Moolks (Pacific crabapple, *Malus fusca*) on the North Coast of British Columbia: Knowledge and Meaning in Gitga'at Culture

by

Victoria Rawn Wyllie de Echeverria
B.Sc., University of Victoria, 2010

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Supervisory Committee

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Abstract

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In this thesis, I examined ethnobotanical uses, traditional knowledge and folk classification of ***moolks***, Pacific crabapple (*Malus fusca* (Raf.) C.K. Schneid.; Rosaceae) for the Gitga'at First Nation of Hartley Bay, and measured morphological variation of sampled trees at the traditional harvesting location. This deciduous tree has historically been an important resource for food, materials and medicine for Indigenous Peoples throughout most of its range along the Pacific coast of North America.

One of these groups is the Gitga'at people, whose knowledge is also interesting due to their recognition of approximately five unique varieties. I conducted interviews with seven Gitga'at elders, who recognize up to five distinct varieties ***moolks***, based on fruit characteristics and harvesting location, each with its specific applications. The cultural importance of crabapples was documented through these interviews, as expressed in their folk taxonomy, linguistic knowledge, ethnobotanical uses and management strategies.

In addition, I conducted a morphological and ecological study to examine the variability within and among 27 crabapple trees. To determine ecological and morphological variability of crabapples within its traditional harvesting area, I sampled foliage and fruits and measured their traits from individual trees and different sites, and recorded information about the localized habitat. While some fruit and leaf traits are correlated, I identified significant variation within and among trees making it hard to delineate the varieties as described by the elders.

In conclusion, by using these two knowledge systems – traditional ecological knowledge and western scientific knowledge – to complement each other, it can result in a more detailed understanding of a botanical species, as they both present us with information about slightly different characteristics. In a rapidly changing world, we need as much collaboration as necessary to allow for resiliency.

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Preface

Personal Introduction

I followed an unconventional path while growing up, which lead me to an unique way of approaching my chosen studies. Through my parents' occupations as marine biologists, we traveled to many different parts of North America and Europe while they were doing their research. In addition to the experiences I gained through seeing other places and cultures, they also taught me and my two sisters to look carefully at the natural world around us, and helped me in develop a strong interest in plants. For the latter half of my teenage years, we settled on a small island in the Northwest corner of Washington State, with a population of about 200 people, and 10 times as many trees. Being schooled at home throughout my entire primary and secondary education, I was able to focus on learning about plants and how people rely on them for such things as food, medicine and making tools.

In university, I learned more about how scientists study plants, but I never lost my connection to getting outside and seeing and learning about plants and the natural world in their natural environment. While I was learning about plant sciences from a western scientific perspective in my academic studies, I was also learning from Kwakwa̱ka̱'wakw elders Clan Chief Adam Dick (***Kwaxsistalla***), Daisy Sewid-Smith (***Myanilth***) and Kim Recalma-Clutesi (***Ogwilowgwa***) about how to view the world through a traditional knowledge lens. This merging of viewpoints has allowed me to become greatly interested in the intersection between how the world, particularly plant knowledge, is viewed by local Indigenous People and western science. I was greatly privileged to work under the guidance of many important elders in the Gitga'at Nation for this project, and I feel so honoured to have learned so much from them, and been allowed to share a small portion of their life.

Importance of Study

Studies that bridge the gap between western scientific methodologies and Traditional Ecological Knowledge to show the inter-relatedness of working in both of worldviews are extremely important. I am lucky enough to be doing this project under the guidance of Dr. Nancy Turner, who is on the cutting edge of this type of research, and has been working with the Indigenous People of the Northwest Coast for over 40 years, and also Drs. Douglas Deur, and Geraldine Allen, who have been working on this coast for numerous years as well. My path has been paved by the research of many of Nancy's, and other's, students, who have also looked at the intersection of TEK with western science (Cullis-Suzuki, 2007; Deveau, 2011; Dilbone, 2011; Karst, 2005; Lloyd, 2011; Mellott, 2011) . These studies show how various knowledge systems can be used to comprehensively show the multiple sides to a problem, and work together to solve it.

Acknowledgments

This project would not have been possible without the help of many people. The entire community of Hartley Bay has been very welcoming, and the people there were very generous with their time and resources.

