid-Smith pers. comm., 28 March 2009) is the principal unit for understanding the K^wak^waka'wak^w resource management system. Some clans have as their crest, an artistic rendering of the supernatural helper that assisted the First Ancestor at the time of the great flood or at its place of decent. Others Clans crests are representations of the First Ancestor or a

²⁵ Referred to as *numayma* by Boas (1966). Mayaniḡ, Dr. Daisy Sewid-Smith corrects this word as nummayum, which means "coming from one" as in a clansmen and Adam Dick Numeema is clanmen.

significant animal, bird or insect that was significant in the Clan's **Gəgalis**²⁶ (origin account). Each clan holds a territory that related to its origin story (Sewid-Smith and Dick 1998; Boas 1895 p. 328, 333-334) and in some cases the clan **Gəgalis** included specific instructions on how a particular resource was to be used. For example, the **Qawadiliqəlla's Gəgalis** instructs the people what was to be eaten, what was to be left alone, and that eulachon were to be used as an important food source for their first ancestors (Audio recording of Chief Mary Dick, **ʔuḡʷamēy** of the **Qawadiliqəlla** Clan, recording ca. 1970s).

The K^wak^waka'wak^w people were organized through the belief that the Creator bestowed both their clan identity and the title to their traditional territory and resources to their original ancestor. The title of **ʔuḡʷamēy** (Clan Chief) is to be held by the eldest male in the family line that traced their lineage to the First Ancestor in "a direct unbroken line" (Mayaniḥʔ, Dr. Daisy Sewid-Smith and K^waxistalla, Clan Chief Adam Dick pers. comm. 2010). The exception to this rule was when a Clan Chief did not have a male heir, and then the eldest daughter held the seat for her first born son, who would be trained to inherit the seat. On rare occasions and for a valid reason, the eldest son was bypassed and the second son took the seat thereby shifting the line of descent for the next generation to the offspring of the second son. While the position of Clan Chieftainship affords the holder a certain degree of privilege and honour, it carries an enormous responsibility, as he was expected to look after the welfare of the clan in both the ritual and natural worlds (Kwaxistalla, Clan Chief Adam Dick, Mayaniḥʔ, Dr. Daisy Sewid-Smith, and Max^wə dʒi, Chief George Shaughnessy pers comm., 2009). The **ṭəkillak^w** gardens and other natural resources were therefore carefully stewarded by the Clan Chief and his designates for long term sustainability and enhanced productivity (K^waxistalla, Clan Chief Adam Dick pers. comm., 2008; Rohner and Rohner 1970, p. 82).

Each Clan in each of the tribes in the K^wak^waka'wak^w Nation had their own **ṭəssa** system, an investing society that handled the economy of the people. The economy was driven by the natural

²⁶ **Gəgalis**: Origin account. Term provided by AD, orthography by DSS, translation by both AD and DSS.

resources of the land and the sustainability of each harvesting practise. The economic, governance, food gathering practises, and the culture were interconnected. Each of the 50 seats in the **p̓essa** had a male name and the positions were ranked. Strict laws governed the **p̓essa**, one had to be from aristocracy to hold a seat. The Clan Chief was the head of the **p̓essa**. It is worth noting that K^waxistalla was last Clan Chief to be initiated into the **p̓essa** before it collapsed after the Anti Potlatch laws of Canada (Indian Act, 1884 Ammendment) successfully suppressed this practise. He also held four **p̓essa** seats in other Clans of the **Kwagilth**, the **Mamaliliqalla**, the **Maʔəmtagilla** and the **Ligʷiʔdaḥ**. (Mayaniʔ, Dr. Daisy Sewid-Smith, K^waxistalla, Clan Chief Adam Dick pers. comm., 12 Dec. 09).

K^wak^wakaʔwak^w tribes were typically made up of clans, which had common original ancestors or whose ancestors' place of descent were in close geographic proximity to one another (Boas 1966, p. 37-41; Mayaniʔ, Dr. Daisy Sewid-Smith, Max^wə dʔi, Clan Chief Shaughnessy, pers. comm., 24 Aug. 2009). The **Dʔawadaʔənux^w** is one of several tribes in the K^wak^wakaʔwak^w Nation that was originally made up of an alliance of five Clans whose first ancestors and place of decenent were not the same. The first Clan was **Qawadiliqalla** (Wolf Clan) whose place of descent was **ʔug^wwʔtollis** (Mountain) and first ancestor was **Qawadiliqalla**. Even though **K^wəliliy** is his younger brother, he is considered first ancestor of the **K^wəliliy** Clan in **Hax^wx^wamis** (Wakeman Sound). While the first ancestors were brothers, they resided before contact in two separate tribes, **K^wəliliy** in **Hax^wx^wamis** (Wakeman Sound), **Qawadiliqalla** in Kingcome Inlet. Other Clans came to be in **Hax^wx^wamis**, but have different first ancestors and places of descent following the receding of the waters of the flood. Members of the Allied Clans from **Hax^wx^wamis** moved out of their village site in the late nineteenth century and now belong primarily to Federal Government Indian Act Bands (First Nations) in Kingcome Inlet and Gilford Island (K^waxistalla, Clan Chief Adam Dick and Mayaniʔ, Dr. Daisy Sewid-Smith, pers. comm.).

The other Clans of the **Dʔawadaʔənux^w** that still have living decendents today are the **Čik^wk^waḥallis** or Bird clan, whose place of descent after the flood was **Galudda** (Mountain) and first

ancestor was named **Qixʷallaʷallis**. The current Chief of this Clan is Kʷaxsistalla's son, Richard Dawson, Walas Gyumdʷi, who inherited his seat from his late grandfather, Tom Dawson, Gyumdʷi. The **Lillawagilla** or Raven clan's place of descent after the flood waters receded, was **Hemsdamma** Mountain. The **Ninelkinuxʷ** or the Mountain Goat Clan's place of descent after the flood was **Ləxlaq**, and its first ancestor was **Wiqəllasugʷilakʷ**. The fifth Clan was **Həlxaboy**, and since no descendants have survived, the Clan has died away. (Kʷaxsistalla, Clan Chief Adam Dick pers. comm., 12 Dec. 09).

An example of a Tribe made of Clans from common First Ancestors is the **Qʷiqʷasutʷtinuxʷ** tribe. Their First Ancestor is **Čəqqamey** and he had four sons. Descendants of three of the four sons of **Čəqqamey** survived a massacre in the mid nineteenth century which make up the following Clans: the **Wiʷumasgəm-mimawigən**, **Sisewagextux**, and the **Ninelbēy Clans** (Mayaniʷ?, Dr. Daisy Sewid-Smith, pers. comm., 12 Dec. 09; Sewid-Smith and Dick 1998). Like most Bands in the Kʷakʷakaʷwakʷ Nation, whose authority is granted under the Federal Government's Indian Act (1876), the membership of the Band or First Nation does not match the three remaining Clan's of the original **Qʷiqʷasutʷtinuxʷ**.

2.2. Kʷaxsistalla, the Living Legacy

Three years ago, I began to learn about the **təkillakʷ** from Kʷaxsistalla (Adam Dick), **ʔuḡʷamey** (Clan Chief) of the **Qawadiliqəlla** Clan of the **Dʷawadaʷənuxʷ** tribe. I am compelled to share his story because, through countless hours spent listening to his traditional knowledge and participating in his traditional food collection, he has taught me that the **təkillakʷ** is best understood as a spoke in a much larger wheel—the Kʷakʷakaʷwakʷ food system, most visibly observed within the traditional seasonal round. This chapter presents a biography of Kʷaxsistalla, but is by no means complete; to achieve that would take many more years of instruction and listening. His story sets the stage for the rest of my thesis by illuminating the other spokes that keep the wheel strong and illustrating how those spokes have been modified or replaced over the course of one man's lifetime. In every wheel the spokes come together in a hub. In this case, Kʷaxsistalla is that hub as his Clan Chieftainship binds him to the welfare

of his clan and territory. Because of his Clan Chieftanship and specialized training, K^waxistalla has a deeper and more comprehensive knowledge about the **təkkillak^w** and other food production systems of the **D^zawadaʔēnux^w** than any other living individual. The following sections are based on K^waxistalla's accounts over many hours of conversations and reflections.

2.3. Birth

K^waxistalla was born on March 3, 1929, but his story began with the **ʔollakalla miḵēy ya** or prophetic dream of his mother ʔanicca, Clan Chief Mary (nee. Williams) Dick. This dream held deep significance to ʔanicca, her husband Chief James Dick and all the **Ḥinoḡad²⁷** of their extended family. When a child was born to such a vision, they had an obligation to care for him in a particular manner and given the anti potlatch laws of the day, decided they must seclude this boy of nobility and prophecy to train him from the age of four as is customary (Recalma Clutesi, pers. comm.).

K^waxistalla's parents were both Chiefs and held **ḡessa** seats in the K^wak^waka'wak^w clan system.²⁸ ʔanicca's mother **Səbəlxiḵ**, was of the **Wallassema** Clan from **ḵ^wəssam** (Salmon River at Kelsey Bay, BC) and was living in **ḵəmatax^w** (Campbell River, BC) when K^waxistalla was born. Her father was ʔawallaskənnis, Charlie Williams from **ʔuk^wanallis**, or Kingcome Inlet (hereafter called Kingcome) and was the **ʔuḡ^wamey** (Clan Chief) of the **Qawadiliqella** (Wolf Clan). ʔanicca, K^waxistalla's mother, was Charlie Williams only surviving child and therefore she inherited the Clan Chieftainship of her father ʔawallaskənnis²⁹. K^waxistalla's father, James Dick, held the name K^waxistalla, which his son Adam

²⁷ **Ḥinoḡad** means knowledge keeper or culturally trained specialists and in this case specifically refers to the traditionally trained Clan Chiefs of K^waxistalla's extended family (K^waxistalla, Clan Chief Adam Dick, Mayaniḵʔ, Dr. Daisy Sewid-Smith, and Max^wə d'i, Chief George Shaughnessy Pers. comm., 2009).

²⁸ The **ḡessa** is an investing society that handled the economy of the people, especially the mountain goat fur, which was the currency of the day. Most of the Chiefs in the K^wak^waka'wak^w today hold Potlatch seats from this system, only a handful of Clan Chiefs are left and seated in the cultural arena (K^waxistalla, Clan Chief Adam Dick, Mayaniḵʔ, Dr. Daisy Sewid-Smith, and Max^wə d'i, Chief George Shaughnessy, pers. comm.).

²⁹ According to traditional K^wak^waka'wak^w historian and linguist Mayaniḵʔ, Dr. Daisy Sewid-Smith, women occasionally held seats in the chiefly investment system (**ḡessa**). These seats carried male names and when a woman undertook **ḡessa** business in the Bighouse, she assumed male dress and the masculine **ḡessa** name she inherited. Mayaniḵʔ also says that a person could not occupy more than one Clan seat at a time, but could hold them in their "box of treasures" (which also contained songs, legends, and tangible items such as ceremonial

inherited. He held a potlatch (**p̓essa**) seat from the **Q̓aq̓agiw̓ēy** Clan of the **Mamaliliq̓ella** (Village Island). James Dick and ʔanicca gave birth to eight children of whom Adam was third eldest. The others were Violet (deceased in Kingcome), Charlie (deceased in Nanaimo), Benjamin (deceased in Nanaimo), Dolly (deceased in Kingcome), Frances (deceased in Kingcome), Ruby, Michael, and Nina. Charlie Dick was the first male born and inherited the name ʔawallask̓ennis from his mother's side. Adam was the second oldest son and because he was born after his mother's prophetic dream, was raised to eventually take over the **Qawadiliq̓ella** Clan Chieftainship as K^waxistalla. Adam's youngest brother, Michael Dick, has often accompanied K^waxistalla, supporting his teachings and providing details from his own recollections.

2.4. K^waxistalla's Early Childhood Years, Seclusion, and Training

K^waxistalla was born into a time of colonial oppression that threatened to break the continuity of K^wak^waka'wak^w culture. By the 1920s, enforcement of the 1884 anti-potlatch law had forced the potlatch underground and had compelled many families to destroy their bighouses and give up their ceremonial regalia to spare their imprisonment (Sewid-Smith 1979; Cole and Chaikin 1990). At the same time, the residential school system separated children from their parents and prevented them from fully learning their language, history, and culture including practices around food harvesting, processing, management, and use. Recognizing the significance of the prophetic dream to which he was born, K^waxistalla's parents and the **N̓inoḡad** (knowledge keepers) on "all four corners of his life" (related to his four grandparents) secluded and trained him to be the reservoir for cultural knowledge of the natural and supernatural world that they had inherited from their First Ancestors (Recalma-Clutesi, 2007). Potlatches continued to be held "underground," especially at Kingcome, where the winter ice-up of the Kingcome River made it difficult for the Indian agent to monitor **D^zawadaʔēnux^w** potlatch activities (Recalma-Clutes 2007, Cole and Chaikin 1990). Because of this, K^waxistalla's cultural education included

regalia) for distribution at a later date. In her lifetime, **ʔanicca** (Clan Chief Mary Dick) held one Clan seat, **Qawadiliq̓ella**, and four p̓essa, all were inherited by K^waxistalla's upon her passing (Pers. comm., 9 March 2009).

training as a Potlatch Speaker, but even with the protection of the winter weather, much of this training was done in seclusion.

2.5. Learning and Practicing the Seasonal Round

At the age of four, K^waxistalla's paternal grandparents bundled their little grandson into a dug out canoe filled with traditional harvesting tools and supplies and paddled to **kuk^wkag^wisnuk^w** (Deep Harbour in Fife Sound), where they lived from early fall to late spring for several years to avoid the RCMP and Indian agents who raided the villages picking up children to force them to go to Residential School. They lived in smaller versions of "bighouses" (traditional clan residences) that had no running water or electricity.

His grandmother used a fire at the centre of the house's earthen floor to cook all of the family's food. She barbecued filleted salmon on stakes driven into the ground close to the fire and used rocks that were heated in the fire until they became red hot to boil food in bentwood boxes or steam it in underground pits. K^waxistalla remembers the pile of cooking rocks that his grandmother kept next to the fire as an integral part of her rustic kitchen. Throughout his childhood when they were able to be at Kingcome, K^waxistalla's grandparents woke him up early in the morning and made him bathe in the Kingcome River, even if it was iced over. If it was cold they would wrap him in a grizzly bear skin immediately after he emerged from the water.

As a child, K^waxistalla routinely helped his grandparents with their seasonal food collecting as an important part of his training. During the late summer and fall they would use long straight hemlock poles called a **ḏūmigat**³⁰ to push their canoe up the Kingcome River above the village to their **xəllāciy**³¹ (smoke house). As a boy he would sometimes use the **ḏūmigat** like a long club and smash it across the heads of the salmon in shallow water as a way of fishing. More commonly, he used a branched pole

³⁰ **ḏūmigat**: A long straight pole, usually made from western hemlock, used for pushing or "polling" a canoe. Term provided by AD, orthography by DSS, translation by both AD and DSS.

³¹ **xəllāciy**: Smoke house. Term provided by AD, orthography by DSS, translation by both AD and DSS.

called a **gáʔkʰayuw**³² to hook the salmon by the gills (pers. comm., 19 Oct. 2008). His family camped in their smoke house for several weeks at a time while they were gaffing salmon, which they cut and smoked in the traditional way to preserve for the rest of the year. One of K^waxistalla's jobs as a child was to pull the bones out of **kawas**,³³ (hard smoked chum or coho salmon) with their teeth or small tweezers (**ciʔalla**).³⁴ He and the other children would do this by firelight in the evenings while the old people would tell **nuyem** or traditional stories about the creatures of the forest, sky, and sea as a way of rewarding their work. His family would return from the upriver smokehouse to the village with a canoe-load of dried salmon, much of which they gave away to members of their Clan and others who were not able to get salmon for themselves.



Figure 2.1. K^waxistalla, Clan Chief Adam Dick in front of a smoke house much smaller than the one his family used to live in while smoking Kingcome River salmon.

After they had caught and smoked their salmon for the year, K^waxistalla's grandparents would then take him to spend the rest of the fall and winter in the small cabin at **kuk^wkag^wisnuk^w** (Deep

³² **gáʔkʰayuw**: A gaff hook or berry hook. Term provided by AD, orthography by DSS, translation by both AD and DSS.

³³ **kawas**: hard smoked chum or coho salmon. Term provided by AD, orthography by DSS, translation by both AD and DSS.

³⁴ **ciʔalla**: Tweezers or tongs. Term provided by AD, orthography by DSS, translation by both AD and DSS.

Harbour). There, K^waxistalla learned how to harvest clams and cockles³⁵ and take care of the **luḵ^wxiwēy** (clam garden), by rolling any large rocks on the clam beach down to a line of rocks at the low water line, which had been placed there by the ancestors countless generations back to help create a productive clam beach. Like the salmon, the clams were a staple food that was preserved for later use. K^waxistalla helped his grandparents steam hundreds of clams at a time on piles of hot rocks covered with **ḵesḵenk^{w36}** (rockweed, *Fucus gardneri* P.C. Silva). The steamed clams were then skewered on sticks and barbecued until they were dry enough to be stored without spoiling. K^waxistalla vividly remembered making **kummāciy³⁷**, or dried clams, with his grandparents:

You take driftwood from the beach and make a square. Then they put rocks in [the middle] and build a fire in there. They burn it till morning. When those big rocks get hot, you move all the unburned wood to the side. You spread out the hot rocks within the square of wood. Then you dump your clams in there, maybe 4-5 sacks, maybe 10. There's about 60 lbs in a sack: lots of clams.... Then you cover it with hemlock branches—anything you can cover it with. If you've got a big enough canvas, (**yawapbēm**)³⁸ then you throw that on top too. You pour a bucket of water on there, then you cover it. Anywhere there is steam coming, you cover it. And then you got to leave a guy there for a couple hours while the clams **kutsa** [steam]. When the clams open up, then they're done.

Our job was to open those clams up and scoop them out with a spoon. Then we put them in the **lēxēy** [clam basket]. When that's all done then you get the sticks, three of them. There about three feet long. You know what they use... thimbleberry trees [**ḡ^watmes³⁹** *Rubus parviflorus* Nutt.], that's what they use, or they used **ḵemcayuw⁴⁰** - like eulachon sticks. The old ladies put the stomachs (**takee**) on the center stick and then you figure-eight the **k^wabek** [lips] around the outer two sticks. When you are done the buttons [**galok^w**, adductor muscle] are all lined up on one side. When you get the clams on the **ḵemcayuw** [stick] you put it next to a fire to get it a little brown. You can chew on the **galok^w** [adductor muscle] all day, like chewing gum. You have to spit it out when you get tired of it. It gets bigger in your mouth when you chew on it. When the **kummāciy** is done, then you put it away. [When you want to eat the dried clams] you break the three sticks

³⁵ There are several different types of clams including the **dōlly** (cockle; *Clinocardium nuttali*), **gawiqaēm** (butter clam; *Saxidomus gigantea*), **ḡelḡlēm** (little neck clam; *Protothaca staminea*), and **metāney** (horse clam; *Tresus capax*). Terms provided by AD, orthography by DSS, translation by both AD and DSS.

³⁶ **ḵesḵenk^w**: Rockweed, *Fucus gardneri* P.C. Silva. Term provided by AD, orthography by DSS, translation by both AD and DSS.

³⁷ **kummāciy**: Dried clams. Term provided by AD, orthography by DSS, translation by both AD and DSS.

³⁸ **yawapbēm**: Canvas tarp. Term provided by AD, orthography by DSS, translation by both AD and DSS.

³⁹ **ḡ^watmes**: Salmonberry (*Rubus parviflorus* Nutt.). Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁴⁰ **ḵemcayuw**: Long skewers used for drying food. Term provided by AD, orthography by DSS, translation by both AD and DSS.

apart to remove them.... The guys from Gilford used to sell the **kummáciy** in Alert Bay; they used to get \$10 a stick (Pers. comm., 31 Jan. 2009)

During the long winter nights at Deep Harbour, K^waxistalla would sit out and look at the stars with his grandpa. His grandpa taught him songs for the Milky Way (**kandōyi**⁴¹; the seam of the heavens) and the Evening Star (**Maṭṭpinatus**)⁴². He also taught him about two star constellations [one of which was perhaps the Pleiades (Suttles 1987, p. 70; Boas 1938, p. 274)] called **ʔeludōy** and **k^wamma**⁴³ and told him that when these stars came close together, it would be time to leave Deep Harbour and paddle back to Kingcome for the early spring eulachon run⁴⁴.

One year, K^waxistalla and his grandparents left for Kingcome a little late, and were slowed down by the huge load of dried clams that they had with them, so his grandfather told him to throw much of their dried clams overboard so that they could paddle faster and not miss the valuable eulachon run. K^waxistalla did this, but when they got to Kingcome, the eulachons did not run that year so they had to go and get more clams. In other years, if the eulachons didn't run, they would make **sax^wk^wis**⁴⁵ (oil), from seal fat (K^waxistalla, Clan Chief Adam Dick and Michael Dick, pers. comm., 21 Feb 2009).

On their way into Kingcome K^waxistalla and his grandparents would stop and harvest herring (**wannēy**⁴⁶; *Clupea pallasii*) spawn. K^waxistalla remembers the process in great detail.

⁴¹ **kandōyi**: The Milky Way; literally, "the seam" of the heavens. Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁴² The Evening Star is the planet Venus. K^waxistalla explained that the song is about how the **Maṭṭpinatus** "comes around twice," being present both in the evening and the morning (Pers. comm., 10 Sept. 2009). Since Venus is a planet, when viewed from earth, its position varies independently of the background stars. Part of the year it is visible in the evening, and part of the year it is visible in the morning (Wikipedia, viewed 12 Nov. 2009). Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁴³ **ʔeludōy** and **k^wamma**: Two star constellations that when in overlapping, mark the arrival of the eulachon. Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁴⁴ Franz Boas (1938, p. 274) noted that the K^wak^waka^wak^w determined the arrival of eulachon fishing season by observing "the relation of high tide and the moon. They set out when the high tide of the second moon after the winter solstice is in the early morning." People were guided in different ways depending on the territory, and clan traditions, as well as on weather and other factors affecting travel and biological events.

⁴⁵ **sax^wk^wis**: Oil. Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁴⁶ **wannēy**: Pacific herring (*Clupea pallasii*). Term provided by AD, orthography by DSS, translation by both AD and DSS.

When herring are starting to spawn you leave the clams alone. You can't touch the shellfish for a month after the herring spawn. You come out to **Wassillas** in [Kingcome] Inlet. They call it **Wassillas** because **wassa** means "spawning". **Limo wassa** [means] "it's spawning now." **Wassillas** is between Charles Creek and Wakeman Sound. The herring spawn was a very short season, a couple hours only.

You tie two hemlock boughs together and hang them over a log. Each is about 4 feet [1 m] long. The log is anchored down so it doesn't drift. The herring come and spawn on the branches. You just lay on the beach [and watch], then you push out [in your canoe] and lift up the branch to check it.... If it is not thick enough, then you push it back down. When it is the right thickness you rinse it in the ocean to get the scales and fertilizer [milt] off. You don't want to have it too thin, too light. You don't want to have it too thick or it won't dry right.... If you could handle two logs, then you have two logs. I've seen lots of them anchored, so you don't have to go look for them on the kelps—on the seaweed. (Pers. comm., 30 Jan, 2009)

K^waxistalla said that they didn't harvest much herring spawn-on-kelp as was done in other locations on the coast because there wasn't much kelp (**papuq'q'w'aniy**⁴⁷; *Macrocystis integrifolia* Bory de Saint-Vincent) in Kingcome (Pers. comm., 31 Jan, 2009).

Once the herring spawn was deposited on the hemlock bows and harvested his family would either peel it off and eat it fresh or preserve it by drying. K^waxistalla said, "If you're going to dry it, you hang it on poles." To cook it he recommended boiling or frying. He said "... soak it with fresh water, 'til you get the right saltiness [you are getting rid of the salt by soaking it], then you boil it briefly. If you cook it too much it gets hard. They turn white when they're done. They call it **ʔeʔent**,⁴⁸ that's the name of the spawn.... I love herring [spawn]. I used to fry it with butter and a little salt. It's enough to make you smile in your sleep (K^waxistalla, Clan Chief Adam Dick pers. comm., 30 Jan., 2009, 10 Dec. 2009).

After the short herring spawning season was over K^waxistalla traveled with his grandparents to Kingcome to fish for eulachons (*Thaleichthys pacificus*) to make **ʔinna**⁴⁹ (eulachon grease). April is usually the month for catching eulachons but they sometimes start running at the end of March and occasionally are still in the river in early May. K^waxistalla's grandfather, as Clan Chief K^waxistalla, was

⁴⁷ **papuq'q'w'aniy**: Kelp (*Macrocystis integrifolia* Bory de Saint-Vincent). Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁴⁸ **ʔeʔent**: Herring spawn. Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁴⁹ **ʔinna**: Eulachon grease. Term provided by AD, orthography by DSS, translation by both AD and DSS.

the guardian of the eulachon (Turner field notes, 2 Nov. 1998) and K^waxistalla remembers going about 30 kilometres up the Kingcome river with his grandfather to see if the eulachon had started spawning yet. They would refrain from fishing until after the female eulachon had laid their eggs. K^waxistalla remembers watching the females laying strings of eggs on the rocks along the shore of the river. Eulachon are called **dāx^wʔen**⁵⁰ in K^wak'wala and K^waxistalla was taught about four different types of **dāx^wʔen**:

... the **təllqiyá** [sexually mature female], the **wissem** [sexually mature male], the **ʔinnağa** [“eulachon grease woman”] and the **mənmentilla** [largest, probably a year older than the sexually mature eulachon]. The **mənmentilla** is a little smaller than a cutthroat trout (Pers. comm., 21 Feb. 2009).

K^waxistalla's grandparents traditionally fished eulachon by constructing a weir across half of the river. The weir forced the spawned-out eulachons that were drifting down the river into the shallows where they were scooped out with a triangular net called a **peḡḡ^wayuw**⁵¹ (Figure 2.2). Later in K^waxistalla's life he started to see people using a **tagaḡ**,⁵² a long tubular net that was held between two hemlock (*Tsuga heterophylla*) wood pilings driven into the river bottom in a swift part of the river. Once caught, the eulachons were placed in a pit on the beach to partially decay and then rendered in a vat for their oil or “grease.” The grease floated to the surface when properly heated, and was skimmed off the top of the rendering vat and poured into containers. K^waxistalla's grandparents occasionally stored their grease in the cured hollow stipes and bulbs of bull kelp [*Nereocystis luetkeana* (K. Mertens) Postels & Ruprecht].

⁵⁰ **dāx^wʔen**: Eulachon (*Thaleichthys pacificus*); four types are distinguished as listed above. Terms provided by AD, orthography by DSS, translations by both AD and DSS.

⁵¹ **peḡḡ^wayuw**: A triangular net used for fishing eulachon. Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁵² **tagaḡ**: a long tubular net used for fishing eulachon



Figure 2.2. A diorama⁵³ of a traditional eulachon weir being used to divert the drifting eulachons into the shallow water where they could be scooped up with a net.

Once the grease-making work was finished his family caught eulachons to smoke whole and preserve as winter food. They strung the eulachons on cedar sticks called **'cəmcayuw**. Eulachons that have been half smoked for a short time and are still soft are called **wayuttən**⁵⁴ and eulachons smoked until they are really dry and hard are called **'cəmdaq**.⁵⁵ **'cəmdaq** stored well and could be eaten without cooking, so they were a popular snack for hunters (K^waxistalla, Clan Chief Adam Dick pers. comm., 10 Dec. 2009).

After the eulachon grease was made, K^waxistalla remembers going to the estuary with his grandfather and “long lining” for common mergansers (*Mergus merganser*). The female merganser is called **ħəmqqayuw** and male, **ḡəḡos**.⁵⁶ They used a choker hook called a **ḡəḡelutəħowyuw**.⁵⁷ They would bait the throat gorge with an eulachon and tie it to a line which was stretched between two poles

⁵³ This diorama was constructed in 2008 by K^waxistalla, Kim Recalma-Clutesi, Melissa K. Grimes, Amy Deveau, and myself under the supervision of K^waxistalla. It resides at the Liliwagela School in Kingcome.

⁵⁴ **wayuttən**: Lightly smoked eulachon. Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁵⁵ **'cəmdaq**: Hard smoked eulachon. Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁵⁶ The female merganser is called **ħəmqqayuw** and male, **ḡəḡos**. Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁵⁷ **ḡəḡelutəħowyuw**: A choker hook or throat gorge was made of deer or beaver bone and used for fishing and duck hunting. It was about 4-5 cm long and half a cm thick and was sharpened on both ends (K^waxistalla, Clan Chief Adam Dick, pers. comm.).

and anchored every few meters with rocks. Seagulls would try and eat their baited hooks while they waited for the tide to rise. The mergansers would forage following the rising tide and swallow the baited throat gorges (K^waxistalla, Clan Chief Adam Dick pers. comm., 9. Sept. 2008; 10 Dec. 2009).

They sometimes caught flounder by this same method. K^waxistalla caught two types of flounder⁵⁸ during the eulachon season. He recalls a big type called **paʔis** (*Platichthys* sp.) and a real big black type called **kadda** (*Platichthys stellatus*). Drag seining was a more common method for catching flounder. He and his grandfather used to drag a seine net along the sandbar offshore from the Kingcome River estuary, where there were holes from the flounders digging. They would clean the area of snags at low tide and fish the area at high tide. Even though they could not see the fish, they were often able to fill a canoe with flounder. The people outside of Kingcome would call these flounders “Kingcome halibut” because “we don’t get true halibut in Kingcome” (K^waxistalla, Clan Chief Adam Dick pers. comm., 9 Sept. 2008; 9 Aug. 2009).

In the beginning of May, K^waxistalla and the other children, who were not away in residential school, would seek out the young shoots of salmonberry (*Rubus spectabilis* Pursh), thimbleberry (*Rubus parviflorus* Nutt.), and cow parsnip (*Heracleum lanatum* Michx.) to peel and eat raw. They would sometimes go up the river to a place where especially robust thimbleberry and salmonberry sprouts grew and return to the village with armloads. As they walked through the village, all the old people would ask them for some of their sprouts, which they dutifully shared. In the fall and winter K^waxistalla would also collect **cakkus**⁵⁹—the large rootstalks of spiny wood fern [*Dryopteris expansa* (C. Presl) Fraser-Jenkins & Jermy]—from avalanche chutes on steep mountainsides, which his grandmother cooked in a steam pit until they were soft. They look like a clump of little bananas; the segments, once

⁵⁸ **paʔis** : *Platichthys* sp.; **kadda**: *Platichthys stellatus*. Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁵⁹ **cakkus** : The large rootstalks of spiny wood fern [*Dryopteris expansa* (C. Presl) Fraser-Jenkins & Jermy]. Term provided by AD, orthography by DSS, translation by both AD and DSS.

cooked, were peeled before they were eaten (K^waxistalla, Clan Chief Adam Dick pers. comm., 28 April 2008).

After the eulachon season was over K^waxistalla's family would again pack up their belongings and go out to the Broughton Archipelago to harvest a type of seaweed called **ṛeqqstən**⁶⁰ (*Porphyra abbotiae* V.Krishnamurthy) and to fish for halibut (*Hippoglossus stenolepis*). The **ṛeqqstən** season is quite short. Usually, the seaweed can only be harvested during about a 10-day window in mid to late May. When K^waxistalla was young he helped his mother and grandmother harvest the seaweed and spread it on the rocks to dry in squares (Figure 2.3). They preserved the seaweed after it was partially dried by pressing it into layered cakes in a bentwood box interspersed with the young boughs of western red cedar (*Thuja plicata* Donn ex D. Don) to keep the layers from sticking together. When he got a little older K^waxistalla would fish **pōy** (halibut) and other bottom fish with his dad or grandfather near the rocky island points in the same vicinity. His grandfather still used **yakkuw** or bentwood fish hooks to catch halibut. The halibut was sliced into thin strips, which were sun dried to make **məlmadūw**. During the time they lived at the seaweed camp they ate a variety of fresh seafood⁶¹ including sea urchin (**məssiq̄**; *Stronglyocentrotus* sp.), octopus (**təqqa**; *Enteroctopus dofleini*), chitons (**qannas**; *Katharina tunicata*), seagull eggs (**ciḡannuw**; *Larus glacescens*), and eelgrass (**cacayem**; *Zostera marina* L.). For this last, they selected the youngest rhizome segments with all but the tender central leaf removed; this leaf was wrapped around the rhizome. People usually harvested **cacayem** at low tide from the canoe, using a long twisting pole called a **kəlpbayuw** (K^waxistalla, Clan Chief Adam Dick pers. comm., 2008; Cullis-Suzuki, 2007).

⁶⁰ **ṛeqqstən**: Red lavar (*Porphyra abbotiae* V.Krishnamurthy). Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁶¹ Terms provided by AD, orthography by DSS, translations by both AD and DSS.



Figure 2.3. **Lhəq'əstə'n** (*Porphyra abbottiae*) drying on rocks in the Broughton Archipelago (left). K^waxistalla showing the author how to make seaweed cakes in a bentwood box (right, photo by Nancy Turner, May 2009).

After the spring harvest, K^waxistalla's family would again paddle the 40-50 km back from the Broughton Archipelago to Kingcome with a canoe-load of dried seaweed and halibut in order to arrive in time for the summer berry harvest. Salmonberries (**qəmdək**⁶²; *Rubus spectabilis* Pursh) were the first to ripen. K^waxistalla and his grandmother picked these by the basketload to make **təqqa**,⁶³ or sun dried berry cakes. They cooked the berries in bentwood boxes using hot stones, and spread the resulting berry mush out in thin layers on skunk cabbage leaves (**kaʔok**^w,⁶⁴ *Lysichiton americanus* Hultén & H. St. John) to dry in the sun. Half way through the day, K^waxistalla would flip the berry cakes over by placing more skunk cabbage leaves over the top of the partially dried berries, turning the cakes upside down, and peeling what had been the bottom skunk cabbage leaves off from the top. The naturally waxy coating and large size of the skunk cabbage leaves made them well suited for berry drying.

⁶² **qəmdək**^w: Salmonberry fruit (*Rubus spectabilis* Pursh). Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁶³ **təqqa**: Sun dried berry cakes. Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁶⁴ **kaʔok**^w: Skunk cabbage (*Lysichiton americanus* Hultén & H. St. John). Term provided by AD, orthography by DSS, translation by both AD and DSS.

As the summer progressed, K^waxistalla and his family harvested and processed a variety of other berries⁶⁵ such as red elderberry (*cixxinna*; *Sambucus racemosa* L.), salal (*nək'ət*; *Gaultherian shallon* Pursh), stink currant (*qisinna*; *Ribes bracteosum* Douglas ex Hook.), trailing black currant (*kəspuliy*; *Ribes laxiflorum* Pursh), red huckleberry (*g'adəm*; *Vaccinium parvifolium* Sm.) and blueberries (*nux'x'a*; *Vaccinium alaskaense* Howell and *V. ovalifolium* Sm.) the same way. Some berries, such as thimbleberry (*cəgət*; *Rubus parviflorus* Nutt.) and trailing blackberry (*dusdək'k'a*; *Rubus ursinus* Cham. & Schtdl.), were so delicious fresh and so difficult to get in large quantities that they were either enjoyed fresh or mixed with other berries to make *təqqa*.

Skunk cabbage (*kaʔok'*) leaves were also used to wrap food that was going to be cooked in underground steam pits. During the hot midsummer days, K^waxistalla said, the old people used to enjoy going up the river to look for *Loq*⁶⁶ or the inner bark of western hemlock (*Tsuga heterophylla* (Raf.) Sarg.). Although he was too young to participate in the harvest himself, K^waxistalla watched as people cut down hemlock trees that were about 30 cm in diameter next to the waterfall at *cəx'x'əlla*. They removed rectangular pieces of bark about 15 cm wide by 60 cm long. Then they scraped the *Loq* off of the inside of the bark, tied it in bundles, and steamed it underground. They always steamed it on location while they were up the river harvesting it. K^waxistalla said that this food smelled like strawberries while it was cooking. Sometimes, he remembered, they would sprinkle brown sugar on it to make it sweeter.

The abundance of berries and edible vegetation in the Kingcome Valley attracts bears, which people hunted for fur and meat. K^waxistalla's grandpa used to take him to check his *gəlden*,⁶⁷ or deadfall traps (Figure 2.4), which were located along game trails in the valley. Each trap consisted of a heavily weighted log placed across the trail about a meter and a half over another log. When the animal

⁶⁵ Terms provided by AD, orthography by DSS, translations by both AD and DSS.

⁶⁶ *Loq*: The inner bark of western hemlock (*Tsuga heterophylla* (Raf.) Sarg.). Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁶⁷ *gəlden*: Deadfall traps. Term provided by AD, orthography by DSS, translation by both AD and DSS.

tried to pass between the logs, it pushed against a nearly invisible string that was connected to a trigger, which freed the top log. This log fell on the bear and broke its neck against the bottom log. Both black bears⁶⁸ (**key**; *Ursus americanus*) and grizzly bears⁶⁹ (**gella**; *Ursus arctos*) were killed this way. Grizzly bears were never eaten but rather valued only for their large dense furs, which were used in specific ceremonial dances, or as bedding, or sold to the Hudson's Bay Company. In the fall and winter when deer⁷⁰ (**giwas**; *Odocoileus hemionus*) and cougars⁷¹ (**mamissa**; *Puma concolor*) were in the valley, they were also caught in this manner and used for their meat and pelts. K^waxistalla's father used to hunt for mountain goats⁷² (**melxuw**; *Oreamnos americanus*) for both fur and meat. K^waxistalla was fond of eating the **yassek**^{w, 73} or belly fat, of a mountain goat. He put a piece of it on a stick and roasted it like a marshmallow. His grandmother rendered mountain goat fat to make a highly prized facial cream. The rib meat of both deer and mountain goat was smoked and dried to preserve it for later use.



Figure 2.4. A 1:15 scale model of a black bear deadfall trap made by K^waxistalla and the author.

⁶⁸ **key**: Black bear (*Ursus americanus*). Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁶⁹ **gella**: Grizzly bear (*Ursus arctos*). Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁷⁰ **giwas**: Deer (*Odocoileus hemionus*). Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁷¹ **mamissa**: Cougar (*Puma concolor*). Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁷² **melxuw**: Mountain goat (*Oreamnos americanus*). Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁷³ **yassek**^w: belly fat of a mountain goat. Term provided by AD, orthography by DSS, translation by both AD and DSS.

All species of Pacific salmon⁷⁴ except sockeye (*Oncorhynchus nerka*) migrate up the Kingcome River and its tributaries to spawn in, and K^waxistalla's family fished them all. The sockeye do not run in the Kingcome River because they spawn in lakes and there aren't any big lakes for them to spawn in the Kingcome River watershed (K^waxistalla, Clan Chief Adam Dick pers. comm., 9 Aug. 2009). **Saccəm**, spring salmon (*Oncorhynchus tshawytscha*) run in May and June. They spawn in the Atlahtsi River, a tributary to the Kingcome River. In July and August the **hanun**, pink salmon (*Oncorhynchus gorbuscha*), and **dāwən**, coho salmon (*Oncorhynchus kisutch*), run up the river. Both the pink and coho salmon spawn in smaller tributary streams. The last to spawn is the **ǵ^waǵnis** dog or chum salmon (*Oncorhynchus keta*). There are two runs of dog salmon. The summer dogs start to run in late August, and the winter dogs start to run in October. They spawn in the main river. K^waxistalla reflected on the beautiful coloring of the dog salmon saying, "The old people say that the reason why the [dog salmon] are really colourful is because they are the last ones to go up the river, so [the creator] had to paint them really pretty (pers. comm., 9 Aug. 2009)."

The different types of salmon were used in different ways. Spring salmon have too much fat to preserve without quickly spoiling, so they were usually eaten fresh. Pink and coho salmon are intermediate in fat content and were either eaten fresh or smoked. Dog salmon were leanest and almost always smoked for use throughout the winter months. It was also a favourite for boiling fresh as a soup. Dog salmon were often caught high in the river valley by which point they had already spawned and had exhausted most of their stored fat reserves. This timing ensured that the smoked meat would not spoil and allowed for the reproduction of the species of salmon on which the people depended most heavily.

Each year K^waxistalla's family made several trips up the river to their smokehouse and inherited fishing ground to catch and smoke coho, dog salmon and pink salmon. They would catch and clean up

⁷⁴ Terms provided by AD, orthography by DSS, translations by both AD and DSS.

to fifty fish every day. While they were there, rainstorms would periodically raise the level of the river, making it impossible to fish, so they would pack wood, work the smoked fish and stay in the smoke houses until the river level receded. Occasionally, K^waxistalla' and his hunting partners Thomas Dawson and Dan Willie would pull a sled up the river to check the spawning ground late into the winter after the river had iced over; they would cut a hole in the ice to gaff the salmon (K^waxistalla, Clan Chief Adam Dick pers. comm., 9 Aug. 2009).

The late summer and early fall were busy with food gathering. In addition to periodic trips up the river to catch and smoke salmon K^waxistalla's family made day trips throughout much of the rest of his clan's territory. In September, **cəlx^w**⁷⁵ or Pacific crabapple (*Malus fusca* C.K. Schneid.) ripened along the slough by the large estuarine salt marsh meadows on the Kingcome River. The people would use a **gəlx^wayuw** or berry hook made from a long crabapple stick with a hook on one end (from one of the branches, trimmed back) to pull the crabapple branches down low enough to pick the fruit. Sometimes they pruned branches off the tree while they harvested. K^waxistalla's favourite way to eat crabapples was to wait for cold weather to soften and sweeten the fruit. At this stage they are called **k^wəmdək^w**. They have the consistency of applesauce and can be picked right off the branches and the soft insides sucked out. His family stored crabapples in water-filled bentwood boxes or wood barrels with a layer of oulachon grease overtop, this was called **cəlx^wstaʔak^w**.

Highbush cranberries⁷⁶ [**t'əls**, *Viburnum edule* (Michx.) Raf.] were another favourite of K^waxistalla's family and were harvested along the banks of the Kingcome River.

It's like cherries. It has big stones inside of them. They look like apples in the summer but towards the winter months they turn red. You harvest them in the early fall. At the same time as **Qiqalis**⁷⁷ (bog cranberries, *Vaccinium oxycoccos* L.) [in] September. They are kind of bitter like

⁷⁵ **cəlx^w**: Pacific crabapple (*Malus fusca* C.K. Schneid.). Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁷⁶ **t'əls**: Highbush cranberry [*Viburnum edule* (Michx.) Raf.]. Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁷⁷ **Qiqalis**: Bog cranberries, (*Vaccinium oxycoccos* L.). Term provided by AD, orthography by DSS, translation by both AD and DSS.

cel̥x̣ʷ. I think there are three or four berries together like **cel̥x̣ʷ** [crapapples], but they are round. In the fall they turn red and get a lot softer. You preserve them like **cel̥x̣ʷ**. You put them in those barrels with the rings around them. They are only about 12 inches high. I think they call them Japanese barrels. But before that they had them in a bentwood box with water and **kinna** on the top. Lots of them grow right on the river banks, up where the bridge was on **ʔax̣ad̥ey** River. Maybe they need lots of water I guess (Pers. comm., 2010).

During the fall K^waxistalla helped his grandmother and his mother harvest the roots of **te̥x̣ʷsus** (springbank clover, *Trifolium wormskioldii* Lehm.), **ləksəm** (silverweed, *Argentina egedii* (Wormsk.) Rydb.), **xuḳʷḳəm** and (northern riceroor; *Fritillaria camschatcensis*), from the clan-owned estuarine salt marsh root gardens (**te̥killaḳʷ**) at the mouth of the Kingcome River. They tilled their **te̥killaḳʷ** in the spring when they got back from harvesting clams, and weeded it then and throughout the summer. By fall the roots were mature and at the right stage for harvesting. They used **ḳellaḳʷ**,⁷⁸ digging sticks made of yew wood, to loosen the soil and to pry out the roots from the soft, worked soil without breaking them. They placed the harvested roots in open-work cedar-withe baskets called **ləx̣ey**.⁷⁹ The large open weave of the basket made it possible to quickly rinse and clean the roots by vigorously shaking the root-filled basket in the river. Once washed, the roots were then steamed in underground pits and eaten with eulachon grease. The traditional management of these root gardens and, in particular of **ləksəm**, is the main topic of the rest of this thesis, and will be discussed in more detail in the remaining chapters.

Later in the fall K^waxistalla and his family traveled up the river to harvest **Qiqalis** (bog cranberries), from some of the extensive floating bogs along the river valley (See Figure 2.5). They also continued hunting deer and fishing salmon throughout the fall.

⁷⁸ **ḳellaḳʷ**: Digging stick. Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁷⁹ **ləx̣ey**: Open-work cedar-withe baskets called. Term provided by AD, orthography by DSS, translation by both AD and DSS.



Figure 2.5. Jimmy Dawson, a childhood friend and close relative of Kwaxistalla, and Jimmy's Mother picking cranberries at the Kingcome River Valley around 1940 (Photographer unknown, courtesy of Kwaxistalla's personal collection).

Whether it was picking berries, replanting riceroot fragments, or pulling out salmon bones from **kawas**⁸⁰ (hard smoked salmon), Kwaxistalla's childhood contribution to his clan's traditional economy was an important part of his education. These activities were, in fact, a required aspect of his training as a Clan Chief, enabling him to understand the key relationship between the people and the other species and places of their territory and the requirements for sustaining and stewardship that are the responsibility of the Clan Chief.

Kwaxistalla's family also participated in a cash economy (See Lutz 2008), and as far back as Kwaxistalla can remember, he learned commercial trades as well. As a young boy of about eight Kwaxistalla worked for the Anglo British Columbia cannery at Glendale Cove in Knights Inlet, in the summer, stacking cans while his father fished and his mother packed salmon into the cans. He earned 5 cents an hour. Most of the other kids did not work, but he was able to get a job because his mother

⁸⁰ **kawas**: Hard smoked salmon. Term provided by AD, orthography by DSS, translation by both AD and DSS.

supervised all the women who packed salmon into cans. Around the age of 10 K^waxistalla fished with his father in a small skiff. They trolled for salmon or jigged for halibut. He cleaned halibut for his father and they sold the fish for 10 cents a pound. They would travel to Rivers Inlet to fish salmon during the month of June, then they would fish in Johnson Strait and Knight Inlet, and then, late in the summer, they would fish in Kingcome Inlet. During the winter K^waxistalla would set up little **golden** to trap small game, like squirrels and weasels, and sell their pelts to the Hudson's Bay Company. At the age of 11 or 12 K^waxistalla started trolling for spring salmon on his own. He would tie the line to his leg and row the skiff around in River's Inlet, fishing for Guildala Cannery. Some of the fish were so big that they would pull the skiff around when he caught them. By selling to cash buyers, he was able to work without a license, which he could not get at his young age.

2.6. Teenage Years: Industry and Responsibility

When K^waxistalla was 13, he applied for a fishing permit. He remembers his age because you had to be 16 to get a permit, so he was "16 for three years." He knew enough English to get the permit, but he had to sign his name with an "X" because he could not read or write, never having gone to western school. At the age of 13 he operated his father's gillnet boat by himself. It did not have a power block, so he had to fish in Parson's Bay where there was not a lot of traffic so he had time to pull the net in by hand. That same year, he took his first job in the forest industry. He worked as a "whistle punk" and would blow a steam whistle to communicate the actions of the steam donkey to the logging crew. Throughout much of his teenage years, K^waxistalla spent his summers working as an engineer on a seine boat called the **Wayus**, which means "sweetheart." Frank Dawson was the skipper and the crew were all teenaged extended family members of the skipper⁸¹. K^waxistalla was handy with motors and was able to keep the German-made 50-horsepower Rustin engine going. He also cooked for the crew on an old coal stove which, he mused, "took nine hours to boil potatoes." During the winters he either

⁸¹ Frank Dawson's crew on the **Wayus** were K^waxistalla, Ernie Scow, Scotty Coon, Peter Coon, and Norman Dawson.

found employment at logging camps close to Kingcome, or worked with his father hand logging in the Kingcome Valley. He enjoyed being outdoors and helping his family out. He reflects on this time saying, “I liked to be out there. There was nobody else, ‘cause everybody else went to residential schools—even my brothers—I was the only one to help out” (Pers. comm., 22 Feb. 2009).

K^waxistalla was doing more than just helping his family out; he was learning from a very young age to be a Clan Chief or ʔuǵ^wamey.⁸² As noted previously, his parents and the Ninoǵad or knowledge keepers who were alive during his early childhood deliberately kept him out of residential school and at times secluded him so that he could undergo training and learn the traditions of his people. His education included all elements of the culture, including being initiated into the p[̇]essa, the investment system, the laws of the Bighouse during the winter ceremonials to all associated with cultivating and harvesting traditional foods. His main cultural teachers were Gyosdisellas, Herbert Johnson ʔuǵ^wamey of the K^weliliy Clan and K̇yodiý, Dick Webber ʔuǵ^wamey of Lillawagilla clan. These Chiefs would take him into the Bighouse with other Ninoǵad, like it was a classroom, and lecture him on many many subjects, including, protocol and the laws of the various systems. K^waxistalla reflected on the intensity of his cultural educating saying, “I wasn’t allowed to play because I was going to school all day. If I went and played, they sent someone to go look for me to go sit in on a conference. If I got tired, they got a stick and hit me with it. They used the wordings, “One day you are going to be on the top of your people” (Pers. comm., 9 Aug. 2009). He was taken up the Kingcome River by canoe and landed on a sandy beach, where they used the sand like a chalk board to draw a square which represented the Bighouse. They explained that they were training him to be a Potlatch Speaker⁸³ (yaqent[̇]alǵes) and put an “X” in the upper left hand corner of the square, indicating his position during Bighouse events. During this time in his life, police boats would raid the villages and take children away to residential

⁸² ʔuǵ^wamey: Clan Chief. Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁸³ yaqent[̇]alǵes: Potlatch speaker. Term provided by AD, orthography by DSS, translation by both AD and DSS.

school. K^waxistalla was always carefully hidden or removed from the village so that he could continue his traditional education (Recalma-Clutesi 2007).

Participating in the seasonal round with his grandparents enabled K^waxistalla to learn firsthand the traditional food ways, plant technologies, and medicines of his ancestors. His grandparents and parents took him throughout the territory that he would one day be responsible for and taught him the history, songs, and other traditions of the **Qawadiliqella** Clan. Living with his grandparents served the dual purpose of educating him and keeping him hidden from the police, since many of the harvesting sites such as his family's smokehouse upriver or the cabin at Deep Harbour, were remote and difficult to access.

When K^waxistalla was about 12, both of his paternal grandparents had passed away. The threat of abduction from the RCMP had subsided so he began to work more closely with his other grandparents and parents. Amazingly, by his early teens, he even occasionally worked independently from his parents. During this time, as noted previously, he and his family had successfully integrated elements of the modern industrial economy with their traditional seasonal round. Fishing and logging contributed some cash to the family economy, but perhaps greater value came from the fish he did not sell, the eulachon grease he continued to make, and the game he hunted. Having a foot in both worlds enabled him to continue his cultural training and use his traditional knowledge to be more competitive in the industrial world. However, his contributions from this new economy were used in the same manner as the traditional economy: to look after the Clan and to potlatch. It was as if the currency changed, but not the products.

2.7. Taking the Helm

By the time K^waxistalla was 20 he had fished for more than 10 seasons and knew the marine waters of the Broughton Archipelago well. He apprenticed with his uncle James Sewid, who was BC Packers top commercial fisherman in the region and a traditionally trained **ʔuḡ^wamey** of the

Wi?umasgəm-mimawigən Clan (Spradley 1969). Although James Sewid's father and K^waxistalla's mother are closely related, K^waxistalla's father culturally adopted James's as K^waxistalla's brother so that K^waxistalla could speak at the Sewid Clan's Potlatches. According to the K^wak^waka'wak^w traditions, a Potlatch Speaker must be the brother of a Clan Chief, speakers were routinely held up and adopted as the Clan Chief's immediate family to act as advisor to the family as well (Mayanił?, Dr. Daisy Sewid-Smith pers. comm., 10 Dec. 2009). James Sewid's boat was called the *Twin Sisters*, for which he took out a loan to have built. It was completed in May of 1951 (Spradley 1969, p. 166). Later that year James got sick. He wanted someone to run his boat while he convalesced so that he could continue to make his payments. Neither of the two senior crew members wanted the responsibility. Though only 22, K^waxistalla was confident on the water and decided to skipper *Twin Sisters*. He reflected on this incident:

On my first day running the boat, I was motoring along in a place where there was not much boat traffic. I saw a fish jump and told the crew to prepare to set the nets. They laughed at me because there were no other boats around and they didn't think I would catch any fish, but I told them to tie it up to the beach and we made a big set. A bunch of fish came in and we pursed the net up and got quite a few. After that every time we set we got a lot of fish. Compared with the 28 other boats that fished for BC Packers, I was the high boat for the week. On the weekend, I went to see how James was doing. James said, "You did well, the manager came to see me, you were the high boat for the week. Do it again, I can't go out again this week." So I took the boat out again, and that was it. It happened, the same thing... I caught lots of fish, 2-3 thousand fish before the day was over. That's how I got my break. (Pers. comm., 9 Aug. 2009)

During those two weeks, K^waxistalla turned the heads of the BC Packers management by being the top fisherman in the region. Impressed by his fishing skills, they leased him a company fishing boat. From then on, K^waxistalla was always the captain of any vessel he worked on and his talent as a fisherman earned him a good reputation with the managers. He recalled:

...they gave me a boat. They call it the *Estra*... my production kept coming up. So they gave me a bigger boat, a lot bigger, the *Azumi Three*. I had that boat for about six years. So they gave me a bigger boat. They gave me the *Exhilder*... A lot bigger, I think it packs about 10,000 pieces. They told me to buy it, all I would need is 10,000 dollars to make a down payment. Both the manager and Jimmy [lent] me 10,000 dollars so my payments were smaller. In three years I paid off the boat. (Pers. comm., 9 Aug. 2009)

K^waxistalla also continued his cultural training throughout his life, until his teachers and mentors passed away. In 1951, the anti potlatch law was revised and in 1952 it was nullified and K^wak^waka'wak^w Clan Chiefs began trying to bring their Bighouse traditions into the public again (Sewid-Smith, 1979). Shortly thereafter James Sewid and Henry (Jumbo) Bell⁸⁴ conducted their first public potlatch in Alert Bay K^waxistalla worked as a **yaqent'alelges** (Potlatch Speaker) and James's daughter, Mayanił (Dr. Daisy Sewid-Smith) who was trained to be a historian and potlatch recorder for her Clan Chief, was entrusted with the potlatch records. He recalled the experience saying "I think that is when they (Clan Chiefs of other tribes) first found out that I can do those things." Due to the nearly 70 years of anti-potlatch legislation and ongoing residential school, several generations of K^wak^waka'wak^w people were unfamiliar with their language, laws, teachings and strict laws and structure of the potlatch and investment worlds of their people. As a Potlatch Speaker, K^waxistalla worked to recolor the faded tradition of his people.

K^waxistalla transitioned smoothly from student to teacher and several interconnected circumstances enabled him eventually to be at the center of K^wak^waka'wak^w cultural revitalization. First, and foremost, was the unique training he had received from the many Clan Chiefs, including his mother ʔanicca, Herbert Johnson, Dick Webber, and later in his life, James Sewid. During his cultural education K^waxistalla was taught the laws, formalities and protocols of the Bighouse, which were very different from the everyday world. K^waxistalla referenced some of these differences when he shared the uniqueness of the language that is spoken in the Bighouse. He said, "We have two languages, the everyday language and what they call the potlatch language⁸⁵. Because, when you enter the Bighouse

⁸⁴ Henry Bell had been arrested in 1921 for representing his daughter's interests at the marriage investment potlatch of Dan Cranmer and his wife Emma Bell on Village Island (Sewid-Smith 1979).

⁸⁵ K^waxistalla occasionally calls the potlatch language the "classic language". He explained that there are nine different **K^wak'wala** dialects, but the potlatch language was more universally (though not completely) understood (Pers. comm., 17 Aug. 2009). K^waxistalla speaks eight **K^wak'wala** dialects as well as the classic potlatch language.

your feelings change, your name changes, and your language changes. That is how powerful the Bighouse is.” He went on to say that speakers were very careful how they spoke in the Bighouse because the **Nawalak**⁸⁶ or Spirit is so close (Pers. comm., 9, 17, Aug. 2009).

K^waxistalla has been the Speaker at hundreds of potlatches, feasts, and ceremonies since the lifting of the potlatch ban. He has spoken for nearly every K^wak^waka’wak^w **ʔuǵ^wamēy**. K^waxistalla was the Speaker for James Sewid’s many potlaches and feasts until his death in 1988. In 1984 he served as the Speaker for a memorial potlatch Chief Harry Assu hosted for his late wife Ida (Assu and Inglis, 1989). As a Speaker, K^waxistalla was faced with the difficult task of renewing ancient traditions in a rapidly modernizing world. This is a skill that the great leaders of his time were capable of doing. With one eye they looked back in time to the traditions and laws with which they were intimately familiar, and with the other they looked forward, trying to do what was best for their people. They were capable of being both traditionalists and progressives. For example, James Sewid worked tirelessly to bring industry to his reserve, so that his people would have control over their own economy and not have to rely on outsiders for the industry that would inevitably come (Spradley 1969). However, investing his people in a modernizing economy did not limit his efforts to revitalize and celebrate his culture. After the anti-potlatch legislation were lifted, Clan Chief James Sewid and Clan Chief Henry Speck of Turner Island, asked K^waxistalla and his Chieftain parents to move to Alert Bay to help constructed the first ceremonial Bighouse of the 20th century in Alert Bay and help bring the culture out of underground. (Spradley 1969, p. 236-257). Kwaxistalla, his brothers and father carved the house posts and cross beams; his mother and father taught everyone to dance; they advised on ways to make the ancient ceremonies work in this new world and economy. Likewise, Billy Assu, a famous chief of the **Weqqey**, brought modern homes with running water and electricity to Cape Mudge in 1920 and at the same time supported the potlatch

⁸⁶ **Nawalak**^w: Devine spirit. Term provided by AD, orthography by DSS, translation by both AD and DSS.

traditions. Harry Assu reflected on his father's accomplishments: "it has been good in both ways: modern and traditional" (Assu and Inglis, 1989 p. 58).

K^waxistalla applied his competence and training in a similar fashion in both the "western" and traditional worlds. He simultaneously worked on seine boats and built dugout canoes. With his grandfather he split planks off the giant cedar trees using crabapple wood hammers and yew wood wedges, but he also cut shingles with a table saw he fabricated on his own and powered with his mother's washing machine motor. He made eulachon grease every year he could, but embraced technologies that made the process of rendering the grease more efficient. For example, he used that same washing machine motor to power a pump that brought the 2000 litres of needed water to the rendering vat. The technologies always seem changed, but the values and laws of food gathering and applying the culture never changes in his K^waxistalla's mind. Most significant, however, was his skill at modifying and adapting the potlatch traditions to the needs of the contemporary lifeways. During the potlatch ban, ceremonies and the transmission of names and titles that traditionally took several days to complete had to be condensed to a single evening to avoid attracting attention from authorities, as well as, later, to meet the expectations of a modern workweek. Out of necessity for sustaining these traditions, K^waxistalla found ways to consolidate them (Recalma-Clutesi 2007). K^waxistalla not only adapted ceremonies, he also made significant corrections.

Watching K^waxistalla operate in the potlatch world is witnessing a fulfilled vision. He is at no other time more vibrant or more alive. The flickering firelight and smoky haze that permeate the Bighouse do little to cloud K^waxistalla's connection to the ancestors. I hear it in his voice, see it in the way everyone reacts to him, and almost feel the energy that he is able to channel, which must be what is called the **Nawalak^w**. These are attributes that come from his lineage and training—an actualized prophesy—and make him the leader that he is. K^waxistalla's role as potlatch speaker is actually closely tied to his knowledge, experience and expertise in the **'tekillak^w**, and other management systems

surrounding K^wak^waka'wak^w resources. These are all part of his holistic training as Clan Chief at a time when such training was rare.

2.8. K^waxistalla the Clan Chief

Throughout K^waxistalla's adult life as the ʔuḡ^wameȳ of the Qawadiliqella Clan, he has hosted dozens of potlatches and countless feasts. Like his ancestors, he was always planning the next potlatch and always amassing wealth for distribution at these events. He reflected on this period of his life saying, "I potlatched so many times. It was cheap. It only cost me \$10,000, in the 60s [to potlatch] (Pers. comm., 9 Aug. 2009)." During a two-year period in 1993 and 1994, towards the end of K^waxistalla's fishing career, he hosted three potlatches in the Bighouse and a fourth during the Commonwealth Games, following the dramatization of his clan's origin story, when he fed over 150 people who worked for him to produce this drama.

K^waxistalla's efforts to retain and invigorate his culture extend beyond his chieftainship and role as Potlatch Speaker. He is an artist and craftsman as well. In the 1960s, K^waxistalla helped James Sewid build the first ceremonial Bighouse of the 20th century at Alert Bay, which was opened on June 18, 1966 (Spradley 1969, p. 228-253). His father, James Dick (also named K^waxistalla), used this momentous occasion to pass on his name to his son⁸⁷ (K^waxistalla, Clan Chief Adam Dick pers. comm., 4 Jan. 2010). He also worked with his extended family in Alert Bay to carve the world's tallest totem pole. The Mayor of the Town of Alert Bay, Dr. Pickup, wanted to make a pole taller than the "world's tallest totem pole" in Victoria. K^waxistalla recalled the experience:

...me, my dad and my two brothers—Benny (Blackie) and Charlie—my cousin Gus, and Daisy's sister, Dodo [built that totem pole]. My dad was the head carpenter, telling us what figure we were going to put on. I was doing the roughing with my brother. My cousin, David Matilpi was working with my other brother doing the finishing touches, and Dodo [Dora Cook] was the painter. It took us six weeks to complete the 173 foot log. [The log] was spliced. An engineer from Victoria went and spliced it, went and added a boom stick on top. And the 60 feet on top

⁸⁷ Prior to this event, K^waxistalla (Adam Dick) went by another Chieftain name, Tlakwagila, which means "Copper Maker." He holds dozens of names, both everyday and Chieftain from his various positions and kin relationship to many Clan Chiefs.

wasn't carved, it was just painted, because you can't see it, it was so high up there. When we completed that pole, it sat there for two years because they couldn't figure out how to raise it. They were worried it was going to snap because the top was only 6 inches thick. They raised it up with an old gravel truck and used a Gin block. They had cables running all the way down the hill. I thought it was going to snap, it was so curved. (Pers. comm., 17 Aug. 2009)

And in the late 1970s, K^waxistalla and his father sat on the Chiefs' Advisory Committee for the construction of the Kwagiulth Museum (now called the Nuyumbalees Cultural Center) at Cape Mudge, which was constructed to house the regalia and cultural objects that had been confiscated following the Cranmer/ Bell Potlatch in 1921 and then repatriated, subject to the building of the museum (Nuyumbalees Cultural Center online, accessed August 2009). When the museum was finished in June of 1979, he gave a speech at the opening ceremony. Sadly, that was one of the last cultural events that K^waxistalla attended with his father, who died later that year, on December 13, 1979 in Nanaimo, BC.

In the late 1980s, K^waxistalla worked for Aldona Jonaitis, anthropologist of the American Museum of Natural History in New York, and with Peter McNair, ethnologist at the British Columbia Provincial Museum (renamed the Royal British Columbia Museum in 1986) in Victoria. He traveled to museums around the world identifying K^wak^waka'wak^w art that had been gathered by early maritime fur traders, explorers and collectors. He has travelled the Field Museum in Chicago, New Zealand, Switzerland, and the Royal Ontario Museum in Toronto. He also made several trips over the course of three years to the American Museum of Natural History in New York. K^waxistalla was tasked with identifying the usage, name, and owner of artifacts and masks at these museums. He often knew from where they originated. This information was compiled in the book Chiefly Feasts, the Enduring Kwakiutl Potlatch, edited by Jonaitis (1991).

K^waxistalla's unique combination of specialized training, oratory skills, innate leadership position and charisma attract attention. Even as a young man, K^waxistalla impressed author Margaret Craven, who modelled the character "Jim" after him in her bestselling novel, I Heard the Owl Call My Name (Craven 1973; K^waxistalla, Clan Chief Adam Dick pers. comm., 24 Aug. 2009). In 1994, when

Victoria hosted the Commonwealth Games, as mentioned previously, K^waxistalla orated in front of 35 thousand people (and 500 million live on television!) at the opening ceremony. He shared the **Qawadiliqella** origin story while giant human-powered representations of the supernatural characters of the story enacted the saga in the stadium field at the University of Victoria. He recollected the scale of the event: “I had 500 people working for me at that Commonwealth Games. The Wolf was 56 feet tall [which is still the largest prop to be shown at a Commonwealth Games] and the Sisuitl was 104 feet long” (K^waxistalla, Clan Chief Adam Dick pers. comm., 17 Aug. 2009). K^waxistalla oversaw every element of the production over the course of the 18 months preceding the event.

Later K^waxistalla featured in the National Geographic film [Ancient Sea Gardens](#) (Szimanski 2005) and shared some of his knowledge of clam gardens and other traditional foods. Most recently, K^waxistalla was the principal subject in the award winning film [Smoke From His Fire](#) (Recalma-Clutesi 2007), which is about his own life experiences and traditional knowledge, especially in his role as a Potlatch Speaker.

In recent years, K^waxistalla has focused on ensuring that his specialized Traditional Ecological Knowledge is documented and remembered. He retired from fishing when the fish prices dropped in the mid 1990s. Since then he has continued to serve as a Potlatch Speaker, but has broadened efforts to include those outside the Ceremonial Bighouse. For example, in 2007 he was featured as an expert on traditional knowledge by Buffalo Spirit, an Aboriginal Media Foundation Production (Crowfoot 2005); in 2008 he led a workshop on traditional eulachon fishing gear in Kingcome; in 2009 gave the keynote address at the Vancouver Island Traditional Foods Conference in Nanaimo and countless other workshops and engagements relating to TEK. He is known internationally as a resource for teaching about his customary laws as it relates to Intellectual Property (Recalma-Clutesi 2007).

K^waxistalla continually works with scholars when their studies support his Clan Chieftain obligations. In 1994 he began a long-term collaboration with ethnobotanist Dr. Nancy Turner (Turner

2005; Deur and Turner 2005; Turner and Turner 2008) and has subsequently worked with several of her colleagues and graduate students on topics including *nuyem* (Bouchard and Kennedy 2002) and indigenous foods like eelgrass, *Zostera marina* (Cullis-Suzuki 2007), *Porphyra abbottiae* (Amy Deaveau, in progress), clam gardens, and of course the 'tekillak' gardens and the root crops they produce (Deur 2000, 2002, 2005), which has been the focus of my research. He has lectured repeatedly at the University of Victoria, UBC, North Island College and Malispina College (now Vancouver Island University) in courses on ethnobotany, ethnoecology and ethnohistory, and has hosted dozens of screenings of the films that feature his traditional knowledge as a regular part these courses' curricula.

K^waxistalla's life is full of contrasts that are testament to his unique character. Despite nearly lifelong illiteracy, he is the teacher of professional scholars and graduate students. Though raised in a small wood house with no running water or electricity, he has built some monumental buildings and enjoys using shop equipment and gadgets of all manner. Hidden away as a child, he now faces the world on filmed documentaries and from the pages of books about his people. While K^waxistalla's greatness stems from his innate character, much can also be attributed to his specialized training, for he not only lived the traditional seasonal round with his family, but he was trained by several of the great Clan Chiefs of his day to be a keeper of the culture, steward to the resources of his Clan's traditional territory and a leader of his clan. At the time of this writing, he is one of the oldest living K^wak^waka'wak^w, the last to speak all 9 dialects of his language and truly speaks with the voice of his ancestors and stands as a conduit of knowledge extending back many centuries before European contact.

Today, the world is much different than it was eight decades ago when his mother dreamt of the arrival of her special son. Sometimes K^waxistalla laments that his profession is finished because today, few people listen, and even fewer understand the ancestral teachings and language of the cultural world he was raised to convey. At these times he regrets having been kept out of the residential schools because he feels it is impossible to accomplish anything in the modern world "without an education."

Though sobering, his frustration is ironic, for it is principally because of his *traditional* education that he has such rich knowledge and so much authority about the ways of his people, and in the case of this thesis, about the stewardship of a food system.

Chapter 3. Tools Used in Association with Edible Estuarine Salt Marsh Roots

3.1. Introduction

In this chapter I describe the various tools, structures, and containers made and/or used by K^waxistalla in managing & harvesting from the 'təkillak', and in processing and serving the harvested roots. Each of these is the product of a whole array of knowledge and skills- from where and when to harvest the materials, to their crafting, to how they are applied.

Harvesting, processing, and eating estuarine salt marsh roots required a wide variety of structures and containers. These included: canoes and paddles, poles, and sails for accessing the 'təkillak', implements for cutting the dead or dying vegetation off the roots, digging sticks for weeding and prying the roots from the soil, baskets for washing and transporting the harvested roots, temporary shelters for the people working on the 'təkillak', earth ovens or cooking pits and cooking rocks to cook the roots, boxes for storing and other purposes, tongs for handling hot food and rocks, and wooden dishes for serving the roots. As part of my apprenticeship with K^waxistalla, Clan Chief Adam Dick, he taught me about most of these tools and in keeping with my experiential approach, we replicated three of the most important: digging stick, harvesting basket, and bentwood box. In this section I will briefly describe each of these tools from the perspective of how they are made and used based on K^waxistalla's teachings.

3.2. Digging Stick

Digging sticks are the most important tool for managing the 'təkillak'. They were used for weeding, soil tilling and root harvesting. People also used digging sticks for a variety of other harvesting activities such as digging clams and collecting tree roots for weaving. I had the opportunity to work with K^waxistalla in making a yew wood digging stick, called a kəllak, and then to practice using it over the

course of a six-month field season. In the end, I was able to make many of these implements, which we gave to the other people who helped with my work. We also crafted miniature **kəllak**^w to distribute at *K^waxistalla's* root garden feast.

3.2.1. Constructing a Digging Stick

The first step in making a digging stick is material selection. *K^waxistalla* said that yew wood⁸⁸ (**kəm̩q̩q̩a**; *Taxus brevifolia* Nutt.) is what he was taught a digging stick should be made from as yew is both strong and hard. It is important to select a yew tree that is straight with few side branches or knots. *K^waxistalla* recalled a special place called **xax^wtemá?** in the middle Kingcome River valley where the yew trees grew so close together that they had few lower branches. Once a tree about 15 cm in diameter is selected and felled, a section about 1/3 longer than the leg of the user of the future digging should be removed. This log is then quartered lengthwise. Quartering the log prevents the wood from splitting, since the summer and fall growth rings dry differentially and are free to move independently when the wood is cut in this way. A log can easily be quartered with the aid of power tools, such as a planer for flattening two sides of the log, and a band saw for cutting the log lengthwise down the middle. The largest and most knot-free quarter should then be selected as a digging stick “blank.” In the old days, before power tools, the tree was cut and split using stone tipped chisels and yew wood wedges.

The side and top profiles of the digging stick are first drawn onto the blank. The “blade” or digging end should be flat-faced, three-sided, sharp-pointed, and a little longer than the depth of the roots being dug so that it can slide easily into the soil and be used to pry out the roots without breaking them. For estuarine salt marsh roots, a digging stick blade 30-35 cm long is adequate. The “shaft” of the digging stick needs to be thick enough to withstand a great amount of torque; 3-4 cm is the usual

⁸⁸ **kəm̩q̩q̩a**: Pacific yew (*Taxus brevifolia* Nutt.). Term provided by AD, orthography by DSS, translation by both AD and DSS.

width. Handle styles are variable, but the top of the handle should be wide enough to enable the stick to be pushed on comfortably by the person digging with their full bodyweight. The digging stick can be cut with a bandsaw and the necessary corners rounded by hand or with power tools.