I would like to thank all of the elders who have allowed me to learn from them and shared their expertise about ***moolks*** – particularly Hereditary Chief Albert Clifton, Hereditary Chief Ernie Hill Jr., Helen Clifton, Belle Eaton, Margie Hill, Goolie Reece, Elizabeth Dundas, Lynne Hill and Rufus Reece. Matriarch Helen Clifton was instrumental in guiding my time in the community.

I would like to thank the Hartley Bay Band Council for allowing me the opportunity to work in their community, and CEO Ellen Torng, who was kind enough to provide a living space for some of my time in the village. Kyle Clifton also provided valuable insights into proper protocols.

I would like to thank the Coastal Guardian Watchmen of Hartley Bay, who allowed me to go up to the field site with them, providing boat and personal resources, particularly Marven Robinson, Glen Reece and Ed Clifton. I would also like to thank Nicole Robinson and Archie Dundas, who provide time and boat resources to take me up to the field site in my second field season. I would like to thank Jennifer Clifton who allowed me to stay with her for my second visit to Hartley Bay.

I would like to thank my committee, Drs. Nancy Turner, Douglas Deur and Geraldine Allen for their help and support, and my sources of funding though a Jacobs Research Fund grant awarded to myself, and a SSHRC grant awarded to N. Turner and N. Mackin (Bringing the Food Back Home", # 410-2010-0877).

I would also like to thank my family, who have let me bounce ideas off them, and understood when I didn't have time to talk, or do the dishes. Tina, Tessa, Rebecca, Jessica and Alison – you have been vital to my sanity.

I joined this masters program with some amazing fellow students – we have shared lots of talks, walks and coffees during our tenure in this school, joining others already here, and having new students expand our ranks as the years progressed.

This work would also not have been possible without the little things. Ken Josephson in the Department of Geography (UVic) kindly made maps for me to use during my research and Jessel Bolton provided a poster printer and technical help in the village.

Chapter 1: Introduction and Literature Review

1.1 Introduction

The purpose of this study was to learn about the ethnobotanical knowledge, including classification systems, of ***moolks***, Pacific crabapple [*Malus fusca* (Raf.) C.K. Schneid.; Roseaceae] by the Gitga'at people of Hartley Bay, one of the Coast Tsimshian communities of British Columbia. Since this thesis presents knowledge from two diverse perspectives and classification schemes – western scientific knowledge and Indigenous, or Traditional Ecological Knowledge (TEK) – I feel it is important to reflect both knowledge systems when describing the background of the taxonomy and ecological characteristics of this tree. According to western scientific taxonomy, there is a single species of native crabapple (*Malus fusca*) on the Northwest Coast of North America, and no varieties or subspecies are delineated (Douglas *et al*., 1999; Klinkenberg, 2010). First Nations peoples who have relied on this species as an important food for centuries and probably millennia, however, recognize and name different types based on fruit morphology, taste, tree location and other characteristics (Compton, 1993; Turner and Thompson, 2006) in their folk taxonomy. Gitga'at elders of Hartley Bay have names for at least five distinct varieties of ***moolks*** (their word for crabapple, in ***Smalgy'ax***, the Tsimshian language) (Hartley Bay School, 1997; Turner and Thompson, 2006). Each variety has particular cultural significance for the Gitga'at, with associated cultural knowledge and practices relating to use, management, ownership and, in some cases, trade.

Investigating the close relationships between Indigenous groups and certain species is extremely important. One of the outcomes of such intimate relationships is that people have become cognizant of very subtle changes in a species' morphological and phenotypical characteristics, and perhaps have even influenced or helped cause such differences through intentional or unintentional selection while managing, cultivating and harvesting important resources.

The term "folk taxonomy" is used to describe a hierarchical classification of organisms by a particular group of people (Brown, 1984; Hunn and Brown, 2011), often an indigenous culture. These folk classification schemes can often over- or under-differentiate a species in comparison to a western scientific classification scheme of that same species (Hunn and Brown, 2011; Martin, 1995; Turner, 1974). Martin (1995) states that when a species is considered to be "of great cultural importance", a single western scientific species can be over-differentiated into multiple folk varieties, such as in the case with Pacific crabapple. Because this species is quite important to many Indigenous groups, some of these groups recognize finer categories than western scientific taxonomy, and this has led to more varieties or subspecies being recognized (Compton, 1993; Turner and Thompson, 2006). In addition, the cultivation and possible domestication of plants and their habitats on the Northwest Coast of North America is a current concept that has been widely documented and accepted, and this may also lead to a finer varietal differentiation for important species (Black, 1994; Deur, 2000; Deur and Turner, 2005a; Doolittle, 2000; Downs, 2006). Learning from elders the knowledge they hold in this respect will lead to greater understanding of cultural links to natural systems and vice versa, and thus of biocultural diversity. My hope is that in the future, by drawing on both ecological and ethnoecological knowledge systems, we will be able to understand many species and their environmental and cultural contexts more fully.