The next step is hardening and treating the digging stick. K^waxistalla said that it is important to fire-harden the tip of the digging stick. This can be done by holding it over a fire and heating it until it nearly starts to burn. Heating the wood should be alternated with rubbing it with oil. K^waxistalla recalled using mountain goat tallow as the preferred oil. He also said that the digging stick should be smoked periodically. Smoking the digging stick gives it a black color and may coat it with creosotes that help preserve the wood. K^waxistalla recalled that his grandmother's digging stick was black. Every year K^waxistalla's grandfather ritually smoked all the tools in the house with the smoke from burning the tip end of the ʔəliwas,⁸⁹ Sitka spruce [*Picea sitchensis* (Bong.) Carrière]. Digging sticks should be stored in a cool dry place.

There is a great deal of variability in digging sticks. As I learned over the course of constructing 11 digging sticks, the length, handle type, shaft thickness, digging-face length, and many other subtle details, are all subject to modification. One might ask, "What makes the best digging stick?"

Lagius⁹⁰, an early K^wak^waka^wwak^w consultant of Edward Curtis, described a digging stick as follows:

... Roots were dug with a yew implement about four and a half feet long [1.4 m], the lower end being shaped like a pointed canoe-paddle, and the handle being provided with two bulging, spool-shaped hand-holds. The back of the blade retained the natural curve of the tree, but the front was flat (Lagius, n.d. in Dzawada'neux'w Land & Resource Office Newsletter 2008).

⁸⁹ ʔəliwas: Sitka spruce [*Picea sitchensis* (Bong.) Carrière]. Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁹⁰ This account was published in the Dzawada'neux'w Land & Resource Office Newsletter in 2008. I was unable to view the original document. While the early nature (likely prior to 1915) of Lagius's description makes it valuable, it must be understood as an observational account and not confused with the account of a culturally trained resource steward.

Edward Curtis (1915) and Franz Boas (1921) also provided descriptions of Kwakwaka'wakw root garden digging sticks. Table 3.1 summarizes digging stick features from a variety of historical and the lessons that I learned while interviewing Kwaxistalla. Yew wood was the wood preferred according to the majority of the sources. There is great variability in the total length of the digging sticks described, but they fall within a range of 75 cm to 140 cm. My experience taught me that people of different sizes require digging sticks of different sizes. This is confirmed by the “hip height” description used by Kwaxistalla when he was instructing me about making digging sticks. Furthermore, different digging activities required different digging sticks, according to Franz Boas (1921, p 188), “Sometimes the man who makes the digging-stick makes a smaller digging-stick for the [clover], for it is thinner and one span shorter than the [silverweed] digging stick,” (bracketed plant names are corrected by the author based on the original Kwakwaka'wakw account). Boas (1921, p. 145) also provided directions for a specialized riceroot digging stick. Digging sticks were likely used, on occasion, to dig items other than what they were designed for. For example, this summer (2010) I used my digging stick, which was designed primarily for silverweed, to dig riceroot, and it worked to good effect. Differentiation in digging sticks may be further supported with linguistic evidence. Kwaxistalla calls the digging stick we made a **kollak**. Other terms that Boas and Laguis (n.d. in Dzawada'neux'w Land & Resource Office Newsletter 2008) used for root digging sticks are **ts!oyayaxa** and **tsoyayu**, respectively.⁹¹

⁹¹ Kwaxistalla explained that **tsoyayu** is another word for **kollak**, but he never heard of the word **ts!oyayaxa** and he speaks all 9 dialects of Kwakwaka'wakw.

Table 3.1. Digging stick specifications from historical and living sources.

| Features | | HISTORICAL LITERATURE | | | | INTERVIEWS | |
|---------------|---------------|------------------------------------|-------------------------------|--|-------------------|----------------------------|--|
| | | Curtis 1915 (Kwakwaka' wakw) | Lagius (Kwakwak a'wakw) | Boas 1921 (Kwakwaka'wakw) | Underhill 1945 | Clan Chief Kwaxsistalla | made with Kwaxsistalla's direction |
| Wood type | | Yew | Yew | Yew | spruce | Yew | Yew |
| Size | total length | 75-140 cm | 140 cm | 140 cm | | Hip height | 75-120 cm |
| | blade length | | | 75 cm | | | 22-38 cm |
| | blade width | | | 10 cm | | | 4-7.5 cm |
| | handle length | | | 60 cm | | | 45-60 cm |
| Handle | | T | Spool | Spool | Spool | Ball | Ball, Spool, Canoe |
| Treat ment | smoke/fire | | | Fire hardened | | Smoked till black | Smoked until black |
| | oil | | | Tallow and perch oil | | Tallow | Tongue oil |
| Name | | | tsoyayu | Ts'loyayaxa (for roots) K'lilakwe (for clams) | | Kelakw | |



Variations in handle style can be attributed to different soil conditions, tool use, or personal preference. Hard soils require a “T” style handle, the “T” shape being created with a separate cross piece “upon which pressure could be applied with the abdomen (Curtis 1915).” I found a handle with two bulges on either side of the grip (making a spool shape) useful from both a standing and kneeling position.

One may also ask why anyone should bother with a wooden digging stick today when steel shovels are available. After a summer of primarily using my digging stick, and occasionally using a shovel, I found that I preferred the digging stick for the following reasons: it is lighter, it doesn’t rust in brackish water, and it slides between roots instead of slicing through them. The last time I harvested camas bulbs with a shovel I sliced approximately 15 percent of the bulbs in half. When I use my digging stick I probably damage less than 5 percent. For estuarine salt marsh roots, a shovel easily cuts through tough grass sod, but it also slices many of the edible roots. A metal clam fork may be the only good modern substitute for a digging sticking. Beverly Lagis (2008) remembered using a clam fork as a child to harvest estuarine salt marsh roots in Wakeman Sound.

As noted previously, the digging stick is an invaluable tool for maintaining estuarine salt marsh root gardens. My experience in learning to make yew wood digging sticks with K^waxistalla, and then in actually using the **ḱellak^w** in working the **ṭekkillak^w**, have helped me to appreciate the subtle details contributing to a good digging stick. I regularly use my digging sticks, and find them to be superior to a steel shovel because they do not damage the roots but rather slide between them and can be used to lever them out of the ground. The digging stick represents an important cultural relationship with the landscapes that historically supported coastal First Peoples. By working with K^waxistalla to create and disseminate several digging sticks, I hope that I have helped revitalize an important piece of K^wak^waka'wak^w culture.

3.3. Constructing a **ləx̄ey** for Estuarine Salt Marsh Roots

The second major item used in association with the **ṭekkillak^w** is a basket called a **ləx̄ey** for gathering and washing the harvested roots. This sturdy, open-work style basket of cedar withes was used for harvesting both estuarine salt marsh roots and clams, enabling the harvester to quickly rinse the dirt or sand off of the roots or shellfish by immersing the entire basket and its contents in water and shaking it vigorously. As we began to develop the root garden, K^waxistalla suggested making a **ləx̄ey**, so that he could demonstrate how the roots were traditionally harvested and cleaned. This required a great deal of time, several field trips to the Royal BC Museum in Victoria to view existing **ləx̄ey**, and consultation with other basket weavers. Various ethnographic sources including Underhill (1945 p. 95-105), Boas (1921, p. 134-136), Goddard (1924 p. 46-53), and Stewart (1984 p. 171-177) were also consulted. The following is an account of our experiences and lessons learned while constructing a **ləx̄ey**.

3.3.1. Constructing a **ləx̄ey**.

K^waxistalla prescribed a suite of materials necessary for **ləx̄ey** construction: split cedar withes, called **teḵḵem**,⁹² form the “ribs,” which are twined together with either split spruce roots or split cedar roots, called **ḵuppek**⁹³, or cedar inner bark, called **dennas**.⁹⁴ K^waxistalla told me that it was easy to harvest the spruce roots from the sandy soil along the lower reaches of the Kingcome River. While I was up in Kingcome doing my fieldwork, I took advantage of the opportunity to collect some **ʔəliwas** (Sitka spruce) **ḵuppek** from the sandy river delta. Although my harvesting experience is limited, I found that harvesting from sites with lower tree density (i.e. where there are bigger trees) is easiest because there are fewer criss-crossing roots. Untangling crossed roots slowed the process considerably, and such roots often were misshapen where they touched another root. Nancy Turner told me that the Haida basket weaver and elder Florence Davidson was careful not to harvest too many roots from one tree, and would often harvest from alternating sides of a tree in alternating years (Pers. comm., 2007; See also Turner 2004 and Turner and Peacock 2005). Another basket weaver from Kingcome also gave me the tip to look for the roots of spruce trees that have recently been undercut by the river, as these are already exposed and easier to harvest.

Roots should be harvested in the late spring and early summer while the sap is running so that the bark will peel easily from the woody roots. The bark can also be loosened by heating the roots over a fire. I found that the easiest way to remove the bark was to rub the roots against the corner of a length of wood. George Hunt also documented a practice of removing the bark by pulling scorched roots through the split crotch of wooden tongs (Boas 1921, p. 117).

Spruce roots are an incredible, tough material. When they are fresh or well-soaked, you can tie them in a knot without the wood breaking and they have a good deal of tensile strength. Franz Boas

⁹² **teḵḵem**: Split cedar withes. Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁹³ **ḵuppek**: A general name for roots from a plant or tree. Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁹⁴ **dennas**: The inner bark of cedar. Term provided by AD, orthography by DSS, translation by both AD and DSS.

(1921, p. 116-119) includes several detailed accounts of how to harvest and prepare spruce roots. He documents a process of removing the pitch by rubbing the fresh-peeled root across the edge of a knife several times until the root turns white. This is supposed to make the root more permanently flexible. I did not remove the sap from my roots and they did become brittle when they dried out. I noticed also that my roots became discoloured with mould very quickly, and I imagine that the sugary damp sap still in the wood caused the growth of this mould. Removing the sap may also have been done to prevent the roots from moulding. After peeling and drying the roots, I coiled them for later use.

Cedar withes (**teḵḵem**)—the long slim branches—provide the structural support and are the main ribs for the **leḵey**. K^waxistalla said it is much easier to peel and process these withes when they are harvested in the summer. He said that good **teḵḵem** are long and fairly straight, with little lateral branching and no heartwood. He gave the word **ḵenak**⁹⁵ for a knot in the wood, and said that “[the knot] is where they usually break.” He noted that the sapwood bends easily while the heartwood is brittle, and that it is best to soak the withes before weaving with them. While splitting our cedar withes, K^waxistalla pointed to a dark section of the wood and said, “See here, there’s no more sap [wood] in here, [the branch is] getting too big. This is what you’ve got to watch.” He even gave the word **k^waḵtoḵʷid**,⁹⁶ which means “turning into wood” or “starting to get hard,” to describe the process of transforming from sap wood into heart wood. K^waxistalla said that basketry materials were collected at a very different season than when the baskets were constructed.

Me and my grandpa used to pole up to the waterfall (**ceḵx^wella**). There used to be lots of cedar up there. Lots of **gəlsəlt^wḵanək teḵḵem** (very long branches, cedar withes). They split it, coil it, and hang it on the wall in the summer. When it’s time to make baskets in the winter—[during the] long hours—they soak it. That’s what my grandmother used to do.

Splitting roots, withes, or inner bark is a skill fundamental to basket weaving, but takes some practice. Max^wə d^ʔI, Chief George Shaughnessy (Pers. comm., 2008) has a good technique,

⁹⁵ **ḵenak**: A knot in wood. Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁹⁶ **k^waḵtoḵʷid**: Turning into wood. Term provided by AD, orthography by DSS, translation by both AD and DSS.

Start by cutting half-way through the material that you are splitting. If you are splitting a cedar withe, you can break the tip end of the withe halfway through. As you split down the length of the material, the split will drift away from the centre to either the right or the left. If the split needs to move to the right, pull down on the right side while leaving the left side vertical.



Figure 3.1. Spruce root cross section (left) with horizontal lines showing split marks. Cedar withes (**teḡḡem**) ready to be debarked and split (center; these are around 120 cm long). Splitting spruce roots (right).

In a trip to view K^wak^waka'wak^w baskets at the Royal BC Museum, K^waxistalla and Mayaniḡ⁹⁷ identified a **leḡey** and elucidated the difference between several other forms of baskets. K^waxistalla identified a large rectangular, flat-bottom basket, labeled as a “clam basket,” as the best representative of a **leḡey**. He also gave names for the smaller berry basket⁹⁸ with a tumpline (**heyaciy**) and small basket with a lid used for small items like jewelry (**pekkuw**,⁹⁹ not shown), and confirmed that the **leḡey** could be used for both estuarine salt marsh roots and clams. The basket K^waxistalla liked best was made of split cedar withe “ribs” twined with the inner bark of western red cedar, which K^waxistalla called **dennas**. He also explained how the bark was harvested from a tree with the help of a bone knife called a **q^wittanna**,¹⁰⁰ which is made from the ulna of a deer and is ground on a rock till it is sharpened to a point.

⁹⁷ University of Victoria graduate student in Linguistics Melissa Kingan Grimes, Dr. Nancy Turner, and Royal BC Museum Curator of Ethnology Brian Seymore were also present to help facilitate this process.

⁹⁸ **heyaciy**: Berry basket, usually used with a tumpline. Term provided by AD, orthography by DSS, translation by both AD and DSS.

⁹⁹ **pekkuw**: A small basket used for storing jewelry. Term provided by AD, orthography by DSS, translation by both AD and DSS.

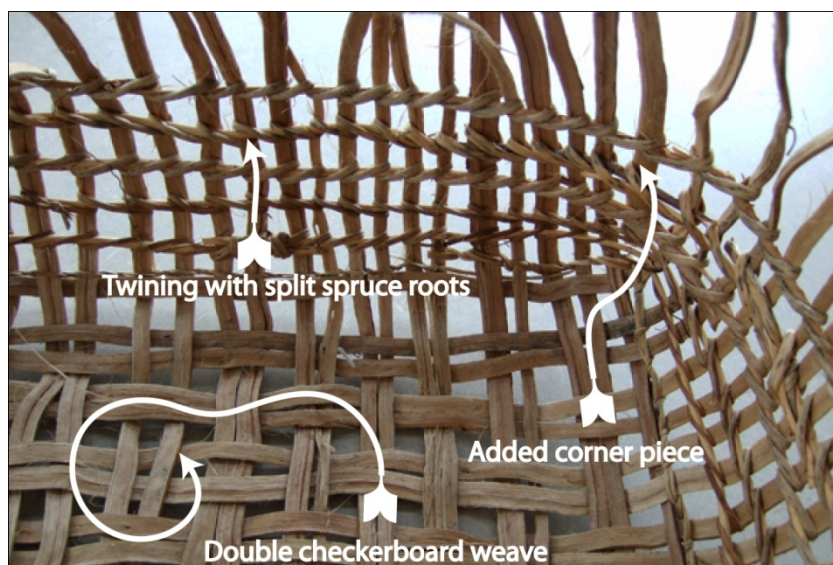
¹⁰⁰ **q^wittanna**: A bone knife. Term provided by AD, orthography by DSS, translation by both AD and DSS.

The **q̣'ittanna** is also used to start a cut for splitting (**pac̣ca**)¹⁰¹ the cedar bark, spruce roots, and cedar withes into halves.



Figure 3.2. Two types of K'wak'aka'wak' open work baskets from the Royal BC Museum collection (Catalogue numbers 12858 and 15433). The photo on the left is a **heyacyi** and in the middle is a **loxey**. The photograph on the right is a **q'ittanna** made by K'waxistalla.

The base of the **loxey** basket has a double checkerboard weave pattern (see Figure 3.3). The perimeter of the base is twined with a split spruce root or piece of cedar inner bark to hold the basal pieces in place. Horizontal cedar withe side pieces are then be twined onto the vertical members (warp). Outward tapering of the basket can be accomplished by adding vertical pieces to the corners. Horizontal pieces continue to be added until the desire basket height is attained. The rim is finished with larger horizontal cedar withes on both the outside and the inside of the basket, which are twined in place.



¹⁰¹ Splitting cedar bark or splitting the pith from stinging nettle fibre.

Figure 3.3. A *lexey* in the process of being constructed by K^waxistalla and the author.

The *lexey* is also described in Franz Boas's *Kwakiutl Ethnography* (1921). Boas recorded both the construction of an open-work basket (1921, p.134-135) and the use of this "flat bottomed basket," for harvesting silverweed and the curly roots of clover (Boas 1921, p. 187, 188-189). He also described a second type of basket that was used specifically for long clover roots.

...the basket for [clover- roots] has no flat bottom, as the one for digging [cinquefoil-roots], for the same basket that is used for clams [as] is used for [clover-roots]; and the other clover basket is smaller. It is for the lower roots, for these are very long, and they grow under the curly [clover] roots (Boas 1921, 188-189).

This smaller clover basket, made entirely from cedar inner bark, had a square base that was shaped to a standardized basal wooden frame (Boas 1921, p. 136-138). Because long rhizomes were much more culturally valued, and were reserved for chiefs at feasts (Boas 1921, p.544) and special occasions, they were carefully harvested and were separated from the curly upper roots. These small clover root baskets are an example of a prescriptive technology (Franklin 1990) that is likely explained by the need for standardized units for trade.

3.4. Bentwood Boxes

This section features K^waxistalla's primary source account of bentwood box construction, based on his grandfather's work making these boxes. A number of authors have provided information on traditional bentwood box manufacturing techniques including Goddard (1924 p. 37-45), Steward (1984 p. 84-92), Boas (1921 p. 60-82), and a publication by Sewid-Smith and Dick (1998), which was co-authored by K^waxistalla and contains some of the same K information as provided in this account. Hilary Stewart's book *Cedar* (1984) is perhaps the most valuable to those interested in constructing a bentwood box because it is filled with fabulous line drawings of many stages of the construction as well as portraying many different styles of finished boxes.

Some other K^wak^waka'wak^w tribes cooked their estuarine roots in bentwood boxes (Boas 1921, p. 530, 535; Curtis 1915 p. 43) and K^waxistalla recalled his family cooking other food in these boxes such as seal meat, potatoes, and berries. K^waxistalla made it clear to me that his family did not cook estuarine roots in bentwood boxes; they always steamed their roots in underground pits. He even talked of a 'sweet spot' in front of the fire pit of the old **gʷukdi**¹⁰² (ceremonial Big House) where his mother and grandmother would pit cook when the weather was poor in the late fall (Kim Recalma-Clutesi, pers. comm.). K^waxistalla and I created a bentwood box for cooking other food as part of my "apprenticeship". This followed a lengthy and ongoing process of learning how to construct bentwood boxes. In this section I provide K^waxistalla's account of traditional bentwood box construction, the process by which we now construct bentwood boxes, and some theoretical considerations for making good boxes. I close with our experiences of cooking potatoes and other food in one of our bentwood boxes.

3.4.1. Making a Traditional Bentwood Box

The first step is to make a split cedar plank¹⁰³ (**ʔatta ak^w**). K^waxistalla remembers splitting planks off from a live standing red cedar tree with his grandfather, Kody, Dick Webber. A large cedar tree with straight grain was selected and deep clefts were chiseled into the tree above and below where the plank was going to be removed. Chisels were made out of deer antler and sharpened with a special type of black rock found on the Kingcome River. Two cedar planks were split (**ʔatta**) off from the tree with yew wood wedges¹⁰⁴ (**ʔəmgayuw**). Sometimes a fro-like tool called a **ʔatdayuw** was used to split the planks from the tree, or to split the planks into halves once they were removed. A sharp rock was used

¹⁰² **gʷukdi**: Ceremonial Big House. Term provided by AD, orthography by DSS, translation by both AD and DSS.

¹⁰³ **atta ak^w**: Split cedar plank. Term provided by AD, orthography by DSS, translation by both AD and DSS.

¹⁰⁴ **ʔəmgayuw**: Yew wood wedges. Term provided by AD, orthography by DSS, translation by both AD and DSS.

to mark the line where the board was to be split. Next the board was shaved flat using 2 types of adzes, a long handled elbow adze or **qendayuw** and a small D shaped hand adze **kemlayuw**.¹⁰⁵

The finished board was the thickness of one finger (**Nemdin**). Transverse groove were then chiseled into the wood at three carefully measured sites along the board, and the board weighted down in a stream to soak for several weeks. After this time, the board was removed from the water, then buried in the sand and a fire made over each of the grooves or kerfs. When the wood around the kerf was hot, it was pulled out using a black bear hide to protect the hands from the heat. Then hot water was poured over the grooves to further soften the wood. The board was then laid on the ground and a yew wood stave was placed next to one of the notches across the width of the board. The stave was long enough to hang several inches over each side of the board. The pegs were driven into the ground on either side of the stave, on both sides of the board, and hemlock branches were used to lash the peg together across the top of the stave (Figure 3.4).

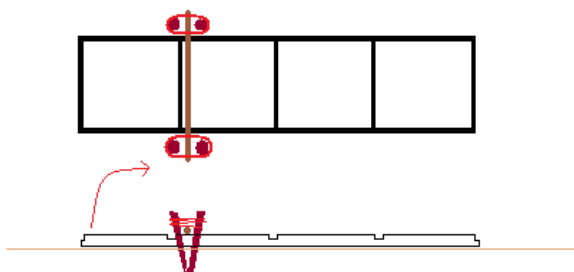


Figure 3.4. Schematic of K^Waxisistalla's method for bending boxes showing (above) the top view and (below) side view.

The still hot board was then lifted against the stave until the board was bent at a right angle along the kerf. Then the board was slid along until the stave was adjacent to the next groove where the next bend was to be, and the bending process was repeated. When the three kerfed corners were all bent, the resulting four-sided box was bound together around a carefully shaped bottom, and allowed to cool. A series of holes were drilled along both ends of the board, now together forming the fourth

¹⁰⁵ **kemlayuw**: A small D shaped hand adze or gouge that is used for carving grooves. The sharp end can be made with a deer bone. Term provided by AD, orthography by DSS, translation by both AD and DSS.

corner of the box. Holes were drilled with a beaver rib tipped hand drill, called **səllayuw**,¹⁰⁶ which was spun between the palms of the builder's hands. The side and bottom joints on the box were then fastened with either pegs or lacing. K^waxistalla's grandpa used yew or yellow cedar pegs, called **ləm'q̄q̄a labəm** or **duk^wləp̄bəm**, respectively.¹⁰⁷ He put small barbs on the pegs so that they wouldn't slip out (Figure 3.5). Some boxes were fastened together with lacing instead of pegs. For this, bear or seal hide, was used. This lacing was called **nikx^w**.¹⁰⁸

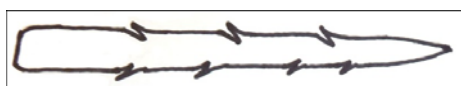


Figure 3.5. **ləp̄bəm** “peg” or “nail” for fastening the corners of a bentwood box. Note the barbs that keep it imbedded in the wood.

K^waxistalla recalled that his grandmother's storage boxes all had lids, each with a prominent lip on one side (Figure 3.6). This lip served as a handle but did not get in the way when the boxes were stacked on top of one-another. K^waxistalla said his grandparents had many different sized boxes, some of them “big enough to sit in.”



Figure 3.6. Bentwood boxes with lipped lids. The box on the left was made by K^waxistalla and me and the box on the right is stored at the Royal BC Museum (Catalogue number 16160 A,B). Both boxes are approximately 12 cm x 12 cm x 12 cm.

¹⁰⁶ **səllayuw**: A hand drill made from a straight stick with a beaver fastened to one end. Term provided by AD, orthography by DSS, translation by both AD and DSS.

¹⁰⁷ Terms provided by AD, orthography by DSS, translations by both AD and DSS.

¹⁰⁸ **nikx^w**: Lacing for shoes or bentwood boxes. Term provided by AD, orthography by DSS, translation by both AD and DSS.

3.4.2. How to Make a Bentwood Box Today.

These instructions are based on my experiences with K^waxistalla in bentwood box making in his fully equipped workshop. Making a bentwood box in the age of power tools and lumberyards usually starts with the purchase of a straight-grained cedar board without any knots. The board should be planed to a thickness of about ½ inch (13 mm). K^waxistalla and I measured out the desired length of each side and used a router to cut kerfs in the board for bending each corner. Several different kerf styles are shown in Figure 3.7.¹⁰⁹ The “U” and “V” style kerfs are convenient because they can be cut with router bits available at most hardware stores. However, these kerfs concentrate all the bending in one focused line, and usually result in a lot of broken wood fibres. The “2” style kerf, which can be seen in several boxes in museum collections (e.g. at the Royal BC Museum), spreads the bending out over a long radius, and usually results in fewer broken fibres. Unfortunately, the asymmetrical shape of this groove does not permit it to be made with a router bit. For that reason, I developed the “ZS” style router bit and tested it with much success in making several dozen bentwood boxes.

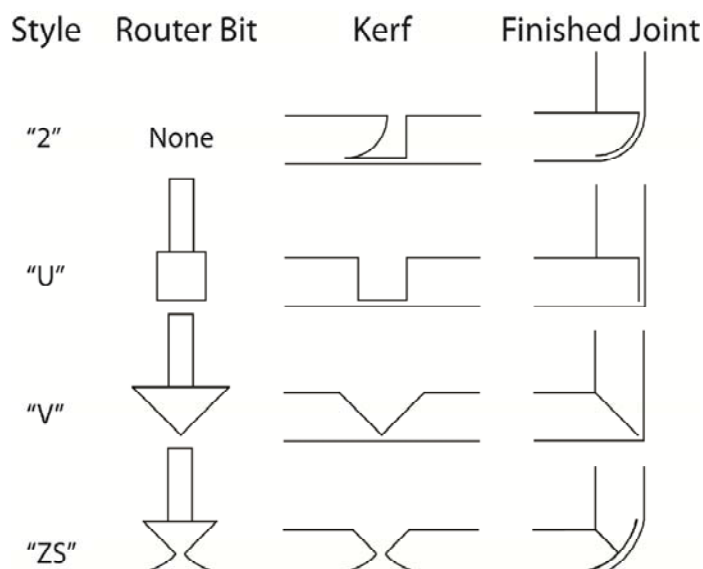


Figure 3.7. Kerf joinery used in bentwood box construction.

¹⁰⁹ Others are shown in Hilary Stewart's book *Cedar* (1984, p. 90).

Beyond the type and quality of the wood, the two biggest factors for successfully bending the sides of a box are the thickness of the remaining wood after the kerf has been removed, and the temperature/water saturation of the wood fibres that are going to be bent. The wood below the kerf should be no more than 2.5 mm. If a “V” or “U” style router bit are being used, 1 mm of residual wood is recommended. Excess wood below the kerf results extensive broken wood fibres. The temperature and saturation of the joints should also be high. Using a steam box (Figure 3.8), it is possible to deliver temperatures above 100 degrees Celsius to the wood, but when steam isn’t possible, boiling water can also be poured onto the grooves.



Figure 3.8. Two styles of modern bentwood box steamers. The steamer on the right steams each groove individually and the steamer on the left steams the entire board.

Once the board is steamed, while the grooved areas are still moist and hot, it can be bent along the kerfs into a square and fastened to itself and a base with wooden pegs. The base should be rabbeted to provide two sealing surfaces (See Figure 3.9).

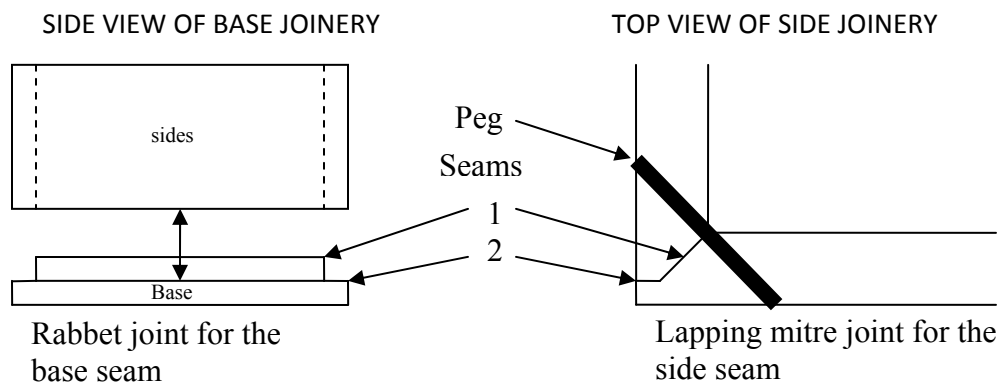


Figure 3.9. More joinery used in bentwood box construction.

3.4.3. Cooking in a Bentwood Box

In order to cook in a bentwood box, all five seams (four on the bottom and one on the side) must be watertight. Careful measurements can produce tight joinery that is nearly watertight. Agnes Alfred (in Reid 2004 p. 85) recalled bentwood boxes being sealed with clay, which is an ideal material since it is available widely, insoluble, nontoxic, and expands greatly when wet. However, K^waxistalla noted that leaks would seal themselves once the box was soaked with water, because the water would cause the wood to expand. Additionally, he said that once the box is used, the oils and food residue would further seal the box. For that reason, K^waxistalla doubted that his grandparents ever washed their cooking boxes, but he recalled that they never mixed the boxes they used for making sun dried berrie cakes (*teqqa*) with those used for cooking meat. Cooking boxes have a special name; they are called *qulaciy*,¹¹⁰ whereas all other bentwood boxes are called *xeccom*¹¹¹ in K^wak'wala. Metal cooking pots are called *henxannuw*.¹¹²

K^waxistalla remembered in detail how to cook in a bentwood box (*qu'la*), and on October 20, 2008 he demonstrated his technique. He went to the beach to collect fine-grained basalt cooking rocks

¹¹⁰ *qulaciy*: Cooking box. Term provided by AD, orthography by DSS, translation by both AD and DSS.

¹¹¹ *xeccom*: Bentwood box. Term provided by AD, orthography by DSS, translation by both AD and DSS.

¹¹² *henxannuw*: Metal cooking pot. Term provided by AD, orthography by DSS, translation by both AD and DSS.

that were about 5-10 cm across, called **tisem**.¹¹³ He told me about a special place, on the east side of the estuary in Kingcome called **xəd^wdamma** where they used to collect cooking rocks. Then we dug a shallow pit about 80 cm across and about 10 cm deep and lined the bottom with our rocks. We built a fire on top of this pit and kept it going until the rocks became red-hot. While I was tending the fire K^waxistalla disappeared into his workshop and came out 30 minutes later with some tongs (**cixalla**) he had made out of cedarwood. These were made to transfer the rocks from the fire to the cooking box and were soaked in water before use so they would not burn.

We added about 6 L of water to the box, then we started to put the glowing rocks into the water. Each one went in with a sizzle and a cloud of steam. After 30 rocks were dropped in the water began to boil (**medelx^wʔid**).¹¹⁴ K^waxistalla disappeared into the house again and came back with two large potatoes, which we cut up and put in the water. The water stopped boiling after a couple minutes and we used the tongs to fish out a couple rocks and add a couple more glowing ones. K^waxistalla said that there is a special spoon, called **Xaludayuw**,¹¹⁵ that was used for scooping the cooking rocks and food out of the box; it had a long handle with a shallow scoop to hold the rocks. It usually took only one more rock to bring the water back to a violent boil. We covered the box with a block of wood to keep the heat in. After half an hour the potatoes were soft and we ate them immediately. They had a slight cedar taste, which K^waxistalla said would rinse out of the box with use.

The next day we decided to cook a chicken (**ḡaḡaʔow**)¹¹⁶ in the box. We again lit a fire and heated the rocks. While the fire was burning, K^waxistalla told me to make some more tongs so that we could have a set for removing the red-hot rocks from the fire and a clean set for fishing the cooler rocks

¹¹³ **tisem**: Rock. Term provided by AD, orthography by DSS, translation by both AD and DSS.

¹¹⁴ **medelx^wʔid**: When liquid boils. Term provided by AD, orthography by DSS, translation by both AD and DSS.

¹¹⁵ A stick that was used for scooping. It looks like a miniature lacrosse stick. The net mesh is made from stinging nettle and the long handle is made from a willow branch. It was used to scoop out the hot rocks from the bentwood box cooker when the water boils.

¹¹⁶ **ḡaḡaʔow**: Chicken. The name derives from a rooster's call. Term provided by AD, orthography by DSS, translation by both AD and DSS.

out of the water in the box. Having separate tongs prevented charcoal on the burned tips of the fire tongs (**cixalla**) from getting into the food. K^waxistalla explained that the tongs were traditionally made out of a stem of willow (**cac'ekammas**; *Salix* sp.) that was split down the middle and pegged together on one end. A small piece of wood was jammed between the two tongs to separate them and to act as a fulcrum. K^waxistalla said the tongs often had a rounded wooden handle (**mek'balla**)¹¹⁷.

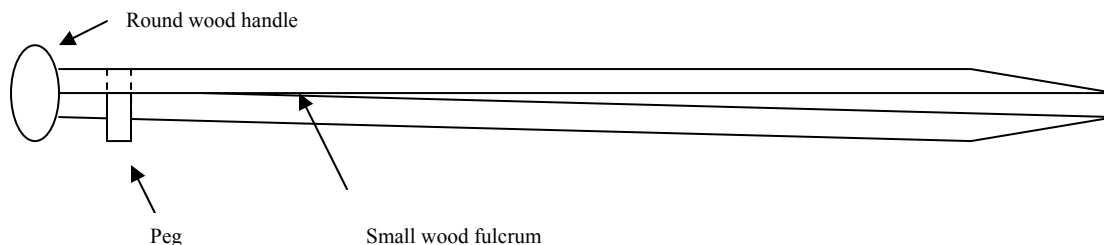


Figure 3.10. Tongs used for moving hot rocks; these tongs were usually of willow.

While I was making these willow tongs, K^waxistalla began making a small dipnet out of a cedar withe bent into a loop and lashed back onto itself. He then wove a net out of stinging nettle fiber (**dēndēnx'ēm**)¹¹⁸ that we had made the previous year. He said a willow (**cac'ekammas**) was usually used for the dipnet frame instead of cedar withe (**te'x'em**), and that the net could also be made from spruce roots (**ʔəliwas'kuppek**; sitka spruce root) or cedar bark (**dēmmas**)¹¹⁹ as well as nettle fibre. This little dip net is called **Xaludāyuw** and is used in the same way that a draining serving spoon is used.



Figure 3.11. **Xaludāyuw** used to fish out food cooked in a bentwood box.

¹¹⁷ A ball on the end of an object, like a halibut club, a baseball bat. It prevents the hand from slipping.

¹¹⁸ Stinging nettle (*Urtica dioica* L.)

¹¹⁹ The stripped inner bark of a young red or yellow cedar tree that has been prepared and is now ready for weaving.

When the rocks were hot we started to add them to the water in the cooking box. Again it took about 30 rocks to boil about four litres of water in the box. We put in the chicken legs and wings and some potatoes. We covered the box with a block of wood and added another hot rock or two every 5 minutes. To keep the box from overflowing we had to use our second pair of tongs to remove some of the rocks. K^waxistalla added a couple teaspoons of salt for seasoning. After 40 minutes, our food was cooked, and soon afterwards, consumed joyously.



Figure 3.12. Two finished cooking boxes (**qulaciy**). The split grain on the corner of the left photo is a result of our use of the “V” style kerf. The decorative grooves chiseled into the side of the box are called **kemtʷlek**.¹²⁰ The box in the right photo has rounded corners, constructed with a “ZS” kerf.

K^waxistalla said that estuarine roots were never boiled in a bentwood box in Kingcome, but always steamed in an earth-oven, such as described in Chapter 2. Historic sources from other K^wak^waka^wak^w tribes document the process of steaming estuarine roots in a bentwood box, such as those documented by George Hunt (in Boas 1921, p 535-544) and reported by Charles Nowell:

...They have Indian boxes about three feet square which they use for cooking roots. They build a big fire in the center of the room and put stones on top of the wood until they are red hot. They pick the stones up with wooden tongs and put them in the boxes. Before this they have put earth on the bottom of the boxes to prevent them from burning. Then they dip the clover roots into water and put them on top of the stones. A bucket of water is poured over them, then the box is covered well with blankets. When cooked it is put into Indian dishes and grease put on top. Then they pass it around to the people, three men eating out of a dish (in Ford 1941, p. 51).