Pacific crabapple is a prime candidate for such a study that links western scientific and folk biological knowledge because there is documented evidence in the literature from ethnoecological studies in British Columbia and elsewhere on the Northwest Coast that this species has been entwined with the cultural heritage of several Indigenous groups throughout its biogeographical range. This can be seen through their use, harvesting and sustaining of this resource (Downs, 2006; Kuhnlein and Turner, 1991; McDonald, 2005; Turner, 1995), and through rights of ownership of some crabapple harvesting sites (Deur and Turner, 2005b; McDonald, 2005; Turner and Peacock, 2005; Turner *et al.*, 2005). Varietal differentiation recognized at the folk classification level by some Indigenous groups (Compton, 1993; Turner and Thompson, 2006) provides additional evidence of its cultural importance.

In this research I sought to learn how Indigenous Peoples, specifically the Gitga'at, relate to crabapples and its varieties, particularly within the context of Gitga'at plant use and environmental knowledge in general, including changes that have occurred over time. Pacific crabapples can also be considered a "cultural keystone species" (CKS), a species of enduring importance despite its lessened use as a food in recent times (cf. Turner and Turner 2008). "Cultural keystone species" (Garibaldi, 2009; Garibaldi and Turner, 2004; Peroni *et al.*, 2007; Turner, 1988) are defined as a "culturally salient species that shape[s] in a major way the cultural identity of a people, as reflected in the fundamental roles these species have in diet, materials, medicine, and/or spiritual practices" (Garibaldi and Turner, 2004, pg. 4). Through interviewing knowledge holders, and through ecological and morphological surveys, in this research I characterize the different ***moolks*** varieties and document the associated cultural knowledge of the use, management, ownership and trade of this important resource by the Gitga'at Nation.

1.2 Pacific crabapple (*Malus fusca*)

Pacific crabapple [*Malus fusca* (Raf.) C.K. Schneid.)] is a small deciduous tree or tall shrub (Figure 1.1a) usually growing from 2-12 m high. It is one of several species of apple (*Malus* spp.) native to North America, but it is the only species whose natural distribution is along the west coast of the continent, from Alaska to California. Its range extends slightly inland in places, mostly due to a plethora of inlets, fjords and rivers along the coasts of Alaska and British Columbia, but generally it is confined to west of the Cascade and Coast mountains (Douglas *et al*., 1999; Klinkenberg, 2010). Pacific crabapple is commonly found in moist to wet habitats, often in close proximity to open water, from low to middle elevations. It grows at the edges of forests, along lakeshores and stream edges and in open thickets, estuaries, swamps, bogs and upper beaches. It is generally shade-intolerant and occurs in nutrient-rich soils (Douglas *et al*., 1999; Klinkenberg, 2010; Pojar and MacKinnon, 1994). Pacific crabapple fruits have historically been an important component of Indigenous Peoples' foodways and cultures throughout most of its range. Since *M. fusca* has been shown genetically as being more closely related to certain species of crabapples in Asia, rather than to one of the other crabapple species in North America, botanists have postulated that Pacific crabapples possibly spread to North America via Beringia during the Late Pleistocene (Routson *et al*., 2012; Williams, 1982). General botanical descriptions presented below for Pacific crabapple are provided by Douglas *et al*. (1999), Klinkenberg (2010) and Pojar and

MacKinnon (1994). A more detailed assessment of the background literature on the botanical characteristics and western scientific classifications of *M. fusca* is presented in Chapter 3, where I review genetic relatedness, morphological classification schemes, genetic variability and diversity, reproduction strategies, pollination and fruit dispersal techniques and species migration patterns.

The trunks of mature Pacific crabapple can range in diameter from less than 10 cm to over 30 cm. Sometimes the trunks are clustered closely together in a dense stand, and at other times, trees stand singly. The branches often bear short, tough and quite sharp thorns. The wood is considered a hard wood, and renowned for its toughness. It was commonly used by Indigenous Peoples to construct implements and tools, such as digging sticks and adze handles (Turner, 2007). The bark is brown, often mottled with grey patches of lichen, and is rough and scaly. Bark of older trees can be deeply fissured. The bark was widely considered to be an important medicine for various ailments and was usually prepared in the form of an infusion or decoction in boiling water to be taken internally or externally (Gunther, 1973; Turner and Hebda 1990). Williams (1982) showed that *M. fusca* bark and leaves contain the phenolic compounds toringin and toringin dibenzoylmethane glucoside, but to date, available literature sources reflect little of the phytochemical complexity of this species. Future research may reveal more clearly the biochemical foundations for the medicinal properties of Pacific crabapple.

The leaves are alternate and lance-shaped to oval, with lightly serrated edges and often with a shallowly indented, pointed lobe on one or both sides giving the leaf a three-lobed appearance. The leaves turn red or yellow-orange in the autumn before they drop.

The flowers have often white (or sometimes pink) petals and smell sweet. Individual flowers are approximately 2 cm across and usually have three styles and 20 stamens. They are borne in rounded clusters of 5-12 flowers. Each flower has a reflexed, hairy 5-lobed lanceolate shaped calyx. Plants in the subfamily Maloideae (which includes Pacific crabapple) generally have self-incompatibility, so flowers usually must be cross-pollinated by an animal vector, often insects and occasionally even birds (Campbell *et al.*, 1991; Pereira-Lorenzo *et al.*, 2009; Sheffield *et al.*, 2005). Pollination is described in greater detail in Chapter 3 of this thesis.

The apples (Figure 1.1b) are globular to ovoid pomes, usually about 1.0-1.5 cm long and 0.5-1.0 cm wide. They have long stems, often ranging from 1.0-5.0 cm long, and are usually borne in hanging clusters of 5-12 fruits. Fruits are green when unripe, and usually ripen to various shades of red and yellow in late summer to fall, depending on genetic strain, and local weather conditions. The fruits have 3-4 chambers in the core, each with 1 or 2 seeds. The seeds are initially white, turning dark brown as they ripen. While no studies were found on the nutritional contributions of *M. fusca* specifically, the fruits of domesticated crabapples were found to be particularly high in fibre, vitamin C and antioxidants (Kuhnlein and Turner, 1991; Seeram *et al.*, 2003; Yoshizawa *et al.*, 2004). In addition, Yoshizawa *et al.* (2004) found that anthocyanins in the juice inhibited HL-60 human leukemia cells from multiplying, and Kuhnlein and Turner (1991) reported that the fruits also contain key minerals and vitamins, including ash (0.4g), calcium (18 mg), phosphorus (15 mg), sodium (1 mg), potassium (194 mg), thiamine (0.03 mg), riboflavin (0.02 mg), niacin (0.1 mg), and vitamin A (4 RE), as well as being a source of protein (0.4

g), fat (0.3 g), carbohydrates (20 g) and water (79 g), and containing 76 kcal of food energy. All of the above measurements were based on the amount found per 100g of fresh weight for the fruits. Also, in general, as fruits ripen, sugar levels are known to increase (Minore and Smart, 1975).

Historically, the fruit was a significant food source for Coastal First Peoples, including the Gitga'at. It was important not only nutritionally but culturally and ceremonially. Crabapples were served at feasts and used as a trade good. and feature in a number of traditional narratives (Turner, 1995). In addition being an important food for humans, the crabapples also provide nourishment for many birds and animals, including grouse, crows, bear and deer. Seeds are spread by human and non-human vectors as they drop unused fruit or excrete digested fruit. Each seed will sprout into an individual stem, which will then sometimes grow into a clonal cluster, with several stems originating from the same root system and thus a singular original seed. Stems can also resprout from cut trunks.

In the following sections, I first outline my study objectives and research questions, and then provide background information on the Gitga'at First Nation, whose traditional knowledge about Pacific crabapple forms the foundation of this study, and within whose traditional territory I undertook this research. The remainder of the chapter presents the framework of the rest of my thesis, followed by a literature review relevant to my research, including biogeographical, ethnobotanical and historical records.