¹²⁰ **kemtʷlek**: Decorative grooves carved into the sides of cedar Bentwood boxes.

3.4.5. Bentwood Boxes in K^wak^waka'wak^w Culture

Bentwood boxes have a higher cultural profile among the K^wak^waka'wak^w than any of the other tools Kwaxsistalla and I have worked on. A store specializing in K^wak^waka'wak^w art would be incomplete without bentwood boxes. Their cultural value is evidenced by the figurative expression “box of treasures” which references the cultural possessions of a chief. These include tangible objects such as masks, blankets, and ceremonial props, and intangible items such as stories, songs, and names. It is also apparent when you consider the number of names they have. A box for food is called a **ḡəccəm**, a box for jewelry is called a **kyuk^walemus**, and a box for cooking is called a **qulac'iy**.

This project focused on a type of bentwood box that has little contemporary recognition. By describing the successful creation of a water tight box and the process of using hot rocks to cook a meal in a bentwood box, I hope to help revitalize this traditional technology much the same way that Dr. Turner's documentation and demonstration of pit cooking has helped revitalize that practice in many First Nations on the BC coast. Furthermore, cooking estuarine salt marsh roots in a bentwood box, while not a practice indigenous to the original Clans of the **D^zawada?ənux^w**, can add another layer to the cultural programming of groups like the *Liliwagala* School in Kingcome, that currently include a unit on the traditional use of the **təkillak^w**.

3.5. Conclusion

The process of making a just a few of the many tools used in association with the **təkillak^w** has illuminated to me the tremendous amount of knowledge required to create even the simplest of tools. For that reason, museum collections alone are an inadequate means of preserving K^wak^waka'wak^w material culture. A museum specimen labeled “yew wood fish hook” may provide the finished form, but missing are the details absolutely necessary for constructing a fish hook, such as where the proper wood can be found, when to harvest the wood, how long to soak and steam the wood before bending it,

what bone to use for the barb, etc. Also missing are knowledge of how to manage for the best materials, how to harvest them in a culturally appropriate way, and perhaps even the knowledge of how to catch fish with the hook.

K^wak^waka'wak^w culture, however, is not in museums, it is among the people, imbedded in their traditions, and must be learned experientially. I learned from K^waxistalla that these traditions, especially those related to material culture are continually adapting and changing in response to new problems and opportunities. In many cases, the function of a particular item is more important than its specific form. For example, K^waxistalla embraced a power drill as the functional equivalent to bone tipped hand drill for boring holes into the corner of a bentwood box. K^waxistalla's use of a power-drill is a modern example of an ancient pattern of sharing material culture. As new technologies became available to First Peoples on the Northwest Coast, they were rapidly adopted by neighbors as is evidenced by the similarity in stone and bone tools among the Salish, Wakashan, and Haida despite the disparity in other elements of their cultures, such as their languages.

While K^waxistalla embraced use of modern power tools he was also keenly aware that he was among the last generation to witness many ancient technologies, and always was careful to provide me with detailed descriptions of older methods when we took modern shortcuts. In the construction of a digging stick, an open work basket, and a bentwood box K^waxistalla found an appropriate balance between technologies that support the ancestral practices and those that are realistically feasible for people interested in revitalizing K^wak^waka'wak^w material culture in a modern world.

Chapter 4. *λəksem*, Pacific Silverweed [*Argentina egedii* (Wormsk.) Rybd.], a *təkkillak*^w Root: its Production and Management

4.1. Introduction

In this chapter I present the results of my experimental work and observations in K^waxistalla's *təkkillak*^w garden site, with particular focus on the growth and production of *λəksem*, Pacific silverweed. K^waxistalla's descriptions of his family's *təkkillak*^w from when he was a child, as well as numerous ethnographic accounts from other similar sites, present a compelling picture of intensive management of family-owned plots, which were tilled, weeded, harvested, and "kept living" over generations (Boas 1921; Deur 2000, 2002, 2005; Deur and Turner 2005; Pukonen 2008).

As a first step towards re-establishing a working *təkkillak*^w at the site of K^waxistalla's original root garden, we decided it would be necessary to clean the ground of the dominant grass and sedge cover, and start to break up the sod, so that the *λəksem* and other edible root species would be able to gain a competitive edge once again. At K^waxistalla's suggestion, with help from local community members, I undertook "modern" tilling of the densely vegetated site using a gas-powered rototiller. To gain a better understanding of the different effects of weeding and other traditional management practices on the growth of the edible roots, I established an experimental design with randomly set plots subjected to different treatments.

One of the shortcomings to this approach was that I was not able, due to the dense turf, to start the process of cultivation with a digging stick, which would have been the original tool used to create and maintain a *təkkillak*^w. The rototiller made cultivation of this long-time fallow site possible, but at the same time, it resulted in the widespread fragmentation of *λəksem* and other edible roots to a greater degree than I would have expected had I tilled the *təkkillak*^w with a digging stick. Another major limitation was the short time frame in which I was able to undertake my observations: one growing

season (2008), followed by a brief follow-up study in 2009. In fact, the cycles of the **'tekillak^w** are much longer and the effects of cultivation more cumulative, possibly taking many years of repeated tilling, weeding, and harvesting to realize the full potential of this perennial gardening method (Turner and Peacock 2005).

Despite these limiting factors, I was able to learn more in my experimental work about the biological effects of tilling and weeding in promoting the growth of **λeksem**, and the processes that would have been a part of the overall **'tekillak^w** production system.

4.2. Research Questions

K^waxistalla has described the importance of tilling (turning up the soil) and weeding (removing unwanted vegetation) in the production of **λeksem** and other **'tekillak^w** roots (Pers. comm., Deur 2000, 2002, 2005). What are the biological mechanisms through which these processes act? And, are these processes interactive and cumulative? Specifically, my experimental approach attempts to quantitatively explore how tilling and weeding affect productivity across variety of metrics including the abundance (Question 1), growth and morphology (Question 2), and below ground biomass (Question 3) of *Argentina egedii*. My final question (Question 4) sought to identify how *Argentina egedii* root size varied with the aerial portions of the plant that are easily visible to root harvesters. Based on conversations with K^waxistalla and review of Deur's estuarine root garden research findings, I expected that tilling and weeding K^waxistalla's **'tekillak^w** would result in greater abundance, size, and total below ground biomass of *Argentina egedii* roots than in (fallow) control plots. My experience harvesting a variety of food plants led me to anticipate a strong relationship between root size and leaf size, a position that was encouraged by similar research on mt. potato (*Claytonia lanceolata* Pall. ex Pursh), an important edible geophyte to the Tsilhqot'in (Chilkotin) people in west-central British Columbia (Mellot 2010).

4.3. Ecology and Vegetation of the Experimental Site

The Kingcome River estuarine salt marsh is approximately 2.2 km wide by 2.3 km long. It is characterized by very gradual slopes ranging from 0.5-2% and meandering river channels that form many side channels and small islands in the Kingcome delta. From the low intertidal zone to the high intertidal zone, soils change from anoxic silts with little organic matter to oxidized sands with high levels of detritus derived organic matter. As with other estuarine salt marshes, the Kingcome delta is rich with nutrient subsidies. Mineral deposits of sand and silt are delivered directly to the salt marsh in pulses during fall flood events and indirectly throughout the summer as high tides allow estuarine waters rich in glacial sediments to settle on the salt marsh. Detrital deposits include leaves and woody debris, with scattered seaweed and fish carcasses. Scat from foraging bears and geese may also make a significant nutrient contribution to the salt marsh.

The vegetation is salt tolerant and characterized by grasses, sedges, and perennial herbs (See Table 4.1 for a species list). Woody plants, which would otherwise overshadow salt marsh vegetation, are limited in distribution to areas above the high tide line due to their intolerance to salt water. However, they are still found sporadically throughout the estuary atop driftwood, and in the highest levels of the estuary where *Malus fusca* and *Alnus rubra* form a patchwork mosaic.

Species lists, which I compiled at four elevations within the range of *A. egedii* in the vicinity of the study site, suggest that species diversity increases with increasing elevation, except for the highest portion of the estuarine salt marsh, which was managed as a hay field by settler Canadians (Halliday 1935; Williams 2001; K^waxistalla, Clan Chief Adam Dick pers. comm.). The lower reaches of the Kingcome estuarine salt marsh are relatively free of non-native species with the exception of sow thistle (*Sonchus arvensis*) and sporadic broad leaved plantain (*Plantago major*). Land that was previously pastured contains several non-native species including tall buttercup (*Ranunculus acris*), and various grass species that were planted for hay (See Table 4.1).

Table 4.1. Native and introduced plant species (in alphabetical order by scientific name) present in the Kingcome River estuarine salt marsh at different points along the *Argentina egedii* elevation gradient.

| Kingcome Inlet Estuarine Salt Marsh Plant Species | Low | Med. Low | High | Farmed High |
|---|-----|----------|--------|-------------|
| 1 <i>Achillea millefolium</i> L. | | N | N | |
| 2 <i>Agrostis aequivalvis</i> (Trin.) Trin. | | N | | N |
| 3 <i>Agrostis</i> sp. | | | | N |
| 4 <i>Alopecurus pratensis</i> L. | | | | I |
| 5 <i>Angelica genuflexa</i> Nutt. | N | N | N | N |
| 6 <i>Anthoxanthum odoratum</i> L. | | | | N |
| 7 <i>Argentina egedii</i> (Wormsk.) Rydb. | N | N | N | N |
| 8 <i>Atriplex patula</i> | | N | N | |
| 9 <i>Bidens vulgata</i> Greene | | N | | |
| 10 <i>Carex lyngbyei</i> Hornem. | N | N | N | |
| 11 <i>Cicuta douglasii</i> (DC.) J.M Coult. & Rose | N | | N | |
| 12 <i>Claytonia sibirica</i> L. | N | | | |
| 13 <i>Conioselinum pacificum</i> Hoffm. | N | N | N | |
| 14 <i>Dactylis glomerata</i> L. | | | | I |
| 15 <i>Deschampsia cespitosa</i> (L.) P. Beauv. | N | N | N | N |
| 16 <i>Eleocharis palustris</i> (L.) Roem. & Schult. | | | | N |
| 17 <i>Equisetum arvense</i> L. | | | | N |
| 18 <i>Fritillaria camschatcensis</i> (L.) Ker Gawl. | N | N | N | |
| 19 <i>Galium mexicanum</i> Kunth ssp. <i>asperulum</i> (A. Gray) Dempster | | | | N |
| 20 <i>Glaux maritima</i> L. | N | | | |
| 21 <i>Holcus lanatus</i> L. | | | | I |
| 22 <i>Hordeum brachyantherum</i> Nevski | | N | N | N |
| 23 <i>Juncus effusus</i> L. var. <i>pacificus</i> Fernald & Wiegand | N | N | N | N |
| 24 <i>Lathyrus palustris</i> L. | N | N | N | N |
| 25 <i>Leymus mollis</i> (Trin.) Pilg. ssp. <i>mollis</i> | | N | N | |
| 26 <i>Lolium perenne</i> L. | | | I | |
| 27 <i>Lonicera involucrata</i> (Richardson) Banks ex Spreng. | | N | N | N |
| 28 <i>Lupinus nootkatensis</i> Donn ex Sims | | | N | N |
| 29 <i>Lysichiton americanus</i> Hultén & H. St. John | | | | N |
| 30 <i>Maianthemum dilatatum</i> (Alph. Wood) A. Nelson & J.F. Macbr. | N | N | N | N |
| 31 <i>Malus fusca</i> (Raf.) C.K. Schneid. | | N | N | N |
| 32 <i>Mentha arvensis</i> L. | | N | N | |
| 33 <i>Oenanthe sarmentosa</i> C. Presl ex DC. | | N | | N |
| 34 <i>Plantago macrocarpa</i> Cham. & Schltdl. | N | | N | |
| 35 <i>Plantago major</i> L. | | I | | I |
| 36 <i>Plantago maritima</i> L. var. <i>juncooides</i> (Lam.) A. Gray | N | | | |
| 37 <i>Ranunculus acris</i> L. | | | | I |
| 38 <i>Ranunculus cymbalaria</i> Pursh | N | | | |
| 39 <i>Rumex aquaticus</i> L. var. <i>fenestratus</i> (Greene) Dorn | | N | N | |
| 40 <i>Scirpus atrocinctus</i> Fernald | | | | N |
| 41 <i>Sonchus arvensis</i> L. | | I | I | |
| 42 <i>Stellaria humifusa</i> Rottb. | | | N | |
| 43 <i>Symphotrichum subspicatum</i> (Nees) G.L. Nesom var. <i>subspicatum</i> | N | N | N | |
| 44 <i>Trifolium wormskioldii</i> Lehm. | N | N | N | N |
| 45 <i>Triglochin maritima</i> L. | N | N | N | N |
| Total spp. (Introduced) | 18 | 25 (2) | 26 (2) | 26 (5) |

N = Native, I = Introduced (USDA Plants Profile, 2009)

In the Kingcome River estuary, *Argentina egedii* grows across a broad spectrum of the salt marsh ranging from the upper end of the low marsh, which is flooded daily by most high tides, to the transitional salt-tolerant meadow, which is only flooded a couple times a year on the highest winter tides. Much of the range is in the high marsh, which is typically defined in the literature by exposure for greater than ten consecutive days per year (Mitsch and Gosselink 1993, p.231). Though *A. egedii* is halophytic and is adapted to grow in anoxic soil conditions (US Army Core of Engineers, 1995), the combination of limited tidal exposure, anoxic sediments, and high salinity establishes the lower limit to its range. I observed robust *A. egedii* plants growing between the “high marsh” zone and the lower end of the “transitional salt-tolerant meadow,” which coincides with the range suggested by Deur (2005) in Figure 4.1. However, I also found large *A. egedii* plant growing throughout the salt-tolerant meadows and along the fringes of woody vegetation. On the high end of this range, I found *A. egedii* growing under Pacific crabapple (*Malus fusca*), and small red alder (*Alnus rubra*) that were adjacent to the river bank, but not under the salmonberry (*Rubus spectabilis*) or Sitka spruce (*Picea sitchensis*) also present, which suggests that the upper range of *A. egedii* may be limited by shade.

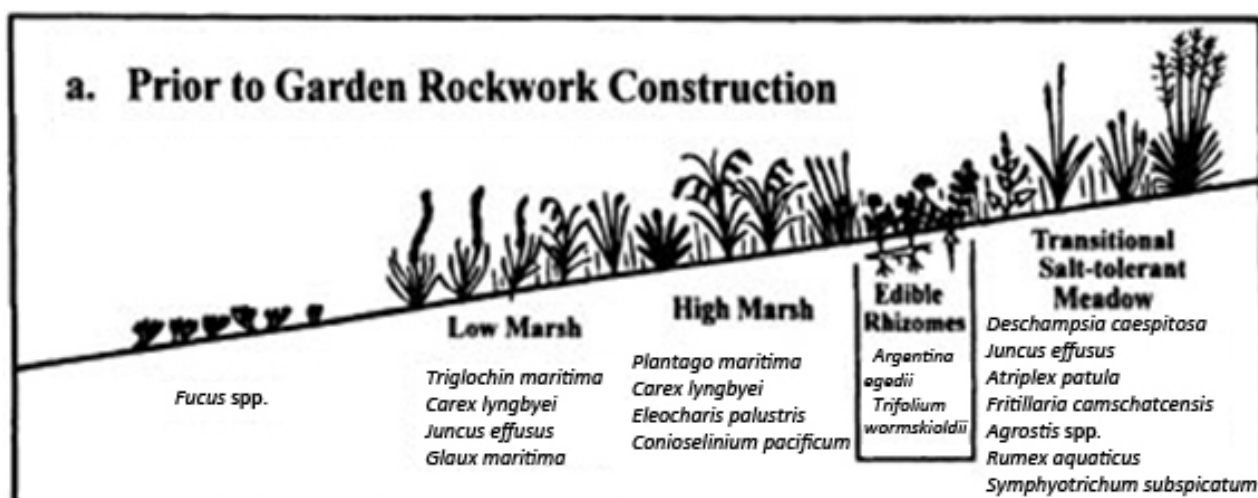


Figure 4.1. Idealized cross section of the Kingcome River estuarine salt marsh (From Deur 2005, with species found in the Kingcome salt marsh).

4.4. Methods

On March 8th, 2008 I began my field work by traveling to the Kingcome River estuary to establish an experimental **təkillak**^w. My site selection goals were to find large patches of *Argentina egedii* with relatively uniform distribution, and to place the experimental **təkillak**^w within K^waxistalla's fallow **təkillak**^w. K^waxistalla had led a field trip to his family's **təkillak**^w several times in the past 15 years, including 2005, and I asked one of his local river boat drivers on the 2005 trip, if he could take me to the same place. He dropped me off on a large island in the center of the estuary. I explored the island and made the following observations: Despite winter dormancy, *A. egedii* could be located by yellow-brown leaf remnants, the size of which varied considerably and tended to increase with elevation. I dug test holes to inspect the soil and look for *A. egedii* roots. The soil from relatively high locations in the intertidal gradient appeared to have the most organic matter and the largest *A. egedii* roots. On March 10th, 2008 I established an 11.5 meter by 20 meter experimental **təkillak**^w plot¹²¹ within K^waxistalla's fallow **təkillak**^w in an area with a relatively even distribution of robust *A. egedii* plants.

The experimental garden consisted of four transects each one meter wide and 20 meters long (Figure 4.2). Transects were separated by a half meter walkway and oriented perpendicular to the river, which was consistent with K^waxistalla's description of the original **təkillak**^w gardens. In September 2008, following his feast, he took a group down to the flats and showed us all the physical markers on the mountains that acted as ancient coordinates that survived the changing estuary flats (Pers. comm., Sept. 2008). Transects were also used for the convenience of tilling the soil with a roto-tiller. Two of four

¹²¹ The size and shape of **təkillak**^w plots appears to be variable. The large duck head-shaped Nimpkish river rockworks, as mapped by Boas (1934, map 21) is roughly 7875 m², with 59 subplots, which are on average approximately 19 meters long by seven meters wide (133 m²; based on the scale provided in Deur 2005 p. 298). K^waxistalla recalled that each subplot in his Clan's **təkillak**^w was about seven meters long and two meters wide, with narrow paths between the one-meter-wide rows for walking along (Pers. comm., 21 August 2008; Turner field notes 16 October 2007). Several subplots taken together made up a family garden that was between 50-105m² (Deur 2000 p. 102). According to Felicity Walkus (in Edwards 1979, p. 6) the late Joshua Moody had a clover garden in Bella Coola that was in total about eight meters wide and nine meters long (72 m²). George Hunt recorded that it might take as many as five days for a woman to harvest all the roots from her **təkillak**^w (in Boas 1921, p. 187).

transects were randomly selected and tilled using a roto-tiller, on March 14, 2008¹²². I randomly assigned the tilling treatment by flipping a coin with heads representing till and tails representing control. If either two heads or two tails was attained before all four transects were allocated, then the remaining transects were assigned to the deficient treatment to maintain an even ratio of tilled and control transects. I used a roto-tiller to till the soil based on K^waxistalla's recommendation. However, in my first tilling efforts, a thick mat of vegetation tangled up the tines of the roto-tiller, necessitating removal of the above-ground vegetation prior to tilling.¹²³ This vegetation was thick and cohesive enough to be rolled up like a carpet and removed from the *təkkillak^w en masse*, a process that, over several years, might produce embankments around the plot similar to what George Gibbs observed among the Coast Salish (Gibbs 1877, p. 223). Two passes were made with the roto-tiller, which tilled the soil to a depth of approximately 15-20 cm. Driftwood stakes 1-2 meters long and 3-10 cm in diameter were cut and pounded into the transect corners to serve as markers. Split Cedar stakes with cedar bark strips tied to them had been used by K^waxistalla's Clan as markers until the 1940's (K^waxistalla, Clan Chief Adam Dick pers. comm., February 2008).

I divided each transect into two rows of 40 50-cm-by-50-cm squares (quadrats) and marked the corners of these squares with small bamboo barbeque skewers. Quadrats were numbered 1-40, and a simple random number generator was used to allocate "till" and "till + weed" treatments within the roto-tilled transects, as well as the location of the "no till" control treatments within the control transects (Figure 4.2B). Each treatment was replicated 30 times.

¹²² Mike Willie, a then resident and teacher at the Liliwagila School in Kingcome helped me till the experimental plots. Melissa Kingan Grimes, a Linguistics Master's student at the University of Victoria, volunteered to help me establish the experimental plots as well as help with documenting the vast K^wak^wala terminology K^waxistalla provided for his 'garden'.

¹²³ According to Lagius (n.d.), "Before beginning the actual digging the woman went over the ground with a large horse-clam shell and cut off the foliage and the exposed portions of the roots, for these were always bitter, like sunburned potatoes." I believe this practice also enabled the harvesters to more easily dig in the soil.

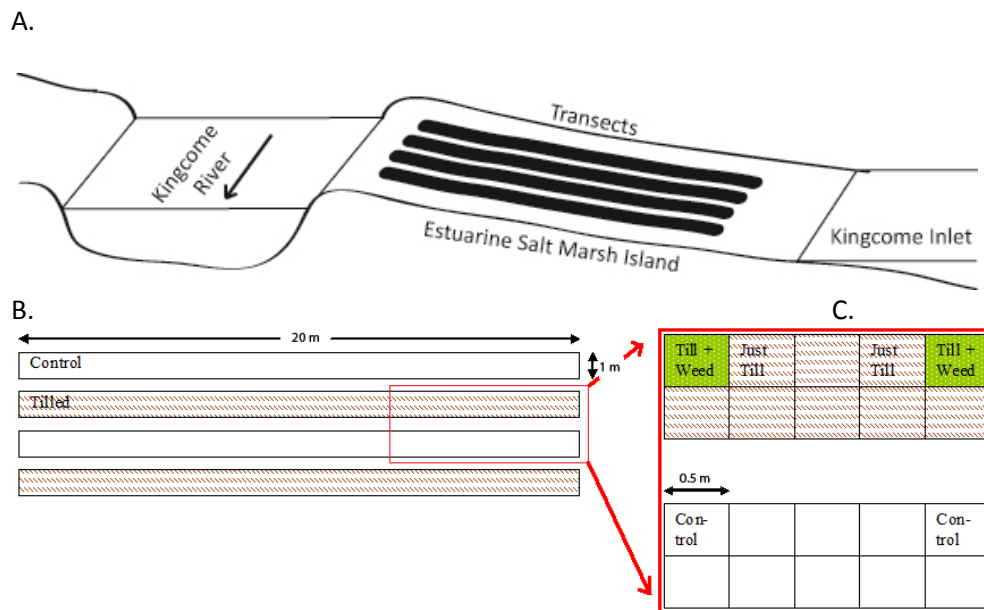


Figure 4.2. Illustration of my experimental design at Kingcome showing the orientation of transects relative to the river and estuarine profile (A.); the control and till transects within the experimental garden (B.); and the specific allocation of treatments within transects (C.).

My quadrat size was selected previous to laying out my experimental design at Kingcome after I visited an estuary at Jordan River, which was more easily accessible from the University of Victoria campus, to determine a baseline abundance of *Argentina egedii*. The quadrat had to be large enough to ensure that the nearly all of my replicates would contribute data, but small enough that the sampling could be done relatively quickly. The Jordan River estuary contained *A. egedii* plants that were no more than 30 cm apart. A quadrat size of 50 cm by 50 cm was selected as a conservative size for capturing at least one individual in each quadrat. The width of the rotor-tiller head was also, conveniently, 50 cm.

The sampling design was partially selective and not truly randomized because all three treatments were not represented in each transect, allowing for the possibility of a confounding transect effect. However, I considered this to be a justifiable risk, necessary due to the logistical challenge of rotor-tilling small segments within each transect. Furthermore, the only apparent variability within the plot occurred across an elevation gradient, and each transect was represented equally across all elevations (Figure 4.2 A) and was randomly assigned a till or control treatment.

4.4.1. Weeding

In July 2008 my field crew¹²⁴ weeded the quadrats for the till + weed treatment. All species not traditionally managed in the *tək̓k̓lak*^w were removed, leaving *Argentina egedii*, *Trifolium wormskioldii* Lehm., *Fritillaria camschatcensis* (L.) Ker Gawl., and *Lupinus nootkatensis* Donn ex Sims. We pulled weeds by their stems, as close to the roots as possible but stems frequently broke from their roots, which remained in the ground. This was acceptable since the goal was to mimick traditional weeding practices and to remove competing vegetation while keeping active soil disturbance to a minimum, so as not to confound the treatments. Because of the high water table and occasional inundations of brackish water, I assumed that sunlight, not moisture availability, was the limiting factor of *A. egedii* growth in this site. About five percent of *A. egedii* leaves were mutilated during this weeding process. The most commonly removed weeds were *Sonchus arvensis* and grasses, which we scattered outside of the plot to desiccate in the sun.

4.4.2. Harvest and Measuring

My crew¹²⁵ harvested roots from my experimental garden in September 2008. We used a trenching shovel to cut the perimeter of each sampling unit to a depth of 35 cm. We then cut the soil within this area into quarters and moved it to a tarp where we removed and measured the *A. egedii* roots. We took great care to keep the roots from breaking or separating from their leaves, but the

¹²⁴ My weeding crew included Peter Coon, Sean Dick, Leigh Joseph, Kate Kittredge. Peter Coon's family is originally from Gilford Island and Shawn Dick is K^waxistalla' great great nephew, both are residents of Kingcome. Leigh was an undergraduate student at University of Victoria from the Squamish First Nation and was working with me as part of a LE, NONET Internship; She is now a master's student in the Ethnoecology Lab at the University of Victoria. Kate is a community health worker and volunteered a day of her time.

¹²⁵ My harvest crew included Fred Speck, Orbit J., Lucy Puglas, and Alex McAlvey. Fred hails from Chieftains from Hopetown and Turner Island and is closely related to K^waxistalla; Orbit resides in Kingcome and Lucy is great grand daughter of Kodyi, Clan Chief of the Lillawagilla Clan of Kingcome and her father from Village Island; Alex is an undergraduate student at Western Washington University. Both Lucy and Alex kindly volunteered there time.

brittle nature of *A. egedii* roots and the senescent quality of the leaves made this task challenging. We weeded out roots from non '*tekillak*' species and returned the soil to the harvested quadrat.

We¹²⁶ measured *Argentina egedii* roots across several variables including the length of the longest root, the diameter of the thickest root, the number of roots, the presence of an attached old root fragment (i.e. the point of asexual root propagation), the length of the old root fragment, and the presence of a bulbous structure on the roots. We also measured the length of the longest leaf and the number of leavers per plant. We documented the presence of broken leaves and roots, and identified and recorded the presence of root fragments by the absence of the root-shoot interface. When appropriate, I excluded broken leaves and roots, and root fragments from the data analysis (e.g. broken roots were excluded from analysis on root length, but not root thickness).

4.5. Data Analysis

My experimental questions (Question 1- 3) were designed to produce three categories of numerical data, which were examined using an Analysis of Variance (ANOVA). My fourth question sought to identify patterns between two sets of numerical data, necessitating generalized linear regression analysis. Data was entered into MINITAB 15 and analyses were performed to answer my experimental questions.

4.5.1. Question 1: The Effect of Management on *Argentina egedii* Abundance

Exploratory data analysis and assumption checking

Due to randomization inherent in the experimental design, quadrats appeared to be independent within treatments and among treatments. However, the variance in plant density among

¹²⁶ I had the help of a number of volunteers to measure roots. These included Alex McAlvey, and undergraduate students from Nancy Turners Ethnoecology class including Miranda C., Heather, Heika L., Pheobe R., Ben W., and Ian.

the treatments did not appear to be constant (Levine's test $p < 0.05$) and the distribution did not appear to be normal (Anderson Darling Test $p < 0.005$), which indicated the need for a data transformation.

Table 4.2. Descriptive Statistics: *Argentina egedii* plant abundance by treatment (# of plants/0.25 m²).

| Treatment | N | Mean | Median | St | | Min | Max | Q1 | Q3 |
|-----------|----|-------|--------|-------|------|-------|--------|-------|-------|
| | | | | Dev | SE | | | | |
| C | 30 | 11.47 | 10.00 | 6.20 | 1.13 | 4.00 | 26.00 | 6.00 | 15.25 |
| T | 30 | 41.83 | 39.50 | 23.21 | 4.24 | 6.00 | 91.00 | 23.50 | 55.75 |
| T+W | 30 | 50.00 | 50.50 | 21.73 | 3.97 | 16.00 | 103.00 | 35.75 | 62.25 |

The Box-Cox method suggested using a power transformation of 0.39, which can be rounded to 0.50. The common transformation for this lambda value is a square root-transformation. A square-root data transformation was performed but the data still did not have equal variance (Levene's Test $P = 0.005$) or a normal distribution (Anderson Darling Test $p = 0.033$). However, the histogram of residuals of the square-root transformed data was fairly normal and the normal probability plot of the residuals was fairly linear (Figure 4.3). Since ANOVA tests are robust to minor violations of normality and equal variance, I still utilized an ANOVA for my analysis.

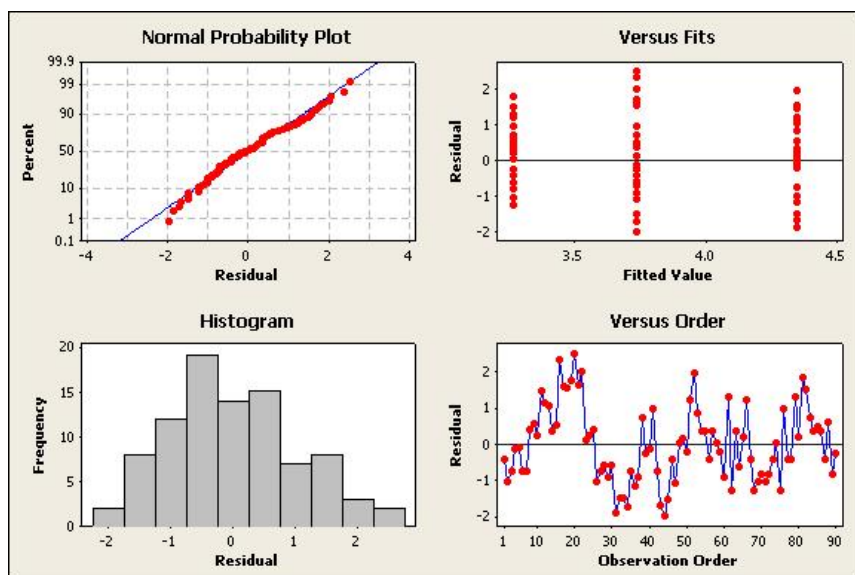


Figure 4.3. Residual plot for square root transformed *Argentina egedii* plant abundance per 0.25m² sampling unit.

equal variance (Levene's Test $p = 0.09$) and normal distribution (Anderson Darling Test $p = 0.185$). An ANOVA test on the square-root transformed root number per sampling unit data showed significantly more roots in both the "till" and "till + weed" treatments than in the control ($p < 0.05$; Tables 4.4 and 4.5), and unlike the number of plants per sampling unit, the tilling + weeding treatment produced significantly more *A. egedii* roots per sampling unit than the tilling treatment alone ($p = 0.034$).

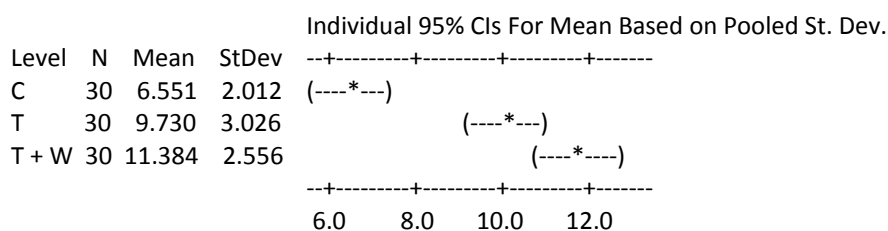
Table 4.4. Descriptive statistics: *Argentina egedii* roots abundance (# of plants/0.25 m²) per sampling unit

| Treat | N | Mean | SE | St | Min. | Q1 | Median | Q3 | Max. |
|-------|----|-------|------|-------|-------|-------|--------|-------|--------|
| | | | Mean | Dev | | | | | |
| C | 30 | 46.83 | 5.19 | 28.43 | 13.00 | 24.75 | 45.00 | 65.50 | 122.00 |
| T | 30 | 103.5 | 10.6 | 57.9 | 13.0 | 51.8 | 98.5 | 144.5 | 214.0 |
| T + W | 30 | 135.9 | 10.7 | 58.6 | 46.0 | 85.0 | 139.0 | 167.3 | 262.0 |

Table 4.5. One-way ANOVA: Square-root transformed *Argentina egedii* root abundance per sampling unit versus treatment

| Source | DF | SS | MS | F | P |
|--------|----|--------|--------|-------|-------|
| Treat | 2 | 361.88 | 180.94 | 27.50 | 0.000 |
| Error | 87 | 572.33 | 6.58 | | |
| Total | 89 | 934.21 | | | |

S = 2.565 R-Sq = 38.74% R-Sq(adj) = 37.33%



Pooled StDev = 2.565

4.5.2. Question 2: The Effect of Tilling and Weeding on *Argentina egedii* Root Morphology

I used the same experimental design, sampling units, and data set to test the effect of "till" and "till + weed" treatments, in comparison with the control on three morphological features of *Argentina egedii* roots: root length, root thickness, and the number of roots per plant.

Root Length

Using an ANOVA, I tested my hypothesis that mean root length in the till + weed treatment would be greater than in the till treatment, which would be still greater than in the control. I recorded the length of the longest root from each individual plant, measuring to the nearest half centimeter. I also recorded length data on root fragments (roots lacking the root/shoot interface), but these were removed from the dataset since they do not accurately represent the total length of the root. Similarly, data on *A. egedii* individuals whose longest root was broken during extrication from the soil were also removed. After “scrubbing” the data, a sample population of $n = 2050$ was used for analysis. Exploratory data analysis revealed a right-skewed sampling population in the “till” and “till + weed” treatments (Figure 4.4), suggesting a need for a data transformation to meet the ANOVA assumption of normally distributed data.

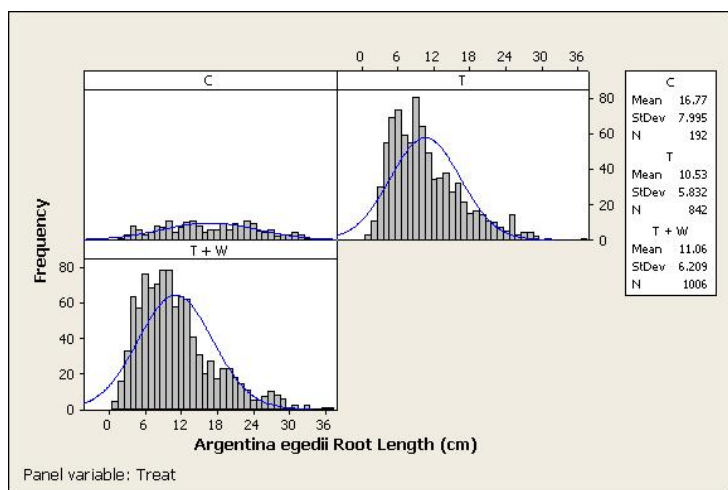


Figure 4.4. Distribution of *Argentina egedii* root length data by experimental treatment.

The right-skewed distribution is most likely explained by root age. *Argentina egedii* roots in the “till” and “till + weed” treatments were at most six months old, and had an even age distribution that reflected younger, smaller individuals. In contrast, the control treatment had a fairly constant distribution across root lengths. Given the perennial nature of *A. egedii*, we would expect the control plants to have a classic uneven aged distribution with root size evidently related to root age.