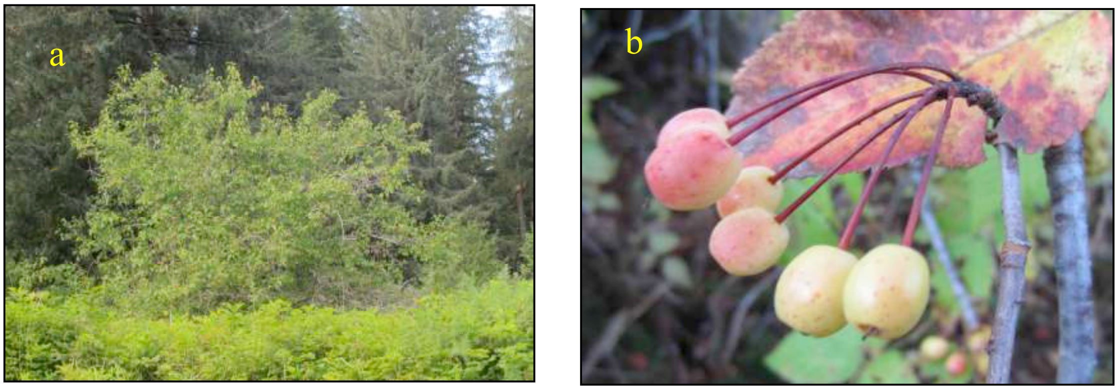

Figure 1.1. (a) Pacific crabapple tree, 30 August 2011; and (b) fruit, 14 October 2011, near Hartley Bay, BC.

1.3 Objectives and Research Questions

The objectives of this research were two-fold. The first was to investigate the cultural significance, in-depth ethnobotanical uses and folk classification systems of ***moolks,*** Pacific crabapple (*Malus fusca*) of the Gitga'at First Nation. The second was to examine the botanical and ecological characteristics of each ***moolks*** variety identified through ethnobotanical knowledge, to determine whether morphological and habitat studies reflect the differences among the crabapple varieties as distinguished by Gitga'at elders. Drawing on both western scientific and Indigenous knowledge systems, I explored the differences and similarities between them and how they can be linked to present a more cohesive picture of a culturally important plant.

To answer the first objective, I posed the following questions:

1. *How many varieties of **moolks** are recognized by Gitga'at knowledge holders?*
2. *Why and how are these different varieties distinguished?*
3. *What is the cultural significance of each **moolks** variety?*
4. *How are **moolks** harvested and processed by the Gitga'at people, and are there differences in preparation techniques for different varieties?*
5. *How do **moolks** varieties feature in traditions of ownership, management and trade for the Gitga'at?*

To address the second objective, I posed the following questions:

1. *Can the folk varieties described through interviews be differentiated botanically through their ecological and/or morphological characteristics? And if so –*
2. *What are the ecological characteristics of each recognized folk variety?*
3. *What are the morphological characteristics of each recognized folk variety?*

My research design incorporated specific methodologies from social sciences and natural sciences to examine the question of the taxonomic status and cultural significance of ***moolks***. From the social science side, I used interviews and participant observation to elucidate the ethnobotanical and ethnoecological significance of crabapples to the Gitga'at people. From the natural science side I documented morphological and environmental characteristics of crabapples with sampling and ecological surveys. Specific methods used in each component are described in the Methods sections of the relevant chapters, along with the results from each component of my study.

1.4 Hartley Bay and the Gitga'at Nation

My research was located on the north coast of British Columbia at Hartley Bay, the current permanent village of the Gitga'at people, and in Gitga'at territory surrounding this village. Hartley Bay, a small community with approximately 200 resident band members, lies nestled in a sheltered bay on the northern side of the entrance to Douglas Channel (Figure 1.2).

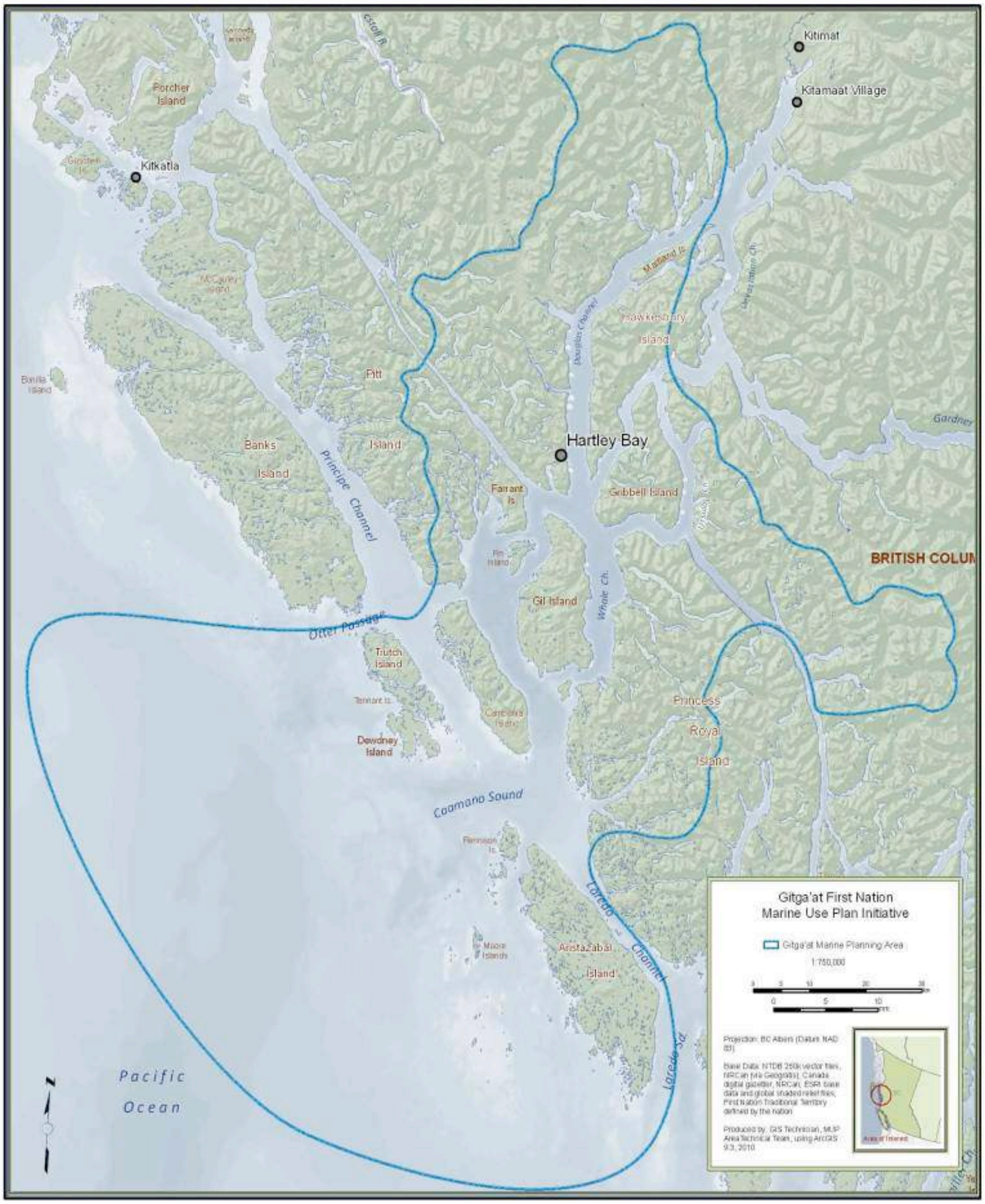

Figure 1.2. Map of Gitga'at territory, showing the location of Hartley Bay (from the Gitga'at Nation, 2011).

There is no road access to Hartley Bay, but boardwalks, navigated by foot, bicycle, small ATVs or golf carts, connect the houses and other buildings. Access from outside the village is by a small weekly-scheduled ferry, personal or chartered boats or by floatplane. The village is backed by high tree-covered mountains that protect it from rough northern gales (Figure 1.3). Outside contact first occurred for the Gitga'at with European fur traders and explorers in the 1780s, and they regularly traded with the Hudson Bay Company when they arrived in the 1830s (Gitga'at Nation, 2004). Formerly a seasonal camp, Hartley Bay was established as a permanent village in the 1880s when the Gitga'at returned to their territory from Metlakatla, AK, where they had moved for a period of time; before this, they had occupied their ancient village site in Kitkiata Inlet, northwest side of Douglas Channel (Gitga'at Nation, 2004).