Argentina egedii root length data did not meet the ANOVA assumptions of equal variance (Levene's Test $p = 0.00$) or normal distribution (Anderson Darling Test $p < 0.005$). A Box Cox plot suggested a transformation lambda value of 0.29. The transformed data showed equal variance (Levene's Test $p = 0.063$) but only visually met the assumption of normality (Anderson Darling Test $p < 0.005$).

A comparison of the means of the raw root length data (Table 4.6) suggests that *A. egedii* roots in the control were dramatically longer (16.8 cm) than those in the till (10.5 cm) and till + weed treatments (11.1 cm; Table 4.6). The ANOVA results supported this observation, demonstrating a significant difference in the means ($p < 0.01$; Table 4.7). This scenario was not consistent with my hypothesis, but does demonstrate that combined weeding and tilling significantly increases root length compared with tilling alone.

Table 4.6. Descriptive statistics: *Argentina egedii* root length (cm)

| Treat | N | Mean | SE Mean | St Dev | Min. | Q1 | Median | Q3 | Max. |
|-------|------|--------|---------|--------|------|------|--------|------|------|
| C | 192 | 16.768 | 0.577 | 7.995 | 2.0 | 10.0 | 17.0 | 23.0 | 35.0 |
| T | 842 | 10.528 | 0.201 | 5.832 | 1.0 | 6.0 | 9.0 | 14.0 | 37.0 |
| T + W | 1006 | 11.064 | 0.196 | 6.209 | 1.0 | 6.4 | 10.0 | 14.0 | 37.0 |

Table 4.7. One-way ANOVA: Box-Cox transformed *A. egedii* root length versus treatment

| Source | DF | SS | MS | F | P |
|--------|------|---------|-------|-------|-------|
| Treat | 2 | 13.354 | 6.677 | 61.02 | 0.000 |
| Error | 2037 | 222.886 | 0.109 | | |
| Total | 2039 | 236.240 | | | |

S = 0.3308 R-Sq = 5.65% R-Sq(adj) = 5.56%

Individual 95% CIs For Mean Based on Pooled StDev

| Level | N | Mean | StDev | -----+-----+-----+-----+ |
|-------|------|--------|--------|--------------------------|
| C | 192 | 2.2188 | 0.3625 | (----*----) |
| T | 842 | 1.9308 | 0.3210 | (-*-) |
| T + W | 1006 | 1.9567 | 0.3325 | (-*-) |
| | | | | -----+-----+-----+-----+ |
| | | | | 2.00 2.10 2.20 2.30 |

Pooled StDev = 0.3308

Root Diameter

Root diameter is another measurement for assessing management induced morphological changes in *Argentina egedii* roots. Using the same experimental design as for root length, I tested my hypothesis that roots subjected to till + weed treatment would be thicker than those subject to only a till treatment. These would, in turn, be thicker than the control (untilled, unweeded) roots of *A. egedii*. I measured the thickest portion of the widest root of each individual *A. egedii* plant, with one notable exception: I observed that *A. egedii* plants frequently (31.7 percent of the time; $n = 3099$) had an abrupt bulbous enlargement on their roots. I recorded the width of these enlargements separately because the bulbous structure does not accurately represent the width of the root, as a whole. I measured root width with a ruler to the nearest 0.5 mm. I removed data on root fragments (i.e. roots lacking the root-shoot interface) from the dataset prior to analysis. However, I kept Individuals with broken roots in the dataset because in most cases the breaks were below the thickest point in the roots, and many of the individuals had more than one root. A comparison of the raw root diameter data across treatments does not support my hypothesis that tilling and weeding will increase root diameter (Table 4.8). In contrast, *A. egedii* roots in the control treatment were on average twice as thick (4.1 mm) as the till (2.2 mm) and till + weed (2.1 mm) treatments.

Table 4.8. Descriptive statistics: *Argentina egedii* root width (mm)

| Treat | Count | N | Mean | SE | St | Min. | Q1 | Med. | Q3 | Max. |
|-------|-------|------|--------|--------|--------|------|-----|------|-----|------|
| | | | | Mean | Dev | | | | | |
| C | 344 | 344 | 4.1177 | 0.0731 | 1.3563 | 1.0 | 3.0 | 4.0 | 5.0 | 10.0 |
| T | 1255 | 1134 | 2.2041 | 0.0262 | 0.8808 | 0.5 | 1.5 | 2.0 | 2.5 | 15.0 |
| T + W | 1500 | 1441 | 2.1464 | 0.0221 | 0.8382 | 0.5 | 1.5 | 2.0 | 2.5 | 7.0 |

This result can be explained by the difference in age between the sampled populations. If we assume that older roots tend to be thicker, the difference in the distribution of root diameter between treatments is easily explained: the control treatment represents individuals from cohorts that are

several years old while the experimental treatments only represent less developed cohorts, all less than six months old (Figure 4.5).

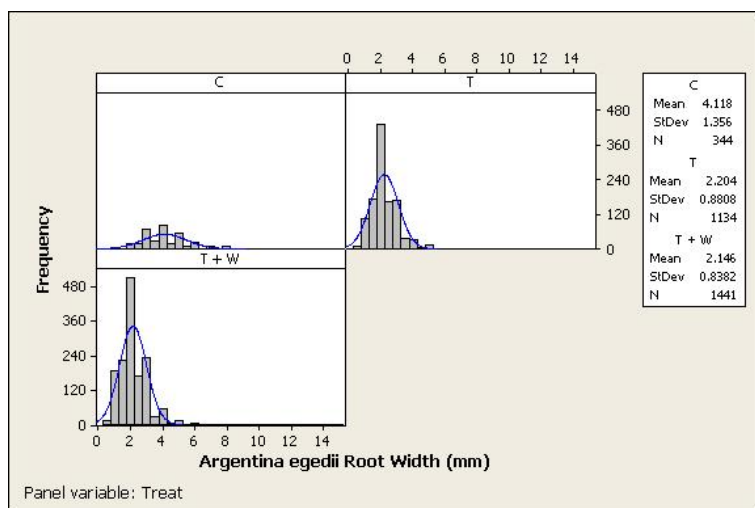


Figure 4.5. Histogram of untransformed *Argentina egedii* root width data by experimental treatment. The C = control, T = till, and T + W = till + weed treatments.

I performed exploratory data analysis to check the ANOVA assumptions and found root diameter data to be heteroscedastic (Levene's Test $p = 0.000$) and non-normally distributed (Anderson Darling Test $p < 0.005$). No transformation could rectify these assumptions, so root diameter data was grouped by sampling unit and averaged. Mean sampling unit root diameter also did not display equal variance (Levene's Test $p = 0.000$) or normality (Anderson Darling Test $p < 0.005$). A lambda -1 transformation enabled these assumptions of equal variance to be met (Leven's test $p = 0.137$) but the data were still not normally distributed (Anderson Darling Test $p < 0.005$).

Because data from the control represent an unevenly aged population, we would expect there to be greater variance in root width than in the relatively young and narrow roots of the experimental treatments. However, a visual inspection of the treatments meets the assumption of normality and I proceeded with an ANOVA.

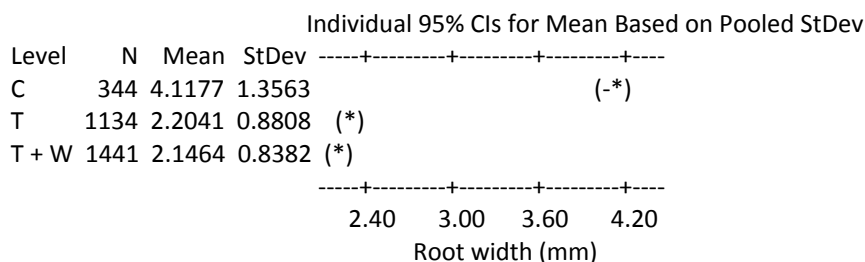
An ANOVA of untransformed ungrouped root diameter data supports the initial observation that root thickness is significantly greater in the control than both the "till" and "till + weed" experimental

treatments ($p < 0.01$; Table 4.9). Among the experimental treatments, I found that tilling and weeding actually had a slightly negative effect on root width ($p < 0.05$) as compared with tilling alone.

Table 4.9. One-way ANOVA: *Argentina egedii* root width (mm) versus treatment.

| Source | DF | SS | MS | F | P |
|--------|------|----------|---------|--------|-------|
| Treat | 2 | 1151.160 | 575.580 | 665.61 | 0.000 |
| Error | 2916 | 2521.576 | 0.865 | | |
| Total | 2918 | 3672.736 | | | |

S = 0.9299 R-Sq = 31.34% R-Sq(adj) = 31.30%



Pooled StDev = 0.9299

Number of roots per plant

The number of roots per plant is the third morphological measure of *Argentina egedii* productivity that I tested. I once again eliminated root fragments from the dataset but retained individuals with broken roots, since I was able to count them. I recorded the number of fleshy roots per individual. Seven percent of the individuals sampled had roots that had been broken during experimental harvesting. I assumed that the break in the root only represented one root and added them to the total accordingly. A comparison of the mean number of roots showed that the individuals in the control had, on average, twice (4.1) as many roots per plant as the “till” and “till + weed” treatments, in which the plants each had on average 2.6 and 2.8 roots respectively (Table 4.10). Histograms of the number of roots per plant show a normal distribution and wide variance in the control, and right skew with less variance in the experimental treatments (Figure 4.6).

Table 4.10. Descriptive Statistics: Number of roots per *Argentina egedii* Plant

| Treat | Count | N | SE | | St | | Min. | Q1 | Median | Q3 | Max. |
|-------|-------|------|--------|--------|--------|--------|------|-----|--------|-----|------|
| | | | Mean | Mean | Dev | Dev | | | | | |
| C | 344 | 344 | 4.084 | 0.133 | 2.469 | 2.469 | 1.0 | 2.0 | 4.0 | 5.0 | 15.0 |
| T | 1255 | 1179 | 2.6344 | 0.0372 | 1.2765 | 1.2765 | 1.0 | 2.0 | 2.0 | 3.0 | 15.0 |
| T + W | 1500 | 1457 | 2.7982 | 0.0337 | 1.2857 | 1.2857 | 1.0 | 2.0 | 3.0 | 3.0 | 12.0 |

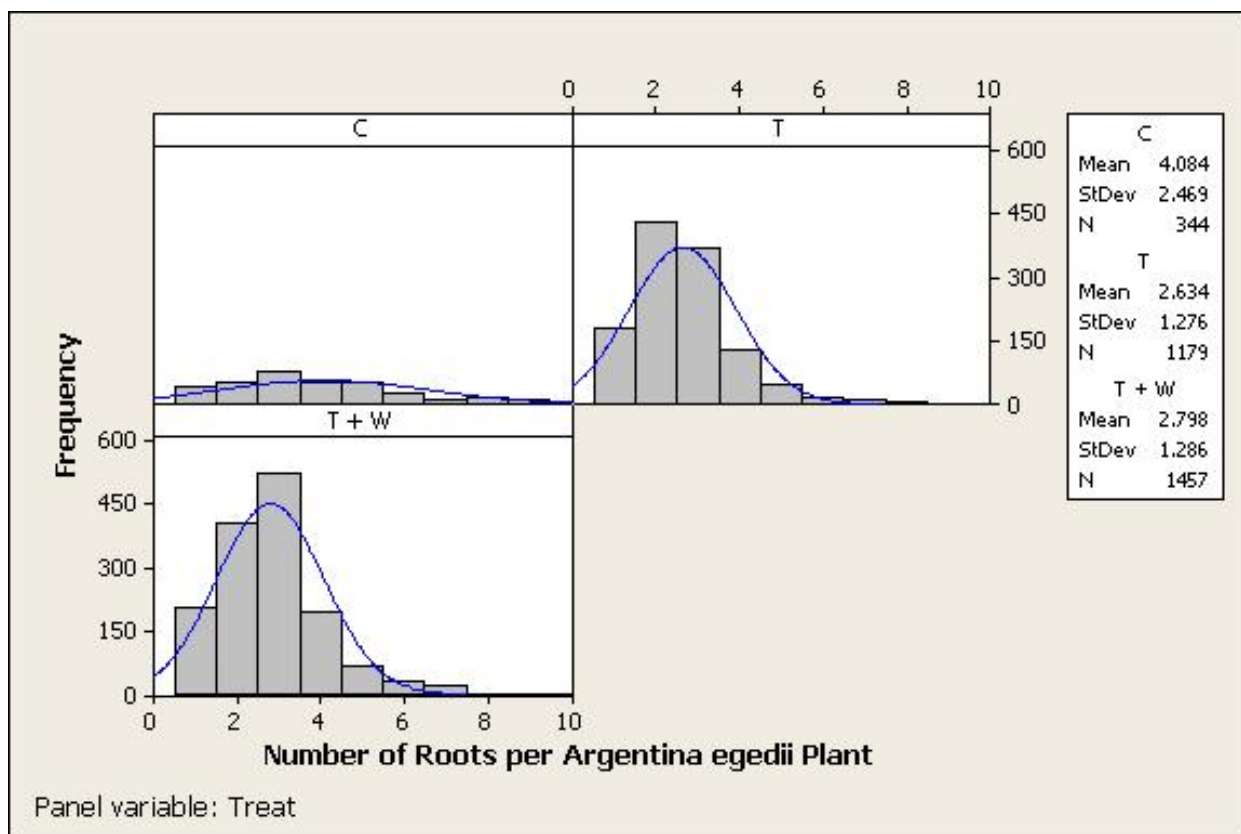


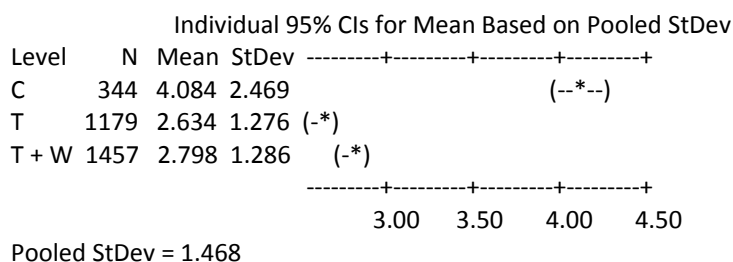
Figure 4.6. The number of roots per *Argentina egedii* plant by treatment. Note when a root branch was found with a broken end, it was assumed to contain only one root branch below the break.

Results from an ANOVA confirmed my initial observation of the means and showed that the control had significantly more roots per plant than the “till” and “till + weed” treatments ($p < 0.01$; Table 4.11). Tilling + weeding significantly increased the average number roots over the till treatment alone ($p < 0.05$; Table 4.11), although this effect was relatively minor.

Table 4.11. One-way ANOVA: Number of *Argentina egedii* roots versus treatment.

| Source | DF | SS | MS | F | P |
|--------|------|---------|--------|--------|-------|
| Treat | 2 | 579.75 | 289.87 | 134.49 | 0.000 |
| Error | 2977 | 6416.67 | 2.16 | | |
| Total | 2979 | 6996.42 | | | |

S = 1.468 R-Sq = 8.29% R-Sq(adj) = 8.22%



4.5.3 Question 3: The Effect of Tilling and Weeding on *Argentina egedii* Root Biomass

Perhaps the most meaningful measure of productivity in *Argentina egedii* is that of below ground biomass. Using the same experimental design as I used for Questions 1 and 2, I tested the effect of “tilling” and “tilling + weeding” on the root biomass of *A. egedii*. The harvested roots were aggregated by sampling unit, dried, and massed. Mass data was recorded with a digital jewelry scale to the nearest hundredth of a gram. The control and the till + weed sampling units appeared to have nearly the same biomass per 0.25 m² with means of 21.87 g and 21.92 g respectively (Table 4.12). The till-only treatment had less biomass, with an average of 18.24 grams of root per 0.25 m².

Table 4.12. Descriptive statistics: Aggregated *Argentina egedii* root mass (g) per 0.25 m².

| Treat | N | Mean | SE | St Dev | Min. | Q1 | Median | Q3 | Max. |
|-------|----|-------|------|--------|------|-------|--------|-------|-------|
| C | 29 | 21.87 | 2.40 | 12.91 | 4.02 | 12.97 | 18.44 | 29.07 | 61.62 |
| T | 30 | 18.24 | 2.01 | 11.02 | 1.76 | 8.66 | 17.45 | 25.51 | 39.70 |
| T + W | 30 | 21.92 | 1.84 | 10.07 | 9.80 | 14.36 | 20.40 | 26.77 | 47.84 |

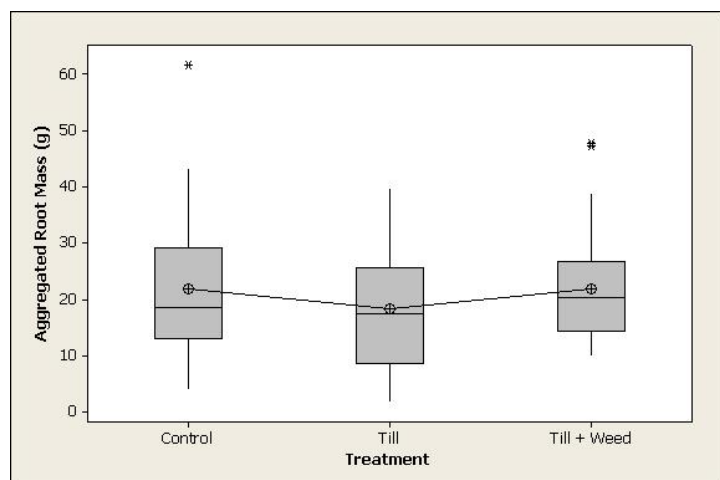


Figure 4.7. Boxplot of aggregated *Argentina egedii* root mass (grams per 0.25 m²) for each of the experimental treatments.

Aggregated root biomass data required a transformation to meet the ANOVA assumptions, but because the transformed and raw data produced similar results, I present ANOVA results for the raw data (Table 4.13).

Table 4.13. One-way ANOVA: Aggregated *Argentina egedii* root mass (g) versus treatment.

| Source | DF | SS | MS | F | P |
|--------|----|-------|-----|------|-------|
| Treat | 2 | 266 | 133 | 1.03 | 0.363 |
| Error | 86 | 11128 | 129 | | |
| Total | 88 | 11393 | | | |

S = 11.37 R-Sq = 2.33% R-Sq(adj) = 0.06%

| Individual 95% CIs For Mean Based on Pooled StDev | | | | | |
|---|----|-------|-------|-------------------------|----------------|
| Level | N | Mean | StDev | -----+-----+-----+----- | |
| C | 29 | 21.87 | 12.91 | (-----*-----) | |
| T | 30 | 18.24 | 11.02 | (-----*-----) | |
| T + W | 30 | 21.92 | 10.07 | (-----*-----) | |
| | | | | -----+-----+-----+----- | |
| | | | | 15.0 | 18.0 21.0 24.0 |

Pooled StDev = 11.37

My hypotheses that experimental applications of either the “till” and “till + weed” treatments would increase the below ground biomass of *Argentina egedii* roots was not supported (P = 0.363), at least within the timeframe of my study. I was unable to detect a significant difference between any of

my experimental treatments, though the data suggested that weeding was important in maintaining the below ground biomass of *A. egedii* (Table 4.13), and on average, it increased aggregated root biomass by 12 grams per square meter over the tilling treatment (Table 4.12).

4.5.4. Question 4: Allometric Predictors of Large *Argentina egedii* Roots

My final research question sought to identify size relationships (allometry) between above- and below-ground parts of *Argentina egedii* that may have guided K^wak^waka'wak^w harvesters in efficiently selecting prime roots. I performed linear regression analyses to identify the predictive power of easily visible above-ground characteristics such as the number of leaves and the longest leaf per plant, and below-ground root characteristics such as the longest, widest, and number of roots per plant. I performed separate analyses on roots from the control treatments and roots from the experimental treatments (Table 4.13), because management may influence the manner in which *Argentina egedii* distributes its plant resources. Given the similarity in root growth response to the experimental treatments, I lumped "till" and "till + weed" treatments together for comparison with the control. I performed data transformations when necessary to meet the assumptions of regression analysis, but when the results from transformed data showed a similar trend than the raw data, the raw data are presented.

General linear regression analysis provides two measures that are useful for elucidating allometric relationships: the correlation coefficient and the goodness of fit. The correlation coefficient is the constant (m) in the equation of the line ($y = mx + b$) that describes the linear relationship between two variable plant parts. In other words, it is the proportion of one plant part to another and the proportion by which plant parts change relative to each other, plus or minus some constant value (b). I arbitrarily assumed that correlation coefficients greater than 0.1 would have been noticed by traditional harvesters and that those less than 0.1 depicted correlations that were likely too small to have been

noticed. For example, if this assumption were true, an *A. egedii* plant with a leaf length of 10 cm above the perceived average and was accompanied by a 2 cm increase in root length would have been noticed (because 2 is greater than 0.1×10), but a similar increase in leaf length associated with a 0.5 cm increase would not have been noticed (because 0.5 is less than 0.1×10).

Goodness-of-fit (or R-sq) is a measure of how well the regression line fits the data and how much variability is explained by the linear regression equation. In the case of root managers, goodness-of-fit can be viewed as the probability of correctly predicting the desired root trait based on a known relationship (correlation coefficient).

In both the experimental treatments and the control, I found that *Argentina egedii* plants with long leaves tended to have longer roots as revealed by linear regression correlation coefficients of 0.368 and 0.296, respectively (Table 4.13). This means that for fallow *A. egedii* plants, an increase in leaf length of three centimeters was accompanied by an increase in root length of about one centimeter. However, there was a high degree of background variability within the linear regression and leaf length could explain only 27 percent of root length variability in the fallow plants and only 14.6 percent of the root length variability in the managed plants.

In terms of numbers, *Argentina egedii* plants with many leaves tended to have many roots in both fallow and managed conditions as shown by correlation coefficients of 0.6 and 0.455, respectively. However, these relationships also displayed an enormous amount of variability (Table 4.13). The relationships between leaf length and root length, and leaf number and root number may result from different habitat constraints. In areas where there is much competing vegetation, *A. egedii* employs a “tall” strategy (i.e. tall leaves, long roots) and in areas where there is little competition, such as recently disturbed or weeded areas, *A. egedii* uses a “wide” strategy (i.e. many spreading leaves, many spreading roots). Though I did not collect data on the production of runners, the “wide” strategy is consistent with my observation of abundant and lengthy runner production among *A. egedii* individuals adjacent to

open areas both inside and outside my experimental garden, and is corroborated by Ove Eriksson's observation that stolon production declined with increasing *Potentilla anserina* [*Argentina anserinsa*] abundance (Eriksson 1986).

The last allometric relationship with potentially observable among traditional root harvesters was the relationship between the overall number of *A. egedii* leaves and the total volume of *A. egedii* roots. Total root volume (ToRV) was estimated from the product of the root width (RW), root length (RL) and root number (RN) according to the formula $ToRV = 1/3\pi(0.5RW)^2(RL)(RN)$, which is the formula for the area of a cone ($1/3\pi r^2h$, where r = the radius and h = the height of the cone).

A focused examination on the R-squared values from the regressions of the various combinations of leaf metrics and root metrics is of less relevance to my study, but pertinent to those interested in allometry. R-squared values greater than 0.25 are shown in bold in Table 4.13, and R-squared values greater than 0.40 are shown in both (red) italics and bold text. The allometric relationship with the greatest explanatory power was found between total transformed root volume and leaf area (Figure 4.8). Leaf area was calculated by multiplying the longest leaf by the number of leaves and does not take into account leaf width, which was not recorded, but arbitrarily assigned the standard value of one centimeter. In essence, this is a crude metric of total above-ground volume compared with total below-ground volume. Given the coarseness of my measurements, I concluded that an R-squared value of 0.474 suggests that total leaf volume is a good predictor of total root volume.

Table 4.14. Linear regressions results from above- and below-ground characteristics of *Argentina egedii* from the control and the experimental treatments (combined). The parenthetical transformation values represent lambda values.

| | | LEAF | | | | | | | | | | | | | | | |
|---|---|------------------------------|-------------|-------|-------------------------------|-------------|------------------------|-------|------------------------------|-------------|-----------------------|-------|------------------------------------|---------------------|------------------------------|--|--|
| | | Control Treatment Only | | | | Length (LL) | | | | Number (LN) | | | | Leaf Area (LL x LN) | | | |
| | | R-sq | P | n | Equation | R-sq | P | n | Equation | R-sq | P | n | Equation | | | | |
| ROOT | Length (RL) | 0.272 | 0.000 | 50 | RL = 3.24 + 0.368 (LL) | 0.011 | 0.304 | 94 | RL = 16 + 0.556 (LN) | 0.132 | 0.011 | 48 | RL = 13.2 + 0.0331 (LL x LN) | | | | |
| | Transformed (.29) Length (TrRL) | 0.354 | 0.000 | 50 | TrRL = 1.45 + 0.0201 (LL) | 0.024 | 0.135 | 94 | TrRL = 2.14 + 0.0365 (LN) | 0.177 | 0.003 | 48 | TrRL = 1.99 + 0.00184 (LL x LN) | | | | |
| | Width (RW) | 0.067 | 0.069 | 50 | RW = 3.03 + 0.00291 (LL) | 0.039 | 0.056 | 94 | RW = 0.357 + 0.0157 (LN) | 0.087 | 0.042 | 48 | RW = 3.57 + 0.00426 (LL x LN) | | | | |
| | Transformed (0.0) Width (TrRW) | 0.082 | 0.044 | 50 | TrRW = -1.23 + 0.0077 (LL) | 0.039 | 0.056 | 94 | TrRW = -1.06 + 0.0386 (LN) | 0.096 | 0.032 | 48 | TrRW = 1.35 + 0.000359 (LL x LN) | | | | |
| | Number (RN) | 0.041 | 0.159 | 50 | RN = 2.75 + 0.0464 (LL) | 0.141 | 0.000 | 94 | RN = 2.36 + 0.600 (LN) | 0.123 | 0.015 | 48 | RN = 3.07 + 0.0105 (LL x LN) | | | | |
| | Transformed Number (TrRN) | 0.293 | 0.000 | 50 | TrRN = 1.41 + 0.00916 (LL) | 0.047 | 0.035 | 94 | TrRN = 1.69 + 0.263 (LN) | 0.206 | 0.001 | 48 | TrRN = 1.63 + 0.000986 (LL x LN) | | | | |
| | Volume (RV) (L x 3.14 x (0.5W ²)) | 0.199 | 0.001 | 50 | RV = -0.366 + 0.0800 (LL) | 0.039 | 0.058 | 94 | RV = 1.81 + 0.259 (LN) | 0.141 | 0.009 | 48 | RV = 4.96 + 0.0756 (LL x LN) | | | | |
| | Transformed (.3) Volume (TrRV) | 0.282 | 0.000 | 50 | TrRV = 0.640 + 0.0156 (LL) | 0.045 | 0.040 | 94 | TrRV = 1.10 + 0.0454 (LN) | 0.208 | 0.001 | 48 | TrRV = 1.01 + 0.00171 (LL x LN) | | | | |
| | Total Volume (ToRV) (Volume of root x # of roots) | 0.085 | 0.041 | 50 | ToRV = -2.13 + 0.450 (LL) | 0.078 | 0.006 | 94 | ToRV = 3.83 + 29.4 (LN) | 0.141 | 0.009 | 48 | ToRV = 4.96 + 0.0756 (LL x LN) | | | | |
| | Total Transformed (.14) Volume (ToTrRV) | 0.246 | 0.000 | 50 | ToTrRV = 0.903 + 0.0114 (LL) | 0.107 | 0.001 | 94 | ToTrRV = 1.17 + 0.05253 (LN) | 0.243 | 0 | 48 | ToTrRV = 1.14 + 0.00147 (LL x LN) | | | | |
| | | LEAF | | | | | | | | | | | | | | | |
| | | Experimental Treatments Only | | | | Length (LL) | | | | Number (LN) | | | | Leaf Area (LL x LN) | | | |
| | | R-sq | P | n | Equation | R-sq | P | n | Equation | R-sq | P | n | Equation | | | | |
| | | ROOT | Length (RL) | 0.146 | 0.000 | 768 | RL = 4.74 + 0.296 (LL) | 0.105 | 0.000 | 1236 | RL = 6.90 + 1.60 (LN) | 0.201 | 0.000 | 763 | RL = 6.72 + 0.0603 (LL x LN) | | |
| Transformed (.29) Length (TrRL) | 0.154 | | 0.000 | 768 | TrRL = 1.61 + 0.0163 (LL) | 0.105 | 0.000 | 1236 | TrRL = 1.69 + 0.0853 (LN) | 0.275 | 0.000 | 765 | TrRL = 1.18 + 0.00164 (LL x LN) | | | | |
| Width (RW) | 0.364 | | 0.000 | 766 | RW = .00875 + 0.00575 (LL) | 0.183 | 0.000 | 1231 | RW = 0.130 + 0.0251 (LN) | 0.415 | 0.000 | 763 | RW = 0.133 + 0.00107 (LL x LN) | | | | |
| Transformed (0.0) Width (TrRW) | 0.350 | | 0.000 | 766 | TrRW = 1.01 + 0.00812 (LL) | 0.174 | 0.000 | 1231 | TrRW = 1.07 + 0.0349 (LN) | 0.375 | 0.000 | 762 | TrRW = 1.07 + 0.00147 (LL x LN) | | | | |
| Number (RN) | 0.188 | | 0.000 | 768 | RN = 1.49 + 0.0623 (LL) | 0.249 | 0.000 | 1237 | RN = 1.36 + 0.455 (LN) | 0.311 | 0.000 | 765 | RN = 1.83 + 0.0140 (LL x LN) | | | | |
| Transformed Number (TrRN) | 0.168 | | 0.000 | 768 | TrRN = 1.14 + 0.00736 (LL) | 0.231 | 0.000 | 1237 | TrRN = 1.12 + 0.055 (LN) | 0.275 | 0.000 | 765 | TrRN = 1.18 + 0.00164 (LL x LN) | | | | |
| Volume (RV) (L x 3.14 x (0.5W ²)) | 0.247 | | 0.000 | 763 | RV = -0.0982 + 0.0126 (LL) | 0.170 | 0.000 | 1229 | RV = -0.0332 + 0.0639 (LN) | 0.36 | 0.000 | 760 | RV = -0.0182 + 0.00265 (LL x LN) | | | | |
| Transformed (.3) Volume (TrRV) | 0.349 | | 0.000 | 763 | TrRV = 0.593 + 0.00778 (LL) | 0.198 | 0.000 | 1229 | TrRV = 0.0362 (LN) | 0.409 | 0.000 | 760 | TrRV = 0.653 + 0.00147 (LL x LN) | | | | |
| Total Volume (ToRV) (Volume of root x # of roots) | 0.223 | | 0.000 | 763 | ToRV = -0.596 + 0.0553 (LL) | 0.195 | 0.000 | 1228 | ToRV = -0.446 + 0.320 (LN) | 0.35 | 0.000 | 760 | ToRV = -0.275 + 0.0121 (LL x LN) | | | | |
| Total Transformed (.14) Volume (ToTrRV) | 0.38 | | 0.000 | 763 | ToTrRV = 0.770 + 0.00665 (LL) | 0.272 | 0.000 | 1228 | ToTrRV = 0.802 + 0.0347 (LN) | 0.474 | 0.000 | 760 | ToTrRV = 0.819 + 0.00129 (LL x LN) | | | | |

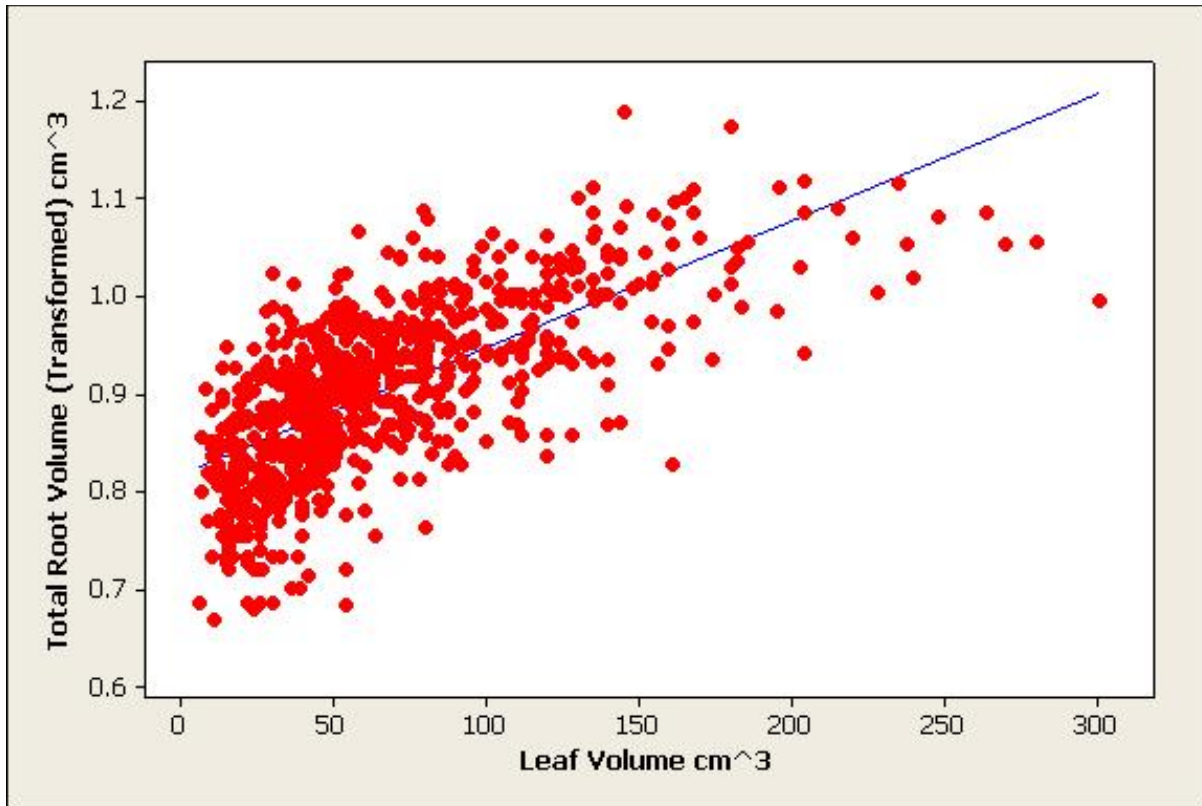


Figure 4.8. Scatterplot of above ground (leaf) versus below ground (root) *Argentina egedii* volumetric data. Total root volume data were transformed using a lamda value of 0.07.

Due to the complex shape of both *Argentina egedii* leaves and roots, I recommend that those who are interested in further exploring *Argentina egedii* allometry consider metrics that require fewer extrapolations in order to reflect multidimensional plant features. Biomass, for example, could serve as a more inclusive approximation of size. I did collect a small amount of biomass data from a small *in vitro* propagation study that I conducted separately.

Above- and below-ground biomass data showed a strong positive correlation with a correlation coefficient of 1.23 and an R-squared value of 0.583 (Figure 4.9). These data are consistent with the trend suggested by volume comparisons and lead me to conclude that the total above-ground vegetation (biomass) may serve as a predictor of total below-ground root biomass.