Figure 1.3. Hartley Bay in the snow, looking out across the village from the upstairs window of a house on the northern side, 30 November 2011.

For generations the Gitga'at have traveled on their seasonal harvesting rounds throughout the lands and waters of their territory, shown on the map above. The Gitga'at's main fall harvesting camp is located about 45 minutes by boat away from Hartley Bay (Gitga'at Nation, 2004). This is where people have often gone to harvest the different varieties of crabapples, although crabapples do grow in many other locations throughout Gitga'at territory.

1.5 Thesis framework

The framework of this thesis is as follows. This chapter presented an introduction to my research, including descriptions of the botanical characteristics and distribution of Pacific crabapple and a literature review of its ethnobotany and biogeography. In Chapter 2, I provide and discuss the results from my ethnoecological interviews with Gitga'at elders. In Chapter 3, I present the results of the morphological and ecological surveys of Pacific crabapple from the traditional harvesting area, and examine how this western scientific data can be overlaid onto the ethnographic data and cultural knowledge collected in this study. Chapter 4, the concluding chapter, discusses the importance of studying many approaches to knowledge systems, why a multidisciplinary approach is key to a comprehensive ecosystem view, and plans for future work. By presenting two very different knowledge systems in examining the classification and ecology of Pacific crabapple, this thesis illustrates how a multidisciplinary approach can be useful in addressing key questions of interest in the conservation, ecology and cultural use of an iconic Northwest Coast fruiting tree.

1.6 Literature Review

1.6.1 Biogeography of Pacific crabapple

To delineate the distribution of crabapple[1] on the west coast of North America, I examined online databases from herbaria located in Alaska, British Columbia, Washington, Oregon and California. Using these databases, I searched for herbarium specimens of crabapple, including most specimens originally collected under synonyms for *M. fusca*; *M. diversifolia* (Bong.) M. Roemer, *M. fusca* var. *levipes* (Nutt.) C.K. Schneid., *Pyrus*

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[1] When I refer to 'crabapples' in the rest of this thesis, unless otherwise stated, I mean Pacific crabapple (*Malus fusca*) specifically.

diversifolia Bong., *P. fusca* Raf., *P. rivularis* Dougl. ex Hook.; and downloaded label information on these specimens, as well as maps of the collection locations if they were available. I then compiled this information onto one comprehensive map of the entire west coast of North America, with dots indicating each location as closely as possible (Figure 1.4). For this compilation, I specifically used the online versions of herbaria databases from the following universities and floras: University of Alaska Museum of the North (ALA), E-Flora (Klinkenberg, 2008) from the University of British Columbia (UBC), University of Washington Herbarium (WTU), Oregon State University (OSC) and Jepson Herbarium (JEPS), and examined in person the collections at the University of Victoria (UVIC) and the Royal British Columbia Museum (RBCM). I also searched several web pages that provide access to specimens from multiple herbaria collections, including Consortium of California Herbaria, Oregon Flora project, Calflora and Consortium of Pacific Northwest Herbaria.

As expected, the majority of the records for *M. fusca* (as indicated from the locations shown in the map in Figure 1.4 were clustered along the Pacific coast, since this species is commonly found west of the Cascade and Coast mountains (Klinkenberg, 2010). However, some of the specimen localities were located further inland than would be expected, outside of their typical habitat, in some cases east of the coastal mountain ranges (Pacific Cordillera), which might represent human-assisted translocation sites (as discussed later). There were few specimens from California, a finding that was surprising because the range of this species does extend into California. This scarcity of herbarium records suggests that these southerly populations may be limited. Sites of these outlying populations include: in British Columbia, east and slightly north of Prince Rupert (close to Terrace); near Prince George; and east of Vancouver, in the Fraser River Canyon; and California in Tulare County.

One limitation of using herbarium voucher specimens is that they only reflect areas where botanists have visited and made collections. This may not be representative of all crabapple populations; however, it is still useful. In addition to mapping the biogeographical range of Pacific crabapple collections, I also examined the records for references to cultural information at the collection site. Sometimes this type of data is not noted in the collecting notes on the herbarium label, or, in the case of the electronic databases, is not transferred from the paper label to the electronic record. While not many of the specimens had collection information relating cultural data, I was able to find a few records that referenced crabapple collected close to culturally important sites, mostly from the herbaria collections I examined in person at the University of Victoria and the Royal British Columbia Museum, but