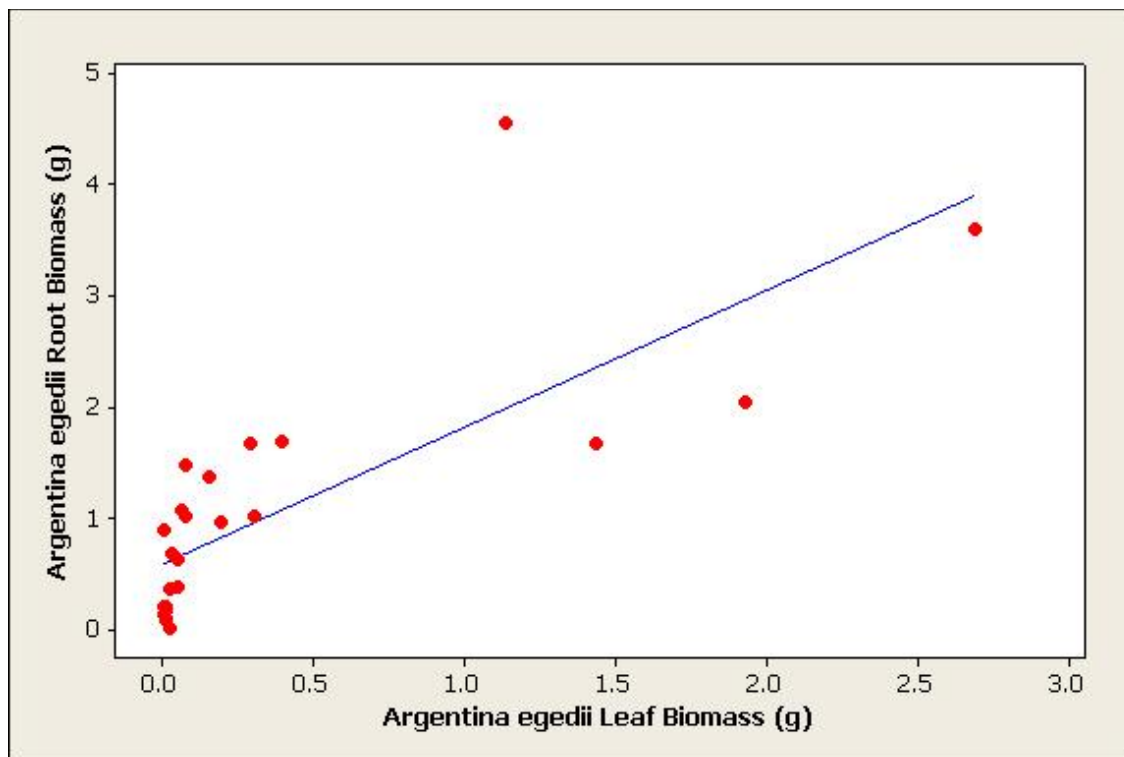


Figure 4.9. Scatterplot with linear regression line for *Argentina egedii* leaf biomass versus root biomass.

4.6. Follow-up; The Effect of Harvesting on Plant Regeneration

Harvesting is another important component of *Argentina egedii* management and because I did not include it in my initial experimental design, I conducted a follow-up survey to better understand the effect of harvesting on *A. egedii* regeneration. In July of 2009, the 30 till and 30 till + weed quadrats that I had harvested ten months prior were surveyed for *A. egedii* plant abundance. Due to the time constraints of my July field visit, the number of *A. egedii* plants per 0.25m² quadrat was the only metric recorded. Abundance data from the 2008 control were used for informal comparison as the control was not surveyed in 2009.

Table 4.15. Descriptive Statistics: Post harvest plant abundance per 0.25m². Note: Control plants are from 2008 and experimental treatments are from 2009 regeneration data.

| Treat | Year | N | SE | | St | | Min. | Q1 | Median | Q3 | Max. |
|-------|-------|----|-------|------|-------|------|-------|-------|--------|-------|------|
| | | | Mean | Dev | Mean | Dev | | | | | |
| C | ('08) | 30 | 11.47 | 1.13 | 6.20 | 4.00 | 6.00 | 10.00 | 15.25 | 26.00 | |
| T | ('09) | 30 | 15.40 | 1.83 | 10.04 | 3.00 | 8.00 | 11.50 | 20.50 | 39.00 | |
| T + W | ('09) | 30 | 19.83 | 1.59 | 8.70 | 6.00 | 13.00 | 19.50 | 24.75 | 40.00 | |

A review of the descriptive statistics suggests that plants from the “till” and “till + weed” treatments regenerated well, even from the “100 percent” harvest. The till treatment had on average 61.6 *A. egedii* plants per m², and the till + weed treatment had 79.32 plants per m². In contrast, the abundance of the control plot from 2008 was only 45.88 per m². Abundance among all treatments had little variance about the mean (Table 4.14).

Experimental data analysis showed that these abundance data did not meet the assumptions for an ANOVA, although this problem was ameliorated with a square root transformation. ANOVA results for raw and transformed data were similar, so the raw data results are presented in Table 4.15. I observed a trend similar to that of my initial harvest abundance: on average plants in the control were significantly less abundant than those in the till treatment, which were significantly less abundant than those in the till + weed treatment ($p = 0.01$; Table 4.15).

Table 4.16. One-way ANOVA: Post harvest plant abundance per 0.25m². Note: Control treatment data are from 2008 and experimental treatment data are from 2009.

| Source | DF | SS | MS | F | P |
|--------|----|--------|-------|------|-------|
| Treat | 2 | 1051.3 | 525.6 | 7.33 | 0.001 |
| Error | 87 | 6234.8 | 71.7 | | |
| Total | 89 | 7286.1 | | | |

S = 8.466 R-Sq = 14.43% R-Sq(adj) = 12.46%

Individual 95% CIs for Mean Based on Pooled StDev

| Level | N | Mean | StDev | CI |
|-------|----|--------|--------|---------------|
| C | 30 | 11.467 | 6.202 | (-----*-----) |
| T | 30 | 15.400 | 10.040 | (-----*-----) |
| T + W | 30 | 19.833 | 8.702 | (-----*-----) |

-----+-----+-----+-----+
12.0 16.0 20.0 24.0

Pooled StDev = 8.466

The appearance of heightened *A. egedii* regeneration following harvesting indicates that harvesting does not threaten the population, and may in fact be an important management component in maintaining healthy populations of edible roots. This is suggested from other studies monitoring edible “root” harvesting (Anderson 1993; Lowen 1998; Cullis-Suzuki 2007; Beckwith 2004).

4.7. Discussion: Understanding Productivity

Understanding the potential role of management in increasing the productivity of *K^wak^waka’wak^w* estuarine salt marsh root garden depends on the quality of biological measurements, knowledge of biological and ecological mechanisms, and awareness of the goals of the traditional managers. This discussion is therefore focused on evaluating my results, exploring the unique attributes of *Argentina egedii* and estuarine salt marshes that make intensive management possible, and grounding my experimental work within Traditional Ecological Knowledge.

A number of different metrics can be used to assess the productivity of *Argentina egedii* in terms of its edible roots. This study has made it clear that looking at one of these factors in isolation can be potentially misleading. For example, when I considered the abundance of *A. egedii* alone, tilling + weeding appeared to affect a five-fold increase in productivity (Figure 4.10). However, when I focused on the actual biomass of *A. egedii* roots, I observed no treatment effect at all within the time frame of my study (Figure 4.10). I must therefore consider what measures of productivity are most important to traditional *təkillak^w* managers.

Both *K^waxistalla* and *Laguis* emphasized the thickness¹²⁷ of *A. egedii* roots as the best indicator of a properly managed *təkillak^w*, using the diameter of their little fingers as an approximation of potential root girth (*K^waxistalla*, Clan Chief Adam Dick pers. comm., 2008 and in Deur 2000; *Laguis*, n.d.

¹²⁷ Helen Norton (1981) also used the diameter of the little finger to describe the thickness width of silverweed roots on Haida Gwaii. John Jewitt described “*kletsup* (the Nuu-cha-nulth word for silverweed) —as being the width of a crow’s quill and 15 cm long (Jewitt 1987 p.120; Pukonen 2008: 36; Turner, pers. comm., 2010).

in Dzawada'neux'w Land & Resource Office Newsletter 2008). At about 15 mm, a “pinky” finger is much larger than any of the roots from my experimental ‘tekillak’; roots in both the “till + weed”, and “till” treatments were, on average, only 2.2 mm in diameter and those in the control were, on average, 4.1 mm. Unexpectedly, the experimental replication of “traditional” management significantly reduced the diameter of *A. egedii* roots by 46 percent. While reduced diameter may be expected when comparing the six-month-old roots in the experimental treatments to the many-year-old roots in the control treatment, it is surprising that there is such a large difference between the size of a little-finger and the managed roots in the experimental treatments. This suggests that some element of the traditional management was not accurately replicated in the experimental management (or the size of the roots was consistently exaggerated in ethnological accounts).

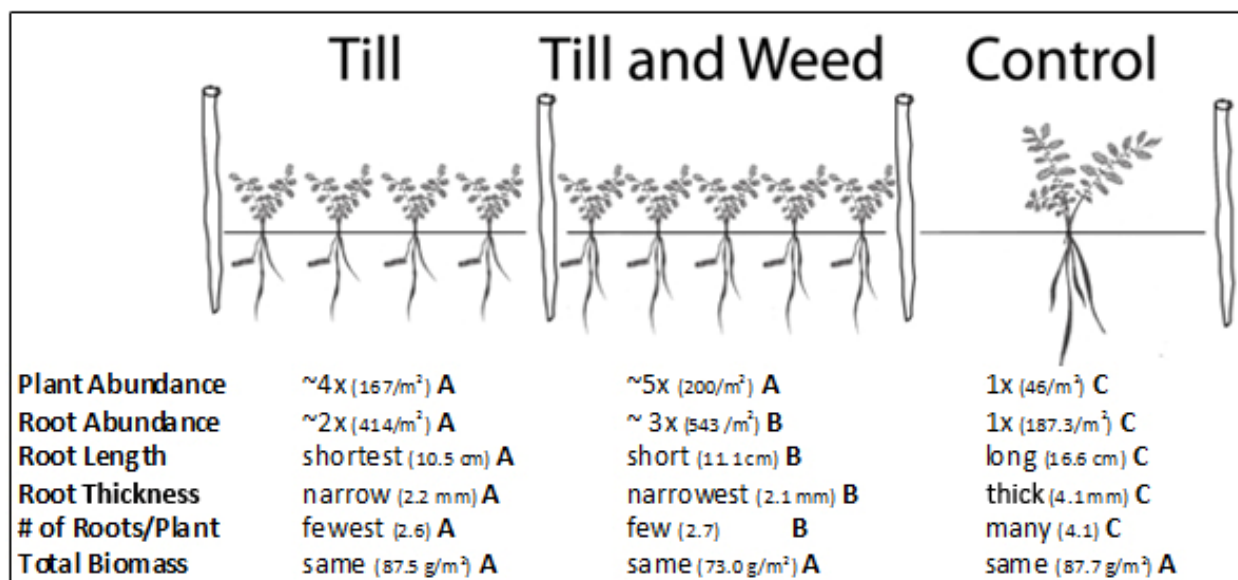


Figure 4.10. Summary of estuarine salt marsh root garden experimental results across various metrics of productivity. Letter changes between columns represent significantly different results at a $p < 0.05$ level. Mean values are displayed in parentheses.

The number of roots per *A. egedii* plant¹²⁸, and to a lesser extent, the length of *A. egedii* roots, experienced similar reductions as compared with the controls after application of the experimental treatments. However, the abundance of individual *A. egedii* plants and total *A. egedii* roots per unit area increased over those of the control. I found no K^wak^waka^wwak^w references specific to *A. egedii* root length, number, or plant abundance. Boas (1921) does erroneously reference the cultural importance of long *A. egedii* roots but a review of the K^wak^wwala text that accompanies this claim clearly shows that he confused the K^wak^wwala words for *Argentina egedii* and *Trifolium wormskioldii* so that his description of *A. egedii* is actually of *T. wormskioldii* and vice-versa (See Chapter 2).

Collectively, these data suggest an inverse relationship between the different metrics of root abundance and of root size (i.e. many small roots or few big roots; Figure 4.11). A piece of land can logically support only so much living biomass. How, then, did traditional management optimize this relationship?

K^waxistalla prescribed weeding as a means of focusing the productive potential of the land towards edible root production. Data on root abundance, root length, and the number of roots per plant demonstrated that weeding slightly increased *A. egedii* productivity, even over just one growing season, which was further supported by non-significant trends in plant abundance and root biomass (Figure 4.10). Only one weeding treatment was applied in one year, and these trends could likely be accentuated with frequent weeding throughout the growing season as suggested by Figure 4.11, as well as weeding over multiple years. Furthermore, the hyperabundance of *A. egedii* that resulted from my use of a mechanized roto-tilling may have created so much intraspecific competition that roots were unable to attain their potential size, just as a patch of garden carrots must be adequately spaced in order to grow large roots.

¹²⁸ I could find no ethnological references for the number of roots per individual plant in a cultivated root garden, though Turner and Kuhnlein (1982, p. 416-418) observed silverweed roots growing in clusters of 2-6 per presumably uncultivated plant.

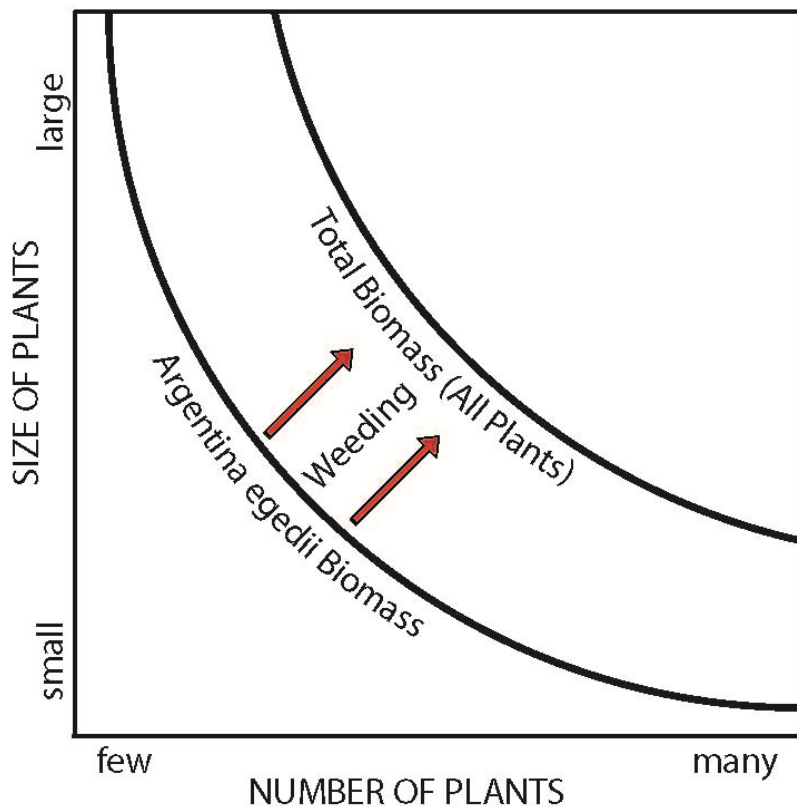


Figure 4.11. A schematic of hypothetical density dependence among *Argentina egedii* plants showing the potential effect of weeding on productivity.

The traditional knowledge presented in this chapter suggested that K^wak^waka'wak^w gardeners also managed the **təkkillak^w** for production of young roots. Lagius (also in Curtis, 1915) states that gardeners were careful to harvest from their **təkkillak^w** every year because the young *Trifolium wormskioldii* rhizomes had the best flavor. This was emphasized by the practice of leasing out gardens, to ensure that annual harvesting was not neglected. Factors that affect the taste of *A. egedii* are explored in further detail in Chapter 5.

Annual harvesting may have been possible due to the ability of *A. egedii* to grow from broken root fragments left in the soil. Despite an absence of K^wak^waka'wak^w references that support this phenomenon, I observed a strong tendency for *A. egedii* to grow from root fragments. Of the 2755 individual silverweed plants that I sampled in the experimental treatments, 719 (26 percent) of them

had propagated from a discernable root fragment. This should be regarded as a conservative estimate, as root fragments easily broke off and/or were soon almost entirely absorbed by the newly growing roots. In contrast, I observed root fragments in only 8 (2.3 percent) of the 344 silverweed plants sampled from the control quadrats.

The ability of *A. egedii* to quickly regenerate after disturbance from tilling or harvesting may be the missing link in the management chain that led to the production of both thick and young *A. egedii* roots. The follow-up survey of *A. egedii* regeneration in “till” and “till + weed” quadrats, which were completely harvested, indicated that *A. egedii* is capable of regenerating even without intentional replanting. However, the resulting above-ground growth was depauperate (~ 12 cm), an indication that the roots may have been too small to be worth harvesting. By comparison, *A. egedii* leaves in the control treatment were on average 40.29 cm long (n = 250), while those in the till treatment averaged 24.7 cm (n = 838) and those in the till + weed treatment were 19.3 cm in length (n = 801). With intentional replanting, *A. egedii* could potentially regenerate more quickly, enabling larger roots to develop.

There are many mechanisms that may enable *A. egedii* regeneration. The plants regenerate sexually from seed and asexually from both stolons (Eriksson 1988a, 1988b) and root fragments. Both soil disturbance and increased light on the soil should improve seed germination rates and available light is known to stimulate *Argentina egedii* stolon growth (Eriksson 1986). I observed one “runner” that colonized the open ground resulting from a piece of driftwood that was moved by a particularly high tide; the stolon grew right down the middle of the bare swath of soil for over 4 meters! In the regeneration survey, *A. egedii* individuals that had regenerated from stolons were distinctly larger than those that grew from root fragments or seed. Perhaps K^waxistalla’s family cultivated ‘*təkillak*’ plots that were long and narrow both for easy access to all parts of the garden and for taking advantage of rapid re-colonization of *A. egedii* from the neighboring periphery.

Root fragments are the last, and I contend, the most significant mechanism of *A. egedii* regeneration. From my findings and observations, I propose four factors that contribute to the regeneration of large roots from root fragments: (1) the size of the original root fragment; (2) the proximity of the root fragment to the surface of the soil; (3) the proximity of the root fragment to the root-shoot interface of the original root; and (4) the soil conditions (and water) that the root fragment is propagated (Figure 4.12)

Firstly, I observed a strong correlation between the length of the root fragment and the root length. Linear regression analysis on 404 roots that regenerated from old fragments produced the equation $\text{Root Length (cm)} = 9.95 + 0.52 \times \text{Old Fragment Length (cm)}$. This regression had a very low R-Squared value (0.04), which I attribute to the 1-dimensional nature of the variables, and a multiplicity of confounding factors, the most important of which may be the soil depth of the original old root fragment.

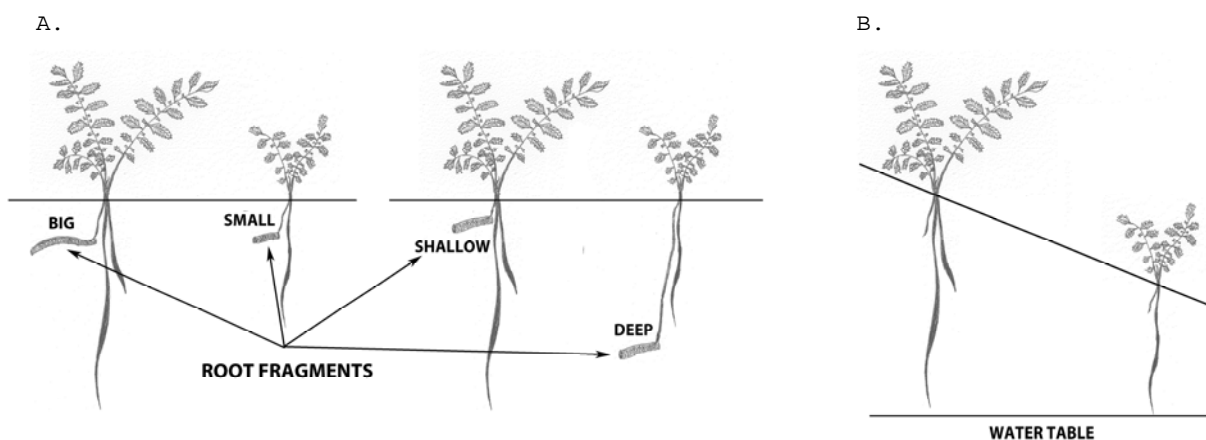


Figure 4.12. The potential relationship between root fragment size and proximity to the soil surface and *Argentina egedii* regeneration (A). The potential effect of the average growing season water table depth on *Argentine egedii* size (B).

No systematic data were collected on the depth of the root fragments, but from observation, I conclude that root fragments closer to the surface would have the opportunity to propagate into plants

with large roots because the growing shoot reaches the surface sooner and subsequently has more time to develop leaves and grow new roots before the end of the growing season (Figure 4.12 A). This is especially true as soil desiccation is not a limiting factor in the Kingcome River estuarine salt marsh environment and root predation—which could disadvantage roots closer to the surface—was limited by preferential waterfowl hunting around root gardens (Edwards 1979; K^waxistalla, Clan Chief Adam Dick pers. comm., 2008).

I propose that K^wak^waka'wak^w managers were aware of the vegetative regenerative capacity of *Argentina egedii* roots and intentionally replanted pieces of the root. The only historic references that explicitly mention *A. egedii* replanting comes from Alice Paul, a Hesquiaht woman, who asserted that the ends of both silverweed and clover were placed back into the ground so that they would grow into new plants (in Turner and Efrat 1983, p. 68, 73). A K^wak^waka'wak^w source, Lagius, did specifically prescribe the replanting of "...such pieces as were not deemed good for food" as a means of insuring future root garden productivity (Lagius n.d. in Dzawada'neux'w Land & Resource Office Newsletter 2008; published in Curtis 1915, v. 10, p. 43), but due to ambiguities in the text it is uncertain if this description of edible estuarine salt marsh roots extends to include *A. egedii* or is more specific to *Trifolium wormskiolldi*.

Several untested field observations also support Lagius's instruction to replant unused root fragments. In addition, it is likely that some segments of the root may regenerate better than others. For example, I observed the upper portions of *A. egedii* roots developing new rootlets more quickly and more abundantly than lower portions of the roots (Figure 4.13). I performed a "casual experiment" to see if individual *A. egedii* tops can recover from root harvest if they are replanted. I harvested 15 plants, removed all the roots just below the root-shoot interface, and planted the vegetative tops in a one meter square plot in the Kingcome river estuary (Figure 4.14) to see if they would be able to survive and grow. After recovering from a short period of stress, the majority of the plants flourished and only 2

individuals were lost. I attempted to further explore *A. egedii* regeneration and asexual reproduction by planting equal masses of different portions (including the segments of the root-shoot interface) of *A. egedii* root segments in a glass-sided planter, with the hope of observing root propagation and growth. This experiment, unfortunately, could not be completed because the planters overheated and dried out apparently due to the greenhouse effect of the glass sides.



Figure 4.13. A multiple-year-old¹²⁹ *Argentina egedii* individual showing root branching and rootlet growth. Note higher rootlet concentration near the root/shoot interface.



Figure 4.14. Time series of regeneration success of *Argentina egedii* tops that were replanted after the roots were harvested.

The ability of root fragments to regenerate is likely affected by soil conditions. Soil near the surface warms up earlier in the year, which could extend the growing season for propagating root

¹²⁹ I observed growth rings on *Argentina egedii* roots that were broken while fresh and allowed to oxidize for a few hours, and on roots that were boiled and broken.

fragments in the upper layer. Other soil conditions, such as porosity, degree of saturation, sediment size, organic content, and mineral availability may also play a vital role in determining *A. egedii* regeneration, just as they would in affecting the natural distribution of *A. egedii* across the landscape (Deur 2000). I found little information in the scientific literature about what soil conditions are best for *A. egedii* though notes about soil conditions show up in the ethnographic record. The finer sediment soils found in the estuaries of the Kingcome and Klinaklini rivers were said to have been preferred by K^wak^waka'wak^w root garden managers to the gravel estuary of the Nimpkish River (Boas 1921 p.188, 190). Deur (2000, p.175-200) provided the most detailed scientific information, having observed large specimens growing near river mouths, in fallow terraced [']tekillak^w sites. Here the loose organic, rich, sandy soils, and places with large deposits of estuarine detritus.

Throughout my 2008 field season I harvested *A. egedii* roots from a variety of sites throughout the Kingcome River estuary and observed a correlation between root size and elevation, presumably related to the depth of the water table (Figure 4.12 B). *A. egedii* growing at the lower end of its range in the salt marsh were subjected to periodic flooding during about 5-10 high tides every month of the growing season, which kept the average water table at about 10-15 cm below the surface. From these areas I collected relatively short, thin, and un-branched *A. egedii* roots. On the other end of the spectrum, the high estuarine salt marsh rarely flooded (0-3 times a month) during the growing season, allowing the average water table to drop several decimeters below the soil surface; this area produced some of the longest and most robust *A. egedii* roots. Figure 4.15 draws on data from other portions of the estuarine salt marsh to illustrate this trend. I propose that the average depth of the water table during the growing season is a principal factor determining the lower limit (and therefore length) of root growth for *A. egedii*. One limiting factor could be that saturated soils create anaerobic conditions which enable sulfate rich seawater-infused sediments to form phytotoxic sulfides, (Mitsch and Gosselink, p. 239) resulting in poor root growth.

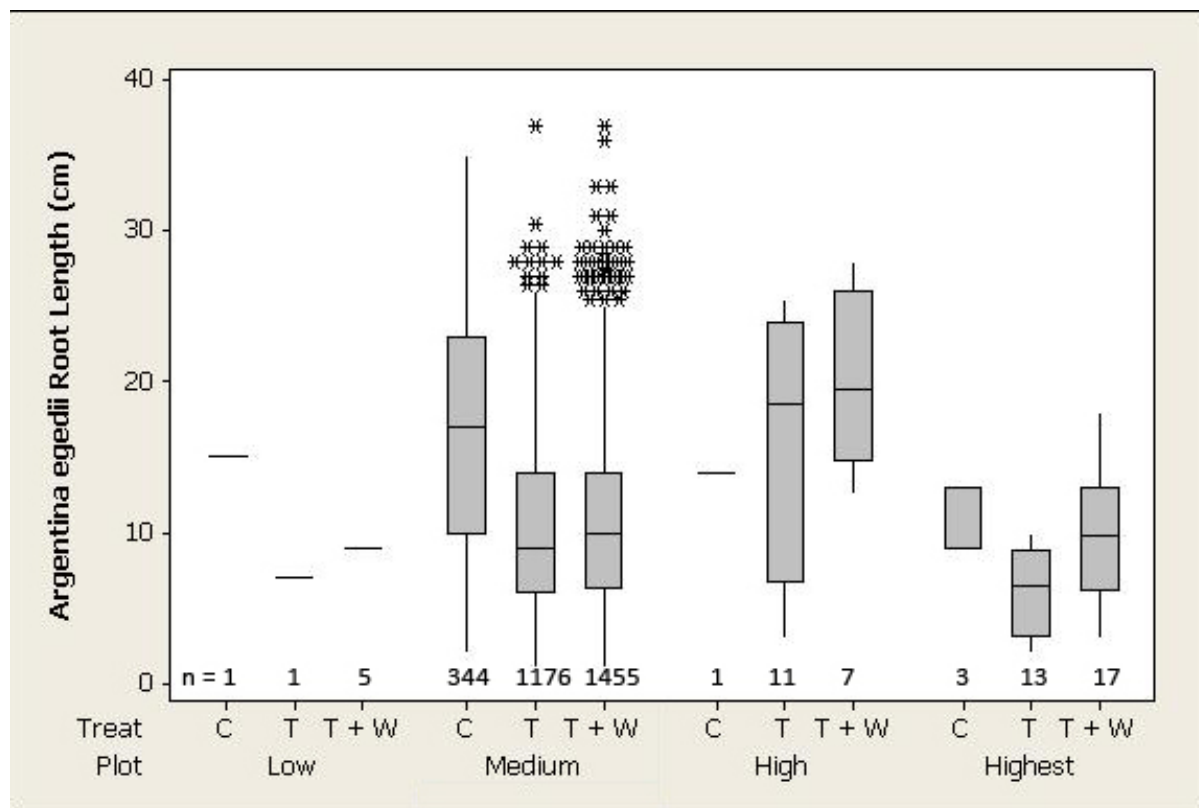


Figure 4.15. *Argentina egedii* root length at various elevations within its natural distribution in the Kingcome River estuary. Note: the highest plot was previously farmed and had a hard pan of sediment ~ 15 cm below the soil surface that may have been compacted by cattle hooves.

I performed a small experiment, starting on March 25, 2008, to test the ability of *Argentina egedii* to grow in different sediment types. Using 4-litre plastic planter bags filled with either sandy loam or pure beach sand both from the Kingcome River bank, I propagated root segments 1 cm long, from four individual *A. egedii* plants on March 25, 2008. To control for the confounding effect of genetic variability, root segments from each of the individual plants were allocated equally among the soil types. Propagule root length, thickness, number of root branches, and total root dry weight were recorded when the roots were harvested 6 months later in September, with results show in Table 4.16.

Table 4.17. Results of experimental planting of *Argentina egedii* roots in sand and loam.

| Variable | Soil | SE | St | Mean | Mean | Dev |
|--------------------------|------|----|-------|-------|-------|-----|
| | | N | Mean | | | |
| Number of Propagules/Pot | LOAM | 5 | 5.40 | 1.75 | 3.91 | |
| | SAND | 5 | 1.200 | 0.200 | 0.447 | |
| Root Length (cm) | LOAM | 27 | 13.37 | 1.72 | 8.93 | |
| | SAND | 6 | 31.33 | 3.23 | 7.92 | |
| Root Thickness (mm) | LOAM | 27 | 3.222 | 0.276 | 1.437 | |
| | SAND | 6 | 2.833 | 0.380 | 0.931 | |
| Number of Roots | LOAM | 27 | 3.370 | 0.550 | 2.857 | |
| | SAND | 6 | 3.000 | 0.683 | 1.673 | |
| Dry Root Mass (g) | LOAM | 25 | 0.910 | 0.226 | 1.130 | |
| | SAND | 5 | 1.012 | 0.235 | 0.526 | |

Despite having planted only one root fragment in each pot, the abundance of *Argentina egedii* plants rapidly increased via runners to an average of 5.4 plants per pot in the loam and 1.2 plants per pot in the sand (Table 4.16). The loam supported significantly more growth than the sand ($p = 0.04$). Root thickness, number, and biomass also tended to be greater in the loam, but not at statistically significant levels. *Argentina egedii* roots grown from propagules in the sandy soil were on average twice as long (31.33 cm) than in the loam (13.37 cm; Table 4.16; $p < 0.01$). While this experiment did not test root growth in clay, silt, or gravel, it does corroborate TEK that *A. egedii* grows well in loamy soils. It is also significant that propagules growing in well-drained pure beach sand were on average much longer than roots from any of my *in situ* sites. This is another potential indication of growth evidently being limited by the depth of the water table. This may also apply to the growth of clover, as suggested in the ethnological account of Agnes Alfred (in Reid 2004, p. 72). She recalled that “people would dig long ditches in the ground where [they] dug for clover...,” which indicates that the K^wak^waka’wak^w were actively lowering the water table in salt marsh gardens.

Other soil properties, such as N levels, may also affect *A. egedii* growth. Little is written about the influence of soil fertility on estuarine salt marsh root growth, but I observed very large *A. egedii*

roots growing near *Alnus rubra*, which has nitrogen-fixing root nodules, in soil that was distinctly orange colored. *Argentina egedii* may also have been intentionally grown in a polyculture with the leguminous *Trifolium wormskioldii* to take advantage of the latter's nitrogen-fixing properties. Additionally, Douglas Deur demonstrated that the stone walls on terraced **'təkillak'** plots trapped detrital deposits, which enriched soils with micronutrients to levels that rivaled greenhouse soils (Deur 2000, p. 117).

As a final point of discussion, I will consider how well my experimental approach at Kingcome actually reflected traditional estuarine salt marsh root garden management practices. The two most obvious differences between my experimental garden and a traditionally managed **'təkillak'** are technological and temporal—I used a roto-tiller to till the soil instead of a digging stick, and I harvested the roots after only 6 months of tilling and weeding, instead of after generations of continuous and repetitive management. The use of the roto-tiller to break up the soil, though novel, came at the suggestion of K^waxistalla, who likely has a better understanding of how root gardens work than anyone else. He recommended using the roto-tiller in particular to help break up the dense growth of inedible roots that had taken over the **'təkillak'** and competing with the edible root-bearing species. Accomplishing this initial task with a digging stick would have taken considerable more time and effort, and would not have been necessary in the era of well managed root gardens when such grasses and other competing species were kept to a minimum. The roto-tiller was successful in cultivating the soil, but its effects differed from those of a digging stick in two ways. First, the roto-tiller was only capable of churning and aerating the soil only to a depth of about 15-20 cm, whereas a properly used digging stick would till the soil to 30 cm or more. Second, the roto-tiller's cutting action produced many small root fragments of *A. egedii*, whereas a digging stick would not have cut up the roots to the same extent. Using the theoretical framework that I established earlier in this discussion, I expect that a garden with a deeper zone of aerobic activity and fewer, large root fragments would produce roots at an abundance and size between my control and my experimental treatments. Despite these theoretical differences,

use of the roto-tiller was very successful at demonstrating the fundamental biological mechanism that makes *Argentina egedii* gardening possible: the ability to regenerate from root fragments. The roto-tiller treatment was an extreme measure that was necessary to break fallow ground and its dense turf, and was scientifically valuable in discerning a clear treatment signal and establishing background level variability. Further study is necessary to determine the long-term effect of management on *A. egedii* growth and estuarine salt marsh root garden productivity, at which point comparative and ongoing use of traditional tools would be an appropriate and desirable means of determining the ideal and “intermediate” level of disturbance (Conell 1978).

Weeding frequency and predator control are other elements of traditional estuarine salt marsh root garden management that deserve further attention. My data strongly suggest that weeding was an important means of increasing productivity, but I only applied a single weeding treatment throughout the growing season, whereas K^waxistalla prescribed continuous weeding throughout the summer (Pers. comm., 2008). Predator control was not included at all in this experiment despite numerous ethnological accounts of hunting around estuarine salt marsh root gardens, and a strong association between edible estuarine salt marsh roots and waterfowl. K^waxistalla said that mallards and geese preferentially forage in areas with disturbed soil, and he would lure them in by digging a patch of soil near a hunting blind (Pers. comm., 2009). Shortly after tilling my experimental plots I observed numerous geese tracks in the bare soil, indicating a confounding “natural” variable of root predation, although I cannot say what the extent of such influence was.

4.8. Conclusions

These root garden experiments have shown that soil disturbance and harvesting itself can dramatically increase *Argentina egedii* abundance. Although “till” and “till + weed” treatments both resulted in smaller *A. egedii* roots than the control, within a single growing season, the addition of

weeding significantly increased the size and number of roots compared with the till-only treatment.

Since large young *A. egedii* roots are desirable, future work should focus on better understanding the role of replanting the root shoot interface on the vigor of root regeneration. Now that the fallow cycle is broken, long term study of **tokkillak**[™] management using culturally appropriate tools is needed to gain a more nuanced understanding of the abundance/size relationship that will yield the most biomass per unit area. Future work should also try and control for, or at least understand, the impact of root predation by waterfowl.

Chapter 5. Factors Affecting Harvest Timing and Taste of Pacific Silverweed (*Argentina egedii*), A Traditional K^wak^waka'wak^w Root Vegetable

5.1. Introduction

There are many reasons why **ləksem** – a root vegetable once widely eaten on the Northwest Coast and obviously appreciated by many – is little used, or even known at all, today. The accounts of K^waxistalla and others identify it as a well-liked and tasty food, known to past generations from time immemorial. It is featured in ancestral narratives, its maintenance and harvesting were significant activities of people's seasonal rounds, and it was served as a prestige food at large feasts as well as at family meals. My research in working with and observing **ləksem** in the **təkillak^w** setting under the guidance and authority of K^waxistalla suggests that these gardens could indeed be revitalized and that the growth and abundance of **ləksem** could again be promoted as it was in the past both at Kingcome and other parts of the coast (Deur and Turner 2005).

People prepared edible estuarine salt marsh roots for consumption in a number of different ways. K^waxistalla said that if large quantities of silverweed and clover were going to be eaten, they were steamed underground. Agnes Alfred described this process:

They would dig a hole and heat stones in the fire. When the stones were red hot they would put them into the hole that had been dug. I saw Łax^waʔa [Lucy Sewid] do this with a plant called **təx^wsus** [clover roots]. She would steam them. They would take **kikaʔok^w** [skunk cabbage leaves] and cover the stones so the food would not get dirty. Then they would put the **təx^wsus** on top and cover it with a mat. They would pour water over it and steam it. They call this **nəka** [steaming] (In Reid and Sewid-Smith 2004, p. 84).

Drucker (1951, p.62) documented a Nuu-chah-nulth account of steaming such a vast quantity of clover roots for a feast that it was necessary for men to climb onto the roofs of their houses to pour water over the roots to create the steam to cook them. Likewise, steamed clover and silverweed roots were an important feast food of the K^wak^waka'wak^w. George Hunt documented that steamed clover and

silverweed roots were “given at a great feast to many tribes.” He elaborated that feasts of steamed clover rhizomes “...are counted when chiefs count their feasts in rivalry” (in Boas 1921, p. 531, 542).

Boas (1921) also described steaming both clover and silverweed in cedar bentwood boxes. The cook placed the roots in the box on top of a scaffolding of wood that kept them above the hot rocks. She then poured water over the hot rocks creating steam that was held in with a woven cedar mat. When the covering mat sagged, the roots were finished cooking. Charlie Nowell recalled a more recent version of cooking clover roots:

We have sticks on the bottom of the saucepan and put this dried clover root on top of these sticks, and the water under the sticks boils. There is a cover on top to keep the steam in. It is only the steam that cooks it. They open the cover, which is made out of cloth, and take out a piece to see if it is soft enough to eat. Then it is done (in Ford, p. 51).

George Hunt also documented the practice of boiling both clover and silverweed roots, with the caveat that boiled roots and rhizomes were never served at great feasts but rather just served to women and children (in Boas 1921, p. 533).

K^waxistalla only ate silverweed roots that were cooked underground in pits in his youth. He recalls eating roots daily through to the late fall, however they seldom ate **təx̄^wsus** and **ləksəm** at the same time. He said it was like choosing to eat turnips or carrots to accompany the meat or fish today.

K^waxistalla recalled that the clover rhizomes were always prepared whole and once cooked he used his finger tips to wind the clover rhizomes into a ball before dipping it in (**kinna**) eulachon grease. Riceroor was also always cooked in the underground pit, never eaten either raw or boiled. K^waxistalla said that it is bitter after it was pit cooked and the bitterness was lessened when the riceroor when dipped in **kinna** (eulachon grease). **Q^wanniy** was the only root of the four that he would eat raw and not cooked underground. He ate all four roots as a main part of his diet each year until well into his twenties (Kim Recalma-Clutesi, pers. comm.). K^waxistalla is the last living person of his Nation who ate the roots from his Clan's **təkillak^w** as a main part of his fall and winter diet (Kim Recalma-Clutesi, pers. comm.).

Even when he was secluded in **íkuk^wkag^wisnuk^w** (Deep Harbour, Fife Sound) for years in his youth, when the other children were in residential school, he remembers travelling by dug out canoe with his paternal grandparents to a relative's **tékillak^w** in Viner Sound to dig roots to pit cook in Deep Harbour.

Nutritional analyses (cf. Kuhnlein and Turner 1991; Turner *et al.* 2009) indicate that these roots are, overall, as nutritious as other root vegetables such as potato (*Solanum tuberosum*), contributing not only carbohydrates, but an array of essential vitamins and minerals to people's diets. One study, through the Nuxalk Food and Nutrition Program (Turner *et al.* 2009: Table 2), demonstrated that the roots of *Argentina egedii* (syn. *Potentilla pacifica*, silverweed or cinquefoil) contain higher levels of carbohydrate (29.5 g per 100 g of edible portion) than any other Nuxalk food except red laver seaweed (*Porphyra abbottiae*).

Taste is also an important factor in any consideration of revitalization possibilities for a traditional food. **ləkseḿ** roots are sometimes characterized as bitter tasting (Table 5.1; Turner and Efrat 1982; Turner *et al.* 1983), and K^waxistalla recalled from eating them in his younger days that they would sprinkle a little sugar on them to improve the flavour (pers. common. 2008). Lagius, a Tsawataineuk Band member who informed some of Edward Curtis' writings on K^wak^waka'wak^w food (Lagius n.d. in Dzawada'neux'w Land & Resource Office Newsletter 2008; Curtis 1915), said that any portions of the **ləkseḿ** that were growing exposed to the air were "...always bitter, like sunburned potatoes." The bitterness of **ləkseḿ** may be due to increased levels of secondary metabolites such as tannins and phenolics, which are potentially astringent and/or bitter, and may serve to protect the plant against predation. There are some indications (Boas 1921, p. 533-534) that the taste of **ləkseḿ** varies with conditions of its growth, most especially the relative age and lifecycle stage of its roots, as well as possibly with genetically and ecologically determined traits.

K^waxistalla said that silverweed roots are ready to be harvested by late summer and early fall (Pers. comm. 2009). Likewise, historical accounts identify fall as the harvest season of other estuarine

salt marsh roots (see Table 5.2; Edwards 1979; Deur 2000, 2005; Turner and Peacock 2005). Menzies observed Nuu-chah-nulth women harvesting clover on September 4th (1792, p. 116-117). September was also the preferred month for silverweed [*Argentina anserina* (L.) Rydb.] harvest among the Secwepenc, or Shushwap (Palmer 1975, p. 66-67). Both roots are also recorded to have been harvested starting at the end of September (Curtis 1915, p. 43; Laguis n.d.) and in October (Turner *et al.* 1983 p. 24, 188). Some phenological indicators include the falling of the tree leaves (Curtis 1915 p. 43), frost-killed silverweed leaves (Boas 1921, p. 186), when the silverweed leaves turn orange (Turner *et al.* 1983) and when the clover “vines wither” (Laguis, n.d.). K^waxistalla elaborated on the duration of root harvest by saying that estuarine salt marsh roots were harvested all throughout the winter whenever snow was not covering the flats (Pers. comm., 2009).

Nootka lupine roots, on the other hand, were harvested mainly in the spring as the first shoots began to emerge (K^waxistalla, Clan Chief Adam Dick pers. comm., 2008, Boas 1921, p. 198; Table 5.2). Riceroor was harvested in many seasons including the early summer flowering time (K^waxistalla, Clan Chief Adam Dick pers. comm., 2008; Boas 1921, p. 201), and the fall (K^waxistalla, Clan Chief Adam Dick pers. comm., 2008; Table 5.2).

Following the knowledge that **ləksem** and the other **tekillak^w** roots were generally harvested in the fall, around the time when the leaves die back and start to turn from green to orange or brown, one would expect that the taste and nutritional content of the roots would be optimal at that stage, with relatively low quantities of bitter principles such as tannins, and relatively high amounts of carbohydrates.

Table 5.1. Northwest Coast ethnographic accounts of bitterness of *Argentina egedii* and *Fritillaria camschatcensis*. Note that bitterness was often counteracted with oil and more recently, sugar.

| Source | People | <i>Argentina egedii</i> | <i>Fritillaria camschatcensis</i> |
|---------------------------------------|---------------|--|--|
| Hooker 1842 | Tlingit | | "The bitter tubers are copiously eaten by the Sitka." p. 306 |
| Lagius n.d. | Kwakwaka'wakw | "...Exposed portions of the roots, for these were always bitter, like sunburned potatoes." | |
| Curtis 1915 | Kwakwaka'wakw | "Bitter, like sunburned potatoes" p. 43 | "Mixed with hemlock bast to counteract the bitterness." p. 44 |
| Boas 1921 | Kwakwaka'wakw | | "It tastes bitter when there is only a little oil with it: therefore they put much oil in, to remove the bitter taste." p. 563 |
| Lucy Brown, in Turner and Bell 1973 | Kwakwaka'wakw | Bitter, sweetened with sugar | |
| Turner & Efrat 1982 | Hesquiat | "A little bitter" p. 73 | |
| Turner et al. 1983 | Nitinaht | "Quite bitter" p. 119 | |
| Adam Dick, in Turner field notes 1998 | Kwakwaka'wakw | | "It's pretty bitter...you gotta put lots of sugar in it." |
| Adam Dick, in Turner field notes 2005 | Kwakwaka'wakw | | "It's very bitter. My grandmother used to use k'laxtu – the brown sugar – [to sweeten it]" |
| Adam Dick 2008 | Kwakwaka'wakw | "Sprinkle a little sugar on it." | Eaten with sugar and grease. |

Table 5.2. Ethnological accounts of the harvest season for Pacific silverweed (*Argentina egedii*) and other edible estuarine salt marsh roots.

| | | Pacific Silverweed | | Springbank Clover | | Northern Riceroot | | Nootka Lupine | | |
|---|---|---------------------------------------|-----------------------------|---|--------------------------|--|------------------------------|------------------------------|--|---------------|
| | | Phenology | Date | Phenology | Date | Phenology | Date | Phenology | Date | |
| K^w ak^w aka^w wak^w | Clan Chief K ^w axistalla 2008 | No snow | Fall-winter | | | Flowering | Fall | | Spring | |
| | Turner and Bell 1973 | | | When the frost killed the leaves p. 285 | Spring or Fall p. 285 | | | Salmonberries budding p. 284 | Spring p. 284 | |
| | Halliday 1935 | | | | Spring p. 156 | | | | | |
| | Boas 1921 | Sl. leaves killed by frost p. 186 | | | | Autumn p. 189 | Blossoming p. 201 | | Salmonberries have buds and eulachon arrive p. 198 | Spring p. 198 |
| | Curtis 1915 | Tree leaves falling p. 43 | | Tree leaves falling p. 43 | | | Autumn p. 44 | | | |
| | Lagius n.d. | Cl. vines begin to wither | End of September | Cl. vines begin to wither | End of September | | | | | |
| Other | Edwards 1979 (Nuxalk) | | | Once the year's first frosts have levelled the plant's foliage p. 5 | Autumn p. 5 | | | | | |
| | Menzies 1792 (Nuu-chah-nulth) | | | | September 4th p. 116-117 | | | | | |
| | Bouchard and Kennedy 1990 (Nuu-chah-nulth) | | April p.131 | | | | | | | |
| | Turner and Kuhlein 1982 | Leaves turned orange and brown p. 419 | July, October-March p. 419 | Leaves turned orange and brown p. 419 | October-March p. 419 | | | | | |
| | Turner and Kuhnlein 1983 | | | | | As soon as shoot appear; After flowering p.212 | Spring; Summer; Fall p. 212) | | | |
| | Turner et al 1983 (Nitinaht) | Tops die p. 18, 24 | Late October p. 24 | Cl. leaves die p. 118 | End of October. P. 118 | After the flowers have finished blooming p. 85 | | | | |
| | Turner and Efrat 1982 (Hesquit) | | Mid-July p. 73 | After the leaves had died p. 68 | Fall p. 68 | | | | | |
| | Norton 1981 (Haida) | | | | | | May p. 441 | | | |
| | Turner 2004 (Haida) | | Spring; May and June p. 141 | | | Before or after flowering | May or July p. 135 | | | |
| | Palmer 1975 (Shuswap) | | September | | | | | | | |
| Dawson 1891 (Shuswap) | | Autumn p. 20 | | | | | | | | |
| Turner et al 1990 | | Spring and fall | | | | | | | | |

5.2. Research Question

Why did the K^wak^waka'wak^w traditionally harvest *Argentina egedii* roots in the fall?

H_{5.1}: *A. egedii* roots taste the best in the fall.

H_{5.2}: *A. egedii* roots are most caloric in the fall.

H_{5.3}: The K^wak^waka'wak^w needed the stored calories that *A. egedii* provided to be available during the winter.

H_{5.4}: The K^wak^waka'wak^w seasonal round only allowed for harvesting *A. egedii* in the fall.

H_{5.0}: The K^wak^waka'wak^w had not particular reason for harvesting *A. egedii* in the fall.

Of course, any combination of the hypotheses listed above may have been true. In this chapter I focus on the potential effect of seasonal variations in taste (H_{5.1}) and nutrition (H_{5.2}). Considerations on the reliance on *Argentina egedii* for winter time calories (H_{5.3}) and seasonal round limitations on harvest opportunities (H_{5.4}) can be found towards the end of this chapter in the discussion.

The taste and nutritional properties of *Argentina egedii* are affected by phytochemicals that undergo seasonal transformations and/or variations in concentration. These chemicals serve many functions in the plant including storing energy, which is usually accomplished in the form of complex carbohydrates—starch in the case of *A. egedii*—and defense against predation, which is often accomplished by secondary metabolites such as tannins. Antioxidants, tannins, and phenolics are potentially astringent and/or bitter substances that tend to increase throughout the growing season (J. T. Arnason, pers. comm., 2008) and their presence may have deterred harvesting during periods of high concentration. *Argentina egedii* is an herbaceous perennial that grows photosynthate-producing leaves in the spring, produces flowers in early summer, and then dies back to its carbohydrate-rich roots in the fall. In the Kingcome River salt marsh, *A. egedii* leaves begin to sprout in mid-March and have grown to full height by June. Leaf senescence occurs throughout the summer as new leaves emerge to replace older leaves, but in late September or October frost kills leaves *en masse* and drives the plant into winter dormancy. The leaves tend to turn from green to orange as they are dying back, and eventually turn brown.

The roots also undergo discernable changes throughout the growing season. In the spring as new leaves are emerging, *A. egedii* begins to produce hair-like rootlets from the main roots, and these continue to grow until July. Root girth of the main roots shrinks considerably during leaf production, giving the roots a deflated appearance. After the leaves mature and flowers have gone to seed, the roots fill out again and a few rootlets are converted into storage organs while the rest wither away.

5.3. Methods

I expected that a plant that undergoes such radical life-history changes would also experience significant phytochemical changes, affecting its taste and nutritional properties over the season. To test this idea I harvested *Argentina egedii* roots before, during, and after the growing season. Replicates for each date were collected from four sites along the topographic gradient of *A. egedii* range in the Kingcome River estuarine salt marsh. With the exception of the March 23rd samples, I washed all the specimens, sealed them in plastic bags and immediately froze them at -20° C in order to arrest root growth and chemical change. I erroneously left the March 23rd samples unfrozen indoors for two weeks, during which time root growth proceeded at an exceptionally high rate presumably on account of ambient room temperatures, which were much warmer than late March soil temperatures. Specimens used for analysis were collected on March 5th, May 22nd, July 10th, August 4th, and December 10th. Half of the December 10th specimens were air dried for one month to approximate the traditional K^wak^waka'wak^w practice of storing the uncooked roots until winter feasts (Boas 1921, p.188).

Specimens were shipped to the University of British Columbia, Faculty of Land and Food Systems, Food Science Laboratory for analysis of starch, soluble sugars, antioxidants, tannins, and phenolics by Karine Teo (2009) under the supervision of food scientist Dr. Christine Scaman. *Argentina egedii* was traditionally eaten as a starchy vegetable or dessert, so assays on starch and sugar were

performed in order to understand the ratio between these carbohydrates throughout the growing season and as a means of estimating relative caloric value and sweetness.

5.3.1. Assays

Starch content was determined using alpha-Amylase and Amyloglucosidase. Alpha-Amylase from *Bacillus licheniformis* was chosen as it is used widely in industry for the liquefaction of starch due to its high pH and heat stability (Pen *et al.* 1992 and Yuuki *et al.* 1985). Soluble sugars were determined using the phenol-sulfuric acid method (Mallya and Pattabiraman, 1997). Antioxidants were measured using the Trolox equivalent antioxidant capacity (TEAC; Re 1999). Tannin concentrations were determined using the protein precipitation method (Hagerman 1978). Total phenolic content was measured using a modified Folin–Ciocalteu colorimetric method described by Singleton and Rossi (1965) as it is an effective method for determining phenol content in plant extracts (Slinkard and Singleton 1977).

Sensory analysis can add valuable information linking sugars to sweetness and tannins to bitterness. Karine Teo (2009) conducted a sensory analysis of *Argentina egedii* roots using a tasting panel. However, due to the compounding effect of high variability in the roots being tasted and perhaps the perceptions of the people doing the tasting, the results were far from conclusive and are not presented here. Teo (2009) recommended that future studies obtain 100 grams of each sample and I suggest in any future sensory analysis that great care be taken to minimize the variability in root size, age, and harvest location within samples.

5.4. Results

Proximate analysis (the process of identifying separate compounds in a mixture) data on *Argentina egedii* roots were examined using a one-way Analysis of Variance (ANOVA) for significant

difference between collection dates. Descriptive statistics for replicated collection dates across each test type are presented in Table 5.3.

Table 5.3. Proximate analysis results for different harvest dates in 2008.¹ Error values (\pm) represent standard error of the mean (From Teo 2009).

| Date of harvest | Total starch (g/100g DW) | Total soluble sugars (g/100g DW) | TEAC (umol Trolox /100g DW) | Total tannin content (g TAE/100g DW) | Total phenolic content (g GAE/100g DW) |
|---------------------|--------------------------|----------------------------------|-----------------------------|--------------------------------------|--|
| 23-Mar ² | 0.32 \pm 0.11 | 10.7 \pm 1.82 | 6050.43 \pm 467 | 1.82 \pm 0.20 | 4.42 \pm 0.44 |
| 05-May | 0.27 \pm 0.09 | 8.31 \pm 1.22 | 5529.10 \pm 1647 | 1.55 \pm 0.21 | 2.26 \pm 0.44 |
| 22-May | 0.11 \pm 0.05 | 7.72 \pm 1.46 | 5946.62 \pm 1599 | 4.31 \pm 0.53 | 4.84 \pm 0.52 |
| 10-Jul | 0.24 \pm 0.14 | 6.61 \pm 1.77 | 6885.03 \pm 2042 | 3.47 \pm 0.73 | 4.85 \pm 0.72 |
| 04-Aug | 0.20 \pm 0.14 | 9.12 \pm 2.14 | 7079.50 \pm 1928 | 4.52 \pm 0.26 | 6.23 \pm 0.33 |
| 21-Aug | 0.16 \pm 0.07 | 8.41 \pm 0.67 | 6122.39 \pm 1576 | 4.81 \pm 0.24 | 4.53 \pm 0.71 |
| 10-Dec | 0.23 \pm 0.01 | 4.96 \pm 4.22 | 1933.33 \pm 452 | 2.69 \pm 0.09 | 1.54 \pm 0.10 |
| 10-Dec ³ | 0.25 \pm 0.11 | 5.35 \pm 2.13 | 2421.00 \pm 492 | 1.58 \pm 0.24 | 2.09 \pm 0.46 |

¹ All values were in means of quadrates except Dec 10 (duplicates) and Dec 10³ (triplicates).

² Roots collected on March 23 were not immediately frozen and continued to grow in the plastic bag.

³ Replicated roots on December 10 were air dried for a month after they were harvested.

Starch levels were not significantly different between the sampling dates at a $p < 0.05$ level, but they do reach a low point in May, adding support to my observation of deflated roots during the period of rapid leaf production. Starch levels tended to increase through July, but took an unexplainable dip in August before recovering throughout the fall and winter to a high in March (Table 5.3).

At concentrations of 0.11-0.32%, total starch was 30 times lower than the cited value of 3.3% for *Argentina anserina* (Wolfred and Fischer 1944). Incomplete solubilization and poor hydrolysis of starch by alpha-amylase and amyloglucosidase can contribute to low starch content (Batey 1982; Holm *et al.*

1986), and existence of these factors for the samples is attributed to inexperience on the part of the laboratory researcher (Teo 2009). While the total amount of starch detected in the assays may be lower than expected, it is likely that the trend observed over the different harvest dates is real (Teo 2009).

Total soluble sugars were also not significantly different in the samples between sampling dates; although sugar levels tended to be highest in March and decreased gradually until July before recovering in August, then declining through the winter (Table 5.3). *Argentina egedii* must convert starch into more easily translocatable sugars in order to grow new leaves in the spring. The apparent pulse in August likely reflects the allocations of plant photosynthate back into the roots and into new root growth in preparation for winter storage.

At 6.61 to 10.7% the total soluble sugar levels observed in our *Argentina egedii* samples were much higher than the 2.79% reported by Wolfred and Fischer (1944) for *A. anserina*. High soluble sugar levels in *A. egedii* could be due to the presence of interfering substances (Teo 2009). In future studies, standardized curves could be determined by adding standard amounts of sugars in the *A. egedii* sample solution (Buyse and Merckx 1993).

Antioxidant levels did not show significant seasonal variability, but tended to increase throughout the growing season and decline towards the end of the growing season. Antioxidant levels recorded for March 23 are likely unnaturally high because the specimens were not immediately frozen and continued to grow.

The antioxidant capacity observed in our *Argentina egedii* root samples is within the middle range of herb-based plants ranging from 43.9 to 17,674 μmol Trolox equivalents per 100g dry weight of samples (Cai *et al.* 2004). *Argentina anserina* is known to contain bioactive constituents such as (+)-catechin, (+)-gallocatechin, quercetin and p-coumaric acid (Kombal and Glasl 1995) which are likely also found in *A. egedii*, accounting for its antioxidant potential (Kalia *et al.*, 2008).

Tannins tell the most interesting story, with significant seasonal fluctuations of tannic acid equivalence (TAE, hereafter referred to as tannin). The bitter-tasting tannins in *Argentina egedii* roots are present at very low levels at the beginning of the growing season (1.55 g TAE/100 g DW), increasing rapidly with leaf growth, and nearly tripling by the end of May (4.31 g TAE/100 g DW; Figure 5.1). This may be an evolutionary response to predation by migrating Canadian Geese (*Branta canadensis*) that stop in the Kingcome River estuary on their springtime migration north. Tannin levels remain high during the summer, dipping insignificantly in early July, and peaking in late August. Root tannin levels decline as the plant goes into winter dormancy, and continue to decline throughout the winter (Figure 5.1). Leaching due to frequent winter and spring flooding may be a mechanism for removing tannins from *A. egedii* roots, which would explain lower tannin levels in springtime roots than those sampled in December. Tannins may also break down naturally with root dormancy or death. *Argentina egedii* roots harvested on December 10 and dried for one month showed significantly less tannin (1.58 g TAE/100 g DW) than those harvested on December 10th and frozen (2.69 g TAE/100 g DW; Table 5.3), which corroborates the historic K^wak^waka^wak^w practice of sun-drying and storing roots for several months (Boas 1921, p. 187-188).

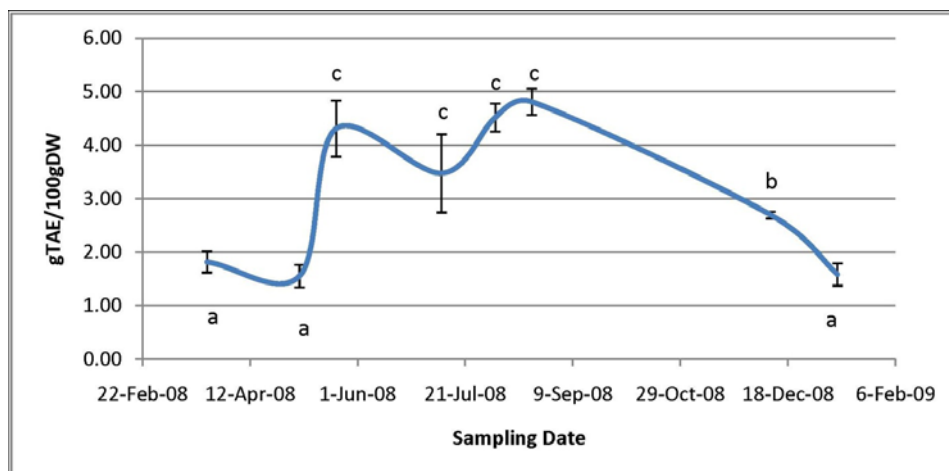


Figure 5.1. Average total tannin levels (gTAE per 100 g dry weight) of *Argentina egedii* roots at various dates throughout the year. Error bars reflect the standard error of the mean. Samples from dates with the same letter are not significantly different at a $p < 0.05$ level (Modified from Teo 2009).

Bitterness can also be caused by plant constituents other than tannins. Tomczyk and Latte (2009) reported the presence of bitter-tasting tormentoside (rosamultin) in *Argentina anserina*. Saponins are another group of bitter-tasting secondary metabolites that may be present in *A. egedii* (Teo 2009). Further research on *A. egedii* taste should survey tormentoside and saponin concentrations and levels throughout the year.

Tannins frequently have medicinal properties. In Europe and Asia, the closely related *Argentina anserina* (formerly *Potentilla anserina*) was used by herbalists as an antispasmodic, antidiarrheal, and antitumor treatment (Tomczyk 2006; Wolfred and Louis 1944; Tunmann and Jankar 1955). At 3.46 %, the total tannin content of Kingcome River *Argentina egedii* roots from July 10th, 2008 was much lower than the 10.76% reported by Wolfred and Fischer (1944) for *A. anserina* sampled in late July 1941. Other studies on *A. anserina* suggest a total plant tannin concentration of 5-10% (Tomczyk and Latte 2009). The higher concentrations cited in the literature may just as likely be attributed to the inclusion of aerial portions of the plant as a different species, since *A. anserina* was also a food plant in those regions of the world.

Phenols are secondary plant metabolites that frequently discourage herbivory and occasionally have medicinal properties. Average *Argentina egedii* root phenol concentrations followed a similar seasonal trend to that of tannin concentrations: they showed a significant increase during spring leaf growth, relatively high levels throughout the summer with a significant peak in early August, and a decline in fall and winter months (Figure 5.2). As in other proximate analyses, I attribute the high March 23rd average to anomalies in material handling (Figure 5.2).

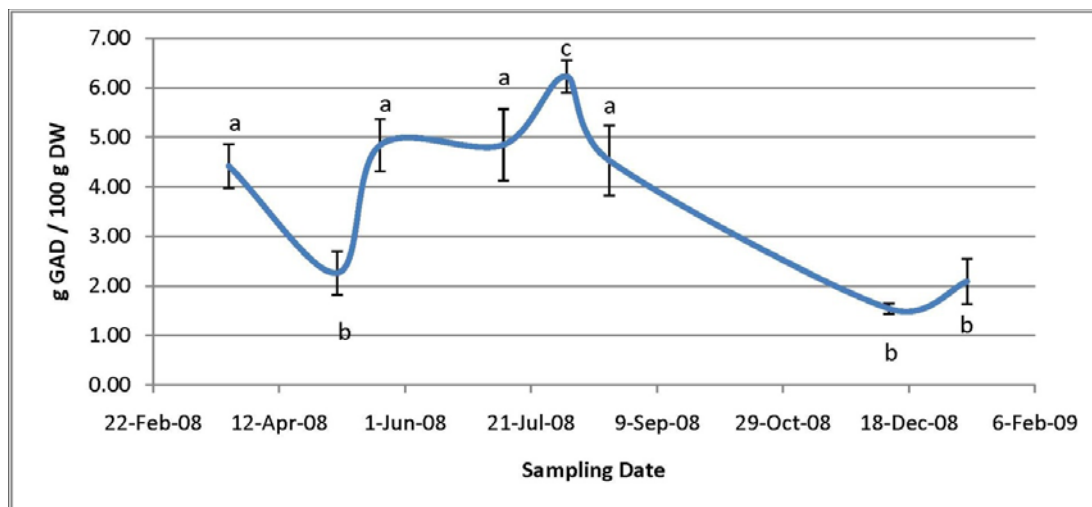


Figure 5.2. Average total phenolics, expressed in g gallic acid equivalent per 100 g dry weight, of *Argentina egedii* roots at various sampling dates throughout the year. Error bars reflect the standard error. Samples from dates with the same letters are not significantly different at a $p < 0.05$ level.

The range of Kingcome River estuarine salt marsh *A. egedii* root total phenols (1.54 to 6.23g GAE/100g dry weight) was within the range reported for *A. anserina* roots by Cai *et al.* (2004). Some of the phenols found in *A. anserina*, such as glycosides of quercetin and kaempferol, are also present in highly active medicinal plants (Kahkonen *et al.* 1999; Teo 2009).

Data in Table 5.3 show a positive correlation between total phenols and total tannins ($r=0.719$, $p=0.044$). This correlation was expected because tannins are polyphenols and *Argentina anserina* reportedly contains both condensed (Kombal and Glasl 1995) and hydrolysable tannins (Tomczyk and Latte 2009). A positive correlation between total phenolics and trolox equivalent antioxidant capacity ($r=0.871$, $p=0.005$) was also observed in our samples (Table 5.3), a situation also verified in the literature (Kahkonen *et al.* 1999, Rice-Evans *et al.* 1995).

5.5. Discussion

The K^wak^waka'wak^w practice of preferential harvesting of *Argentina egedii* roots in the fall poses some interesting discussion points in light of the experimental results. My initial hypothesis that *A. egedii* roots taste best in the fall ($H_{5.1}$) was supported among Kingcome river roots by the low

concentrations of bitter phenolics and specifically tannins in the fall samples. While tannins were lowest in the spring among frozen fresh specimens, a month of dry storage brought the late fall-harvested roots to the lower tannin concentrations, making them more palatable. It was indeed a common practice among traditional harvesters (Boas 1921, p. 188) to wait until winter before consuming *A. egedii* roots. My analysis of sweetness data, on the other hand, does not support fall harvesting, but suggests that sugar concentrations are lowest in the fall and highest in the spring just before plants leaf out. Data from other sites collected with higher temporal resolution are needed to generalize these trends for all *A. egedii* roots.

Perhaps then, the nutritional value of *A. egedii* was an important consideration for traditional managers (H_{5.2}). My hypothesis that *A. egedii* is most nutritious in the fall cannot be supported in terms of carbohydrate content, since data suggested that roots are highest in both sugar and starch concentrations in the spring just prior to leaf growth. However, *A. egedii* plants did make a good recovery of starch concentration in the fall, indicating that autumn is an acceptable time to harvest the roots. If harvesters were trying to optimize the storability of *A. egedii* roots, then a fall harvest would be logical because at that time, easily-molding sugars are at low concentrations while more stable starches are reasonably high.

Access to stored carbohydrates may have been more critical for people during winter months than other times of the year (H_{5.3}). For one thing, cool, wet, and storm-prone maritime winters combined with short daylight hours made food gathering and travel difficult. In general, stores of foods were vital to K^wak^waka'wak^w cultural and nutritional well-being, as all of the most important ceremonial and political activities were carried out during winter-time feasts and potlatches, and feeding the guests and witnesses was an important component of these events. Stored foods included protein from dried fish and shellfish, fat from eulachon, seal, deer, and mountain goat, fruit from a variety of berries and

crabapples, and starch from inner bark, fern rhizomes, and estuarine salt marsh roots (See Chapter 2; Turner 1973).

Carbohydrate rich vegetables were never a large part of the diet of central and northern Northwest Coast First Peoples (Turner 1995, p. 9-11), and many health professionals believe that the current First Peoples' diabetes epidemic is in part linked with modern diets high in carbohydrates (Young *et al.* 2000; Nabhan 2004). Diets that mimic a traditional nutrient regime rich in fats and proteins, such as that portrayed in the CBC documentary My Big Fat Diet (Bissell 2008) have successfully enabled participants to lose weight and decrease diabetes medication (Acurso *et al.* 2008). However, since complex carbohydrates were part of the traditional diet, attention needs to be given to the means by which they were traditionally consumed. Indigenous complex carbohydrates and fruits were usually eaten with eulachon grease at least in the central and northern regions (K^waxistalla, Clan Chief Adam Dick pers. comm., 2008; Turner 1995, p. 10), which would work to lower their glycemic index (TermaNord 2005, p. 18), and many were frequently eaten as a dessert or "after food" (Charles Nowell in Ford 1941, p. 50-51) close to bedtime, when a lower sleeping metabolism may have processed the starches more slowly.

Lastly, I consider the possibility that *A. egedii* harvest was driven by logistical factors of the seasonal round (H_{5,4}). The seasonal round practices of the original Clans of the **D^zawada?ēnux^w** tribe of the K^wak^waka'wak^w supports this argument, as root harvesting is conveniently located in space and time near other estuarine salt marsh resources such as crab apples (*Malus fusca*) and waterfowl, and riverine resources such as salmon (*Oncorhynchus spp.*) and bog cranberries (*Oxycoccus oxycoccus*; See chapter 2), and like these, were available before winter snow cover. Interestingly, the only accounts of spring 'tekillak^w harvest are easily attributed to convenience within the seasonal round (albeit sometimes a largely modified one). Lucy Brown (1904-1975), who was from the **Mamaliliqalla** tribe but later in her life lived in Alert Bay, reported that the people from New Vancouver (Turner Island) ate *Trifolium*

wormskioldii and likely *A. egedii* in March while in Knights Inlet harvesting eulachon (Turner field notes 20 August 1969). This was corroborated by Henry Speck, who grew up on Turner Island (Pers. comm., 2008). Willie Seaweed (1873-1967), a Nak^wadax^w man from Blunden Harbour, also ate *T. wormskioldii* and *A. egedii* roots in the spring (Holm 1983, p. 24) apparently as it fit best into his parents' seasonal round. Autumn use of the roots may have been replaced by potatoes and turnips, which were a part of his diet at that time (Holm 1983, p. 24). Similarly, the people of Scotland and the inhabitants of the Islands Tirey and Cole made use of *A. anserina* as an emergency food during the lean time in the spring after the potatoes were seeded and before they were ready for harvest in autumn (Lightfoot 1777, p. 269; Milliken and Bridgewater 2004, p. 47, 49). One could conclude, therefore, that there were logistical as well as taste, and possibly nutritional reasons for the timing of root harvests.

5.6. Future Work

Traditional knowledge suggests additional variables that may affect *Argentina egedii* flavour including root age, soil type, and post harvest techniques of drying and storing the roots. The Ditinaht were careful to eat only the young present year's roots, noting that roots visibly degraded with age: "[Young roots] are yellowish on the outside and firm and white inside, whereas the second-year roots, already beginning to die, are grey outside, and pulpy and brownish within..." (Turner et al. 1983, p. 17). The K^wak^waka'wak^w apparently recognized the superior taste of young roots, as evidenced by George Hunt's record of weather-bound travelers relying on wild and therefore either several-year-old *A. egedii* roots for food. Apparently, they were bitter enough to be compared to tea and required "much water" to flush the bitterness from the palate (Boas 1921, p. 533-534). Similarly, Lagius' account of *A. egedii* and *Trifolium wormskioldii* states that "roots of more than a year's growth were not tender" (Lagius n.d. in Dzawada'neux'w Land & Resource Office Newsletter 2008) also in Curtis 1915, V. 10 p. 43). The superior taste of young *A. egedii* roots has also been supported by casual observations by Mike Willie, from Kingcome Inlet (Pers. comm., 2008). However, the UBC panel facilitated by Teo felt that lighter

coloured (younger) roots were more bitter than the darker coloured older roots (Teo 2009, p. 39). A multiyear *in-vitro* study comparing the age effect on *A. egedii* root flavour is therefore recommended.

Many ethnographic accounts state that *Argentina egedii* is preferentially harvested from soft sandy soils (Turner et al 1983, p. 17, 18, 118, 145; Lightfoot 1777, p 268; Boas 1921, p. 190; Edward 1979, p. 5; Holm 1983, p. 24) even though it also grows in silt and gravel. Ease of harvest, large root stature, and cleanliness of the roots were usually given as reasons for harvesting from sandy soils. Though taste was never mentioned, sediment type may also affect root flavour and warrants experimental analysis.

Further investigation into the chemistry of the bitter compounds in *Argentina egedii* and how they change with storage¹³⁰ is also needed. For example, other compounds, such as saponins or tormentosides may also contribute bitter flavours to *Argentina egedii*. It would be interesting to explore the different storage techniques employed by Northwest Coast First Peoples to better understand how bitter flavours can be ameliorated. For example, the Nuxalk stored *Trifolium wormskiolldi* (and probably *A. egedii*) roots amongst moist soil, keeping them alive (Edwards 1979, p. 6), the K^wak^waka'wak^w sun dried *A. egedii* roots (Boas 1921, p. 187) and kept them in either a "cool corner of the house" (Boas 1921, p. 188) or in a deep root seller next to the cooking fire (Boas 1905, p. 416).

Autumn storage of edible roots would be advantageous on account of the cold weather, diminished light availability, and nocturnal timing of low tides that would have made winter root harvesting arduous. However, some evidence suggests there is more to it than convenience. The Nu-

¹³⁰ Estuarine salt marsh roots were stored after they were harvested for winter use. Boas (1921 p. 188) reported that dried silverweed roots were placed in a basket and covered with dry grass and placed in a cool corner of the house until they were eaten. He noted that both long and short sun-dried clover rhizomes were stored in a similar manner after they were bound into portion sized bundles (Boas 1921, p. 193). Charlie Nowell said that clover and silverweed roots were stored in bentwood boxes by the side of the house (in Ford 1941, p. 51), and elsewhere Boas (1904 p. 416) reported that they were kept in a root cellar dug near the fire ring (Boas 1905 p.416). Both Boas (1905, p. 425) and Nowell (in Ford 1941 p. 53) said that if they were to be eaten immediately, they would be kept in a storage box next to the fire ring. Edwards (1979, p.6) also records a Nuxalk practice of storing fresh living roots in a cellar with cool moist estuarine soil. Over the last century, the tradition of storing estuarine salt marsh roots ended and K^waxisistalla recalled only eating the roots fresh, which is corroborated by Curtis (1915, p. 43-44) and community members from Kingcome.

chah-nulth believed that clover roots grow sweeter with storage (Drucker field notes; Box 2 Part 23 V. 1 p. 82), and the K^wak^waka'wak^w had a taboo against eating riceroot and silverweed while the salmon were spawning (Boas 1932, p.223), which could have delayed consumption until December. This taboo may have evolved out of the recognition that these roots taste better after storage.

Chapter 6. Conclusion

K^wak^waka'wak^w managers of *Argentina egedii* and other estuarine salt marsh root species responded to complex environmental consideration in their harvesting and processing of edible roots. Chapter 1 provided ethnographic accounts of the **'tekillak^w** which demonstrated that the K^wak^waka'wak^w possessed detailed knowledge of the natural history of each edible root species including information on where the roots are found, what types of soil they grow in, and how big they are. These accounts also showed that the K^wak^waka'wak^w modified the **'tekillak^w** by tilling, weeding, trenching, terracing, and hunting waterfowl, in a focused effort to enhance the productivity of edible roots. Such intensive management was made possible by the cultural mechanism of root garden ownership, which ensured that the manager's family retained the fruits of their labour in perpetuity. Chapter 2 showed how K^waxistalla's family moved throughout their diverse territory to take advantage of the seasonal availability of a variety of Indigenous foods. Tools were essential for root garden management, and in Chapter 3, I suggested that some tools, such as digging sticks, were specifically manufactured for harvesting *A. egedii* and were customized to the length of the roots and the size of the harvester.

Throughout the rest of this thesis I used experimental methods to tentatively identify several autecological factors of *A. egedii* that influenced cultural practices including: (1) the ability of *A. egedii* to regenerate from root fragments; (2) the ability of weeding to increase *A. egedii* root abundance, length, and thickness; (3) the seasonal fluctuations of bitter tasting tannins in *A. egedii* that influence its palatability; and (4) the ability of storage to further decrease tannin levels in *A. egedii* roots. My **'tekillak^w** experiments attempted to provide some quantitative assessment of the importance of intensive management to the productivity of edible roots. I felt that it was necessary to contribute some quantitative data—the language of western resource managers—to supplement the existing ethnographic, linguistic, and archeological data that outlined a model of **'tekillak^w**

management (Deur 2000, 2005; Deur and Turner 2005). As I have stressed throughout this thesis, my experimental methods tested only a simplified model of traditional **təkillak**^w management and has limited inferential power. For example, my analyses of tannin fluctuation throughout the growing season indicated low tannin levels in both the spring and the fall. If bitterness were the only consideration, these results would indicate two optimal harvest times. However, the situation is much more complex due to seasonal patterns of movement, the timing of cultural activities such as feasts that require these roots, and the need for stored wintertime food. How the various factors such as taste and the timing of harvest mesh is just one of still many unanswered questions.

However, now that the literal and figurative fallow ground has been broken on the topic of experimental **təkillak**^w research, long term investigation should use a more sophisticated model of root garden management, including repeated weeding and the use of digging sticks to cultivate the soil, to focus on how to achieve *A. egedii* roots “as thick as a little finger,” and discern how post-harvest processing improves the taste of *A. egedii*. Additionally, experimentation should extend to include the other root garden species: *Trifolium wormskioldii*, *Fritillaria camschatcensis*, *Lupinus nootkatensis*, and possibly even *Conioselinum pacificum*.

The **təkillak**^w continues to be a fascinating case study at the centerpoint of an emerging new understanding of the Northwest Coast First Peoples as intensive land and resource managers. K^waxistalla, as a D^zawada?ēnux^w Clan Chief who was trained to be a steward and reservoir of knowledge about his clan’s natural and cultural worlds, has provided accounts of fundamental importance to scholars that are slowly dismantling the “hunter-gatherer” paradigm. For that reason, the biography of K^waxistalla (Chapter 2), the traditional ecological knowledge that he shared with me about the **təkillak**^w, and his knowledge of tool manufacturing (Chapter 3) are perhaps the most significant contributions of this thesis.

In 1689 philosopher John Locke proposed that labour gave man title to land (Locke 1980), an argument that was used widely by colonial governments as a legal means of establishing dominion in the New World. However, as a growing body of literature—including this thesis—has demonstrated, the First Peoples inhabiting the Northwest Coast were not just passively collecting the fruits of the land, but actively stewarding food resources, enhancing their productivity and long-term sustainability. While the desire for land and its vast natural resources may have blinded colonial authorities to this reality, several other factors made it difficult to discern. Principally, amber fields of waving grain were nowhere to be seen; the European model of agricultural subsistence based almost entirely on a few annual, terrestrial species was entirely absent on this coast in Canada. Rather, Indigenous food systems utilized hundreds of species throughout the year from ecosystems ranging from as deep as a halibut could dive to as high as a mountain goat could graze. Many of these foods were intensively (and labouriously) managed—and, one could argue, cultivated—but because of the diffuse nature of the resources across space and time, they were difficult to observe. Indigenous food systems were also invisible to the untrained eye because they relied on polycultures of native species, managed in a way that frequently mimicked natural processes. For example, the weeding and tilling of the **təkillak**^w emulated the foraging and harvesting of a guild of native estuarine roots by waterfowl and bears. In short, colonists were looking for a grain-based terrestrial agriculture—a monoculture of non-native species relying on sowing of seeds and annual soil disturbance—and ignored (perhaps for their own convenience) the various and diffuse perennial polycultures of native species and ecosystems that they encountered. Since many Northwest Coast Indigenous Food Systems, such as the **təkillak**^w, did require significant inputs of labour, the ironic logic that was used to disenfranchise First Peoples of their land, can be employed by First Peoples trying to reclaim it.

Here again, the biography of K^waxsistalla and the mediated knowledge that other Nⁱnoḡad have illuminated for me how the traditional rights and responsibilities of a Clan Chief, can make a significant contribution. The rights to resources are deeply layered within a traditional governance structure under an ancient Clan system that inherited title directly from the First Ancestor, with the Clan Chief as the traditional steward of these rights and obligations. This thesis therefor appears to be supporting a growing body of literature that further demonstrates the need to assert Ancestral Clan governance structures as a foundation for future claims processes. By failing to negotiate any land claim settlements with ancestral leadership, such as with the Clan Chiefs, the Canadian government risks yet another usurpment of Aboriginal Title under the guise of reconciliation.

It is similarly important for scholars that are interested in Traditional Ecological Knowledge to attempt to learn in a manner that is consistent with the knowledge system of the people that they are studying. In the case of this thesis, that meant learning from Nⁱnoḡad under the authority of the Clan Chief while adopting the protocols of the K^wak^waka'wak^w. Though this was a challenging process—for me, much harder than any other part of this thesis—this kind of culturally appropriate participatory research is anti-colonial and has the capacity to empower Indigenous collaborators. For the last four years I have had the rarest of opportunities to learn just a piece of the vast knowledge with which K^waxsistalla, Clan Chief Adam Dick, was entrusted by his ancestors. Had I tried to bend him to conform with my research interests, I would have learned little; but having given up control and learned through apprenticeship, I have not only learned in immeasurable ways, but will forever be his student.

Ultimately, I hope, this thesis contributes to our growing understanding of a different human-environment relationship than that reflected in the dominant western society. The idea of humans as a part of, and not separate from, or above, the rest of nature is reflected in Indigenous Peoples' worldviews in many parts of the world. The potentially positive contribution of humans in helping

to maintain biological diversity, rather than reducing it, is becoming widely accepted in the thinking of ethnoecologists and those concerned with systems of traditional land and resource management (Anderson 2005; Deur and Turner 2005; Carlson and Maffi 2004; Nazarea 2001). The **təkillak**^w gardens, tended and maintained by generations of **D^wawada?ənux^w**, overseen through the authority and wisdom of the Clan Chiefs, present a unique biocultural system that could serve as an analogue for modern anthropogenic habitats.

6.1 **Təkillak**^w Revitalization

At the end of my first field season in 2008, K^waxistalla, Clan Chief Adam Dick hosted a traditional K^wak^waka'wak^w **q^wilas** (feast) to celebrate the harvest of his **təkillak**^w root garden. He organized a work “bee” to go to his **təkillak**^w in the Kingcome River estuary to harvest his **ləkseḿ** (Pacific silverweed), **Q^wanniy** (Nootka lupine), **təx^wsus** (springbank clover), and **xuk^wk^wəḿ** (northern riceroot). K^waxistalla directed some young men to another place called **xəd^wdamma** where K^waxistalla had collected special cooking rocks for pit cooking for close to eight decades. When we all returned to the village, K^waxistalla oversaw another team of young men in digging a pit and building a fire so that we could pitcook the estuarine salt marsh roots we had gathered. Throughout this sunny September day, K^waxistalla had small teams organized, bundling the estuarine salt marsh roots, wrapping them in thimbleberry leaves, collecting sword fern fronds and salal branches to protect the food from the hot rocks, barbecuing salmon, and preparing the **g^wud^w?i** (Ceremonial Big House) for the **q^wilas**

By the time the late summer shadows of the massive spruce trees around the Bighouse stretched out to the east, the food was cooked and the call was sent out for everyone to gather at the Bighouse for the feast to begin. We circled around the cooking pit and K^waxistalla spoke in his Big House voice to his guests. He formally recounted in the potlatch language his memories of the old people cooking roots from his **təkillak**^w. He offered prayer chant for the sacred food as the delectable

aroma of cooked roots, fragrant salal, and warm soil radiated out from the cooking pit at the center of our group.

K^waxistalla's directed the pit to be opened by Clan Chief Richard Dawson of the **Čik^wk^waǰallis**, Max^wə d^ʔi, Chief George Shaughnessy, and his younger brother Michael Dick. He called upon the younger men to do the hard digging and soil removal. Once the roots were extracted, he called upon the **qum^ʔelle** (noble women) to dance the roots that had been placed in wooden feast dishes and baskets into the **ǧ^ʔud^wʔi**, placing them on the feast table next to the **ǧl^ʔowbuq^w** (barbecued salmon), **ǰinna** (eulachon grease), and **Puyas** (Labrador tea) with wild mint from the **təkillak^w** and the tips of spruce branches mixed together into a giant vat for tea. There was no coffee or other things like Caesar salad, only food that K^waxistalla remembered being served at feasts in his youth. When the food was finished, feast songs were offered as a way to thank the host Chief for the bounty they had been served, in this case the main food was that from the root garden harvest.

It is customary for the host to give gifts to the invited guests—actually payment—for witnessing and remembering accurately the events and all that transpired, especially if the Chief were to 'open his box' and show some of his dances. Since K^waxistalla planned show his **ǰak^ʔeyma** (The Spirits of the Forest dance complex), he had organized work bees in his carving shed over a two-month period to prepare special witness gifts that would serve as reminders of traditional foods. He and his crew made yew wood digging sticks (**kəllak^w**); as well as miniature **kəllak^w** necklaces; bentwood boxes (**ǰəccəm**); steam-bent yew-wood halibut hooks (**yakkuw**), and fish cutting knives (**ǧa^ʔlayuw**).

K^waxistalla commissioned Max^wə d^ʔi, Chief George Shaughnessy to design a T-shirt (Figure 6.1) with his **Gəgalis, Qawadiliqalla** (the First Ancestor born of the Wolf) sitting on his box of treasures to signify that K^waxistalla's clan, cultural, and stewardship obligations make up the foundation of his vast knowledge. The T-shirts, which bore the wording, "Q^waxistalla **G^wilas Təkkilək^w** September 14, 2008," were given to each of the guests as witness gifts. Even though witness gifts have a rank associated with

how they are given, K^waxistalla insisted that T-shirts were made for all of the children in the village (Kim Recalma-Clutesi, pers. comm.).



Figure 6.1. A stylized design of K^waxistalla's crest for T-shirts that were given away as witness payments during a feast hosted by K^waxistalla to celebrate the root gardens. Max^wə d'i, Chief George Shaughnessy produced this design on a commission from K^waxistalla.

K^waxistalla closed the ceremony by showing the *ʔakəʔeyma*, ("Spirits of the Forest") dance complex¹³¹ to remind his people that all in the environment is sacred and interconnected.

At the time of writing this thesis, it has been two years since that magical celebration of the *ʔəkillak*^w harvest, but the legacy of K^waxistalla's work in preserving and reviving the *ʔəkillak*^w over the last decade has lived on with far more vitality than a memory. Since K^waxistalla's *q^wilas* in Kingcome in 2008, the Liliwagila School has gone on two field trips down to K^waxistalla's *ʔəkillak*^w. K^waxistalla

¹³¹ The *Ninoḡad* carefully explained, translated, and included me in most of the preparations of the feast as a way to demonstrate an adopted person's obligations to a clan chief when they feast, potlatch, or conduct ceremonies.

himself has hosted 2 more feasts, organized and conducted potlatches and feasts for other Chiefs, installed 2 new Clan Chiefs into their seats and continues to instruct graduate students and scholars on his vast TEK (Kim Recalma-Clutesi, pers. comm.). During the summers of 2009 and 2010, the community hosted the 3rd and 4th Annual Youth Conferences, for which I oversaw field trips to the root garden. When I reflect on the half century or more that the traditional knowledge of the 'tekillak' was kept alive in the memories of K^waxistalla, I am delighted by the resilience of traditional knowledge, and encouraged by the now growing understanding of the 'tekillak' in Kingcome today.

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Personal Communications:

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Dick, Michael Interviewed by T. Abe Lloyd on 21 February 2009 at Qualicum Beach, BC.

Lagis, Beverly 2008 Interviewed by T. Abe Lloyd on 11 August 2008 at Kingcome, BC.

Macko, Mary 2008. Interviewed by T. Abe Lloyd on 7 August 2008 at Kingcome, BC.

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Appendix 1. Comprehensive table of estuarine salt marsh root garden references for the Northwest Coast.

| | Source | Garden Location | Root names | Owned | Value | Marked | Tilled | Weeded | Hunting | Harvest Season | Harvest Technique | Root Size | Replanting | Drying | Storage | Tools | Digging Stick | Cooking/Eating | Taste | Threats | Legends | | |
|-----------------------|----------------------------------|--------------------------------|------------------------|-----------------------|-----------------------|-----------|---------------|--------|--------------------------------------|------------------------|-------------------------|--------------|------------|-------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|------------------------|---------|---------|-----------------------------|-------------------------|
| K'wak'aka'wak' | Curtis 1915 | s,c (43-44) | s,c,r,** (332-333) | c (43-44) | c (43-44, 304) s(304) | | | | | s,c (43-44) | c (43-44) | c (43-44) | c (43-44) | | * | x | s,c | s,c | s,c | | c (253) | | |
| | Lagius n.d. | s,c | | s,c | s,c | | | | | c | s,c | s,c | c | | | | s,c | s,c | s,c | | | | |
| | Curtis 1915 | s,c | | s,c,r,** | | | | | | s,c | c | c (116-117) | c | | * | x | s,c | s,c | | | c | | |
| | Dawson 1887 | c (11) | | | | | | | | | | | | | | | | | | | | | |
| | Boas 1893 | c (46, 63) | s,c,r (70) | | | | | | | | | | | | | | | | | | | | |
| | Cotton 1894 | c | | | | | * | | | | | | | | | | | | | | | | |
| | Boas 1895 | | | | | | | | | | | | | | | | | | | | | | |
| | Boas 1905 | | | | | | | | | | | | | | s,c (416) | c (385, 405) | | c (428) | c (425) | | | | |
| | McKenna McBride 1914 | s,c (207), x (118,222) | s,c,r,l (188) | s,c (207) | | s,c (207) | | | | | | | | | | x (207) | x (207) | | | x | | | |
| | Boas 1921 ¹ | s,c,r | | s,c | | | | | | s,c | s,c,r | | | | s,c,r | s,c | s,c,r | s,c,r | s,c,r | | | | |
| | Hunt 1922 | | c | | c | | | | | | | | | | | | | | | | | | |
| | Newcombe n.d. | | s,c,r,l | | | | | | | | | | | | | | | | | | | | |
| | Boas 1931 | | s,c,r,l (164) | | | | | | | | | | | | | | | | | | | | |
| | Boas 1934 ⁴ | s (56), c (37, 49, 56, 81) | | c (37) | | c (37) | | | | | | | | | | | | | | | | s,c (22, 24) | |
| | Boas and Hunt 1902-1905 | | | | | | | | | | | | | | | | | | | | | | s,c (318-321, 361, 391) |
| | Haliday 1935 | c (156) | c (156) | | | | | | | | | | c (156) | | | | | | | | | | c (156) |
| | Charles Nowell in Ford 1941 | | | c (51,52) | | c (51) | | | | | | | | | | c (53) | | | c (51) | | c (51) | | |
| Drucker n.d. | | | | | | | | | | | | | | | | | | | | | | c (Box 1, 2/2) | |
| Boas 1966 | | | | | | | s,c (17) | | | | | | | | | | | | | | | | |
| Rohner 1967 | c | | | | | | | | | | | | | | | | | | | | | | |
| Wallas 1981 | | | | | | | | | | | | | | | | | | | | | | x (26) | |
| Reid 2004 | c(57, 65, 71-72, 86-87) s(86-87) | c(57, 65, 86-87), k(87), s(86) | c(57, 86-87), s(86-87) | c(57, 109) | | | | | | | | | | | | | | | | | | c (84, 172), s(172), r(172) | |
| Adam Dick 2008 | s,c,r | s,c,r,l | s,c,r | | s,c,r | s,c,r | s,c,r | s,c,r | x | s,c,r | s,c,r | s,r | r | | * | s,c | s,c | s,c,r | s,c,r | | | c | |
| Bella Coola | Mcllraith 1948 | | | | s,c (1:194,537) | | | | | | | | | | | | | | | | | | |
| | Edwards 1979 | c (4, 6) | s,c (11) | | | c (6) | c (6) | | c (8-11), s (11) | c (5) | | c (5) | c (5,6) | * | c (6) | | | c (5,7-8), s (7) | | | | | |
| Nuu-cha-h-nulth | Mozino 1792 | | | | s,r,c (21) | | | | | | | | | | | | | | | | | | |
| | Mezies Journal 1792 | | | | | | c,r (116-117) | | | c (116-117) | | c (116-117) | | | | | | | | | | c (116-117) | |
| | Drucker 1951 | | | s,c (Box 2, 23/1: 64) | | | | | | | | | | | s,c | | | | | | | s,c (62) | |
| | Drucker n.d. | | | | | | | | | | | | | | s,c (Box 2,23/1: 81) | | | | | | | | |
| | Stewart 1987 | | | | | | | | | | | | | | | | | | | | | c | |
| Turner and Efrat 1982 | r, c, s (55,68, 73) | r, c, s (55,68, 73) | | | | | | | s,r,c (17, 55, 68, 73) | | | c,s (68, 73) | r (55) | r (55) | | | c (68) | c (68) | | | | | |
| Turner et al 1983 | c(110-112) | s,c (17-19, 110-112) | s (120) | | | | | | s,c (17-19, 110-112, 118-120), r(85) | c,s (110-112, 118-120) | c, s (110-112, 118-120) | | | s,c (17-19, 110-112, 118-120) | s,c (14, 17-19, 110-112, 118-120) | s,c (14, 17-19, 110-112, 118-120) | s,c (14, 17-19, 110-112, 118-120) | s,c (14, 17-19, 110-112, 118-120) | c,s (110-112, 118-120) | | | | |
| Other | Boas 1916 (Tsimshian) | | | | | | | | | | | | | | | | | | | | | c (908) | |
| | Norton 1981 (Haida) | s, r (442) | | | | | | | | | | s (442) | | s (442) | s (442) | | | | | | | s (442) | |
| | Turner et al. 1990 (Thompson) | s (262-263) | | | | | | | | s (262-263) | | | | | s (91, 262-263) | s (21) | | | | | | s (31, 262-263) | |
| | Boas 1894 (Chinook) | | | | | | | | | | | | | | | | | | | | | s (188) | |
| | Boas 1901 (Klathlamet) | | | | | | | | | | | | | | | | | | | | | s (36, 55, 188) | |
| | Boas 1888 | | | | | | | | | | | | | | | | | | | | | s (38,41,150,151,209) | |
| Goddard 1924 | c(77) | | c (77) | | | | | | | c (77) | | | | | | | | | | | | | |

¹ Note that these are references as written by the author who may be known to have confused silverweed and dozer

x = General estuarine salt marsh roots; s = Pacific silverweed, *Argentina egedii*; c = Spring bank clover, *Trifolium wormskökeli*; r = Northern riceroot, *Fritillaria camschotensis*; * = Explicitly negated; ? = Ambiguous estuarine salt marsh root; ** = Misidentified as tiger-lily, *Lilium columbianum*; k = Gamas, *Comosia sp.*; l = Nootka lupine, *Lupinus nootkatensis*.

Appendix 2. Section M, Free and Informed Consent.

Revised 5/8/2011 4:47:00 AM

Kwakwaka'wakw ethnoecology

My name is Abe Lloyd and I am a Masters of Science student in the School of Environmental Studies at the University of Victoria. I am conducting research under the supervision of Dr. Nancy Turner that explores the traditional harvest of food plants.

An important part of this project is to interview and collaborate with knowledgeable people from Kwak'wala speaking First Nations, such as yourself, regarding (A) the life history, ecology, harvest, preparation, and management of food plants and animals (B) the taste of traditional food plants and animals (C) and the cultural stories related to these resources. This information sheet is meant to inform you of what to expect in the interview, should you decide to participate, as well as of the benefits and risks that may be associated with your participation.

A. Life history, ecology, harvest and management of traditional food resources. This interview will take place in a location of your choosing and will likely last one hour. You may choose to be interviewed alone or you may choose to invite one or more other people to participate or to help translate if you wish to speak in Kwak'wala. With your consent, I will record all interviews on audio and/or video cassette. The interview process will involve an informal discussion of your past and present knowledge of food resource and associated plants and animals. I may ask questions such as: "How much do you remember your family harvesting in the past?", "What tools were used to harvest the plant or animal?", "How was the plant or animal prepared so that it could be eaten?" and "How would you describe the taste?" I may also ask you to point out important harvest areas, trails or other important landscape features on a map of the Kingcome/Broughton Archipelago area. You will be free to decline to answer any questions asked of you in the interview. I may ask for a follow up interview in which I would ask for clarification or expansion on the topics we covered in the first interview.

B. Taste

This "taste test" survey will be conducted in a location of your choosing and will include sampling different foods without knowledge of where they came from or how they were prepared. It will likely last an hour. You may choose to be interviewed alone or you may choose to invite one or more other people to participate or to help translate if you wish to speak in Kwak'wala. The taste test process will involve tasting a number of specimens. You may be asked to evaluate the taste of the specimens on a 5 point scale ranging from 1 (barely edible) to 5 (excellent, no need for improvement). You may also be asked to rank the specimens by your taste preference. You will be provided with fresh water to rinse your mouth out after each tasting.

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

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

If I use information that you have provided in your interview in publications or presentations, I intend to give you full credit for your contributions. In this case, you will have the opportunity to review and edit documents before they are submitted for publication and review and edit presentations before they are presented. If you would prefer to remain anonymous or would like to have certain statements that you have made remain anonymous in publications or presentations please inform me verbally or in writing and I will gladly protect your identity. After I complete this project, I will send you all of the original audiotapes, videotapes and in written manuscripts from your interview. With your consent, I will submit a copy of your interview (on audiotape, videotape and/or in

written form) to my academic supervisor Dr. Nancy Turner and to the Tsawataineuk First Nation. I will also provide you with a summary of the research, as well as photographs and other materials from our work together.

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

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

If you decide to withdraw participation or withdraw all or part of your contributions please inform either Dr. Nancy Turner or myself of your decision either personally or through the office of the First Nation to which you belong.

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

- a. Understanding the effect of traditional management techniques on the productivity and taste food plants and animals that have had cultural importance to you and your community.
- b. Understanding the cause of variation in the taste of food plants and animals, and understanding what conditions produce the best tasting foods.
- c. Understanding the cultural framework of songs, stories, and recipes that support, explain, and guide traditional food practices.

I hope that your collaboration in this project will benefit you by facilitating the recognition of your knowledge about the use and management traditional food plants and animals.

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

T. Abe Lloyd (250) 853-3297
talloyd@uvic.ca

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

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

If you would like to verify the ethical approval for this study or raise any concerns you might have about the ethics of this study, please contact the Associate Vice-President Research of the University of Victoria:

(250) 472-4545
ovprhe@uvic.ca

Section M, Free and Informed Consent

Kwakwaka'wakw ethnoecology

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

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

- a. have read and understood the information sheet provided by T. Abe Lloyd titled, *Kwakwaka'wakw ethnoecology: Information Sheet*.
- b. am aware that my participation one or more interviews with T. Abe Lloyd is completely voluntary, that I can withdraw participation at any time without consequences.
- c. am aware that the information that I provide in this interview with T. Abe Lloyd is completely voluntary. I am aware that I can withdraw information at any time and that I have the right to review and edit all publications and presentations pertaining to the specific information that I provide in the interview.
- d. consent / do not consent (*please check one box*) that this interview with T. Abe Lloyd be recorded on audio cassette. I am aware that the interview can proceed without the interview being recorded on audio cassette. Even if I do consent to have this interview audio-recorded, I am aware that I am free to request that the audio recording be turned off at any point during the interview.
- e. consent / do not consent (*please check one box*) that this interview with T. Abe Lloyd be recorded on video cassette. I am aware that the interview can proceed without the interview being recorded on video cassette. Even if I do consent to have this interview video-recorded, I am aware that I am free to request that the video recording be turned off at any point during the interview.
- f. consent / do not consent (*please check one box*) that this interview with T. Abe Lloyd be photographed and that photographs from this interview may be used in publications and presentations pertaining to the specific information that I provide in the interview. Even if I do consent to have this interview photographed, I am aware that I am free to request that photographs not be taken at any point during the interview.
- g. consent / do not consent (*please check one box*) to having my name associated with the traditional ecological knowledge I provide in publications and presentations prepared by T. Abe Lloyd.
- h. consent / do not consent (*please check one box*) that information from this project may be used for future projects conducted by T. Abe Lloyd that are related to traditional preparation, harvest, and management of culturally important resources.

 (Participant)

 (Date)

 (T. Abe Lloyd)

 (Date)

Appendix 3. K^wak'wala terms for estuarine salt marsh root gardens. Words in bold (and red) are incorrect translations.

| Source | Root garden names | English name in text | Actual root associate | Page | Notes |
|---|---|----------------------------------|-------------------------------|------------------|--|
| Boas 1921 | <i>l̥ex E dzās</i> <i>LEG'E dzōwē</i> | "Cinquefoil garden" | <i>Argentina egedii</i> | p. 138 | |
| | <i>LEX Edzowē</i> | "Clover garden" | <i>A. egedii</i> | p. 186 | Used in an account of LExsE'm |
| | <i>t!Ek ɪlakwe t!Egǔdzōwa</i> | "Cinquefoil garden" | <i>Trifolium wormskioldii</i> | p. 189 | Used in an account of t!Exusō'sē |
| | <i>t!Ek ɪ^Flakwē t!Egǔdzōwa</i> | "Cinquefoil garden" | <i>T. wormskioldii</i> | p. 190 | Used in an account of t!Exusō'sē |
| | <i>t!Ek ɪ^Flakwē t!Egǔdzowa</i> | "Cinquefoil garden" | <i>T. wormskioldii</i> | p. 191 | Used in an account of t!Exusō'sē |
| | <i>LEG'dzōwē</i> | "Cinquefoil garden" | <i>T. wormskioldii</i> | p. 138 | Used in an account of a small basket for long clover roots |
| Boas 1921* | <i>leged^zuw' wī</i> | "Clover garden" | <i>A. egedii</i> | p. 186 | Used in an account of "digging clover [cinquefoil] roots" |
| | <i>ṭəkkillaʔak^w k^wi ṭəḡ^wəd^zuw' wā</i> | "Cinquefoil garden" | <i>T. wormskioldii</i> | p. 189 | Used in an account of "digging cinquefoil [clover] roots" |
| Boas 1934 | <i>bē^εs, bēce</i> | Clover Garden (Koskimo) | | p. 49 | |
| | <i>t!Ek ē'^εlak^u</i> (<i>t!Ek -[g]ila-k^u</i>) | Made soil, garden bed | | p. 56 | |
| | <i>t!ē't!Ek i'^εlak^u</i> | Clover garden | | p.56; Map 13.106 | |
| | <i>ts!ōyadē^ε</i> | Havind root digging | | Map 13.90 | In Bond sound |
| Grubb, David 1972 | <i>t'egwedzū</i> | Clover patch | <i>T. wormskioldii</i> | | |
| Agnes Alfred in Reid and Sewid-Smith 2004 | <i>d^z uyas</i> | "Digging garden" | <i>T. wormskioldii</i> | p. 71 | |
| | <i>Hixsolis əlaʔ</i> | | | p. 71 | Name of specific garden patch |
| | <i>Wax^w ba'ʔas</i> | | | p. 71 | Name of specific garden patch |
| Deur 2005 | <i>ts'o'yadi'</i> | "Having" roots | | p. 315 | |
| | <i>ts'o'is</i> | "beach" with roots | | p. 315 | |
| | <i>t'aki'lakw</i> | "[Human-] manufactured" soil | | p. 315 | |
| | <i>k'agekw</i> | "[human-] place" logs, crosswise | | p. 315 | This placename is used near the Kingcome salt marsh in Boas 1934 but due to the location on the map I believe it may be a canoe skid or a bridge on a trail. |
| Adam Dick, Daisy Sewid-Smith 2008 | <i>taki'lakw</i> | root garden | | | |
| Adam Dick 2.19.10 | <i>tsusa</i> | "going to dig edible roots" | | | |
| Boas 1895 | <i>Tliksɪ'uaē</i> | "cloverroot in an estuary" | <i>A. egedii</i> | p. 166 | |
| | <i>λəksiwi</i> | Clover roots | <i>A. egedii</i> | p. 368 | DSS and AD recognise this placename as "Cluxewe" which is derived not from the term for "clover root" but from the Kwakwalak word tlexse'm "silverweed." |

* Retranslated by Daisy Sewid-Smith in 2006

Appendix 4. K^wak'wala terms for *Trifolium wormskioldii* and *Argentina egedii*. Words in bold (and red) are incorrect translations.

| Source | English name in text | Kwak'wala name in text ¹ | Actual root | Page | Notes |
|---|---|---|---|---|---|
| Charlie Nowell and Bob Harris in Newcombe n.d. | Silverweed Clover Clover - larger kind | <i>kliksimn</i> <i>ToXsos</i> <i>Klaxâbalis</i> | <i>Argentina egedii</i> <i>Trifolium wormskioldii</i> <i>T. wormskioldii</i> | | |
| Boas and Hunt n.d. Kwakiutl Texts | Clover-roots Clover-root Cinquefoil-roots Clover | <i>!Exsō'sē</i> <i>!Ex^u sō's</i> <i>LEX' SE'm</i> <i>LEX' SE'm</i> | <i>T. wormskioldii</i> <i>T. wormskioldii</i> <i>A. egedii</i> <i>A. egedii</i> | p. 318-321 p. 361 p. 361 p. 391 | |
| Boas 1910. Kwakiutl Tales | Clover Clover Clover-roots Clover-roots Clover-roots Cinquefoil-roots Clover-roots | <i>!E gu'xsik</i> <i>!Ex^u sō's</i> <i>LEXSE'm</i> <i>Lixse'mē</i> <i>LEX' SE'mē</i> <i>!Ex^u sō'sē</i> <i>LEX' SE'm</i> | <i>T. wormskioldii</i> <i>T. wormskioldii</i> <i>A. egedii</i> <i>A. egedii</i> <i>A. egedii</i> <i>T. wormskioldii</i> <i>A. egedii</i> | p. 64-65 p. 203-205 p. 359 p. 359, 367, 369 p. 361, 367, 369, 457 p. 458 | |
| Boas 1921. Kwakiutl Ethnography | Long cinquefoil roots Curly cinquefoil roots Clover-roots | <i>Lāxabālisē</i> <i>LE^F wa !Ex^u sōsē</i> <i>!E mkwa !Ex^u sōsē</i> <i>LEX' SEMē</i> | <i>T. wormskioldii</i> <i>T. wormskioldii</i> <i>A. egedii</i> | p. 190 p. 189 p. 186 | |
| George Hunt 1922. Necombe Field Notes, n.d. | Lupine Not given ? <i>Trifolium fimbriatum</i> <i>Potentilla anserina</i> <i>Lupinus littoralis</i> <i>Lupinus columbianus</i> Not given Not given Clover Long clover root Brown clover White clover | <i>q!wane</i> <i>LEX!sem</i> <i>LEX'S EM</i> <i>taxsus</i> <i>tliqsiwae, tliksim</i> <i>q!w ā^F nē</i> <i>q!w ā^F nē</i> <i>q!wane</i> <i>K'wani</i> <i>Laxabane</i> <i>Laxabales</i> <i>Lexsemaks</i> <i>!EXSOSE</i> | <i>Lupinus nootkatensis</i> <i>A. egedii</i> <i>A. egedii</i> <i>T. wormskioldii</i> <i>A. egedii</i> <i>L. nootkatensis</i> <i>L. nootkatensis</i> <i>L. nootkatensis</i> <i>L. nootkatensis</i> <i>T. wormskioldii</i> <i>T. wormskioldii</i> <i>A. egedii</i> <i>T. wormskioldii</i> | | Hunt doesn't recognize this name Largest root reserved for the chief and his family. |
| Charles Newcombe n.d. | Silver leaf cinquefoil; <i>Potentilla anserina</i> var. <i>grandis</i> | <i>kliksimin</i> | <i>A. egedii</i> | | BC Archives MSS 1077 Vol. 24 Folder 6 |
| Boas 1928. Bella Bella Texts | to gather clover place where clover grows clover roots clover roots cinquefoil roots to get cinquefoil roots | <i>Lg ā</i> <i>Lg'it</i> <i>!EX'saa'm</i> <i>!x'saa'm</i> <i>!EX^u sō's</i> <i>!Eqō'L</i> | <i>A. egedii</i> <i>A. egedii</i> <i>A. egedii</i> <i>A. egedii</i> <i>T. wormskioldii</i> <i>T. wormskioldii</i> | p. 281 p. 281 p. 281 p. 281 p. 221 p. 221 | |
| Boas 1969. Kwakiutl Tales | clover root clover root clover root | <i>!EX^u sō's</i> <i>!EXUSō'sa</i> <i>!EXSō's</i> | <i>T. wormskioldii</i> <i>T. wormskioldii</i> <i>T. wormskioldii</i> | p. 4 p. 4 p. 4 | |
| Lucy Brown 1969, Turner Field Notes | clover plant clover root silverweed plant silverweed root | <i>tukwanu</i> <i>tuksus</i> <i>tukwanu</i> <i>tuksus</i> | <i>T. wormskioldii</i> <i>T. wormskioldii</i> <i>T. wormskioldii</i> <i>T. wormskioldii</i> | | Lucy Brown was asked for the K ^w ak'wala name for silverweed but gave the K ^w ak'wala name for clover. |

1. Orthography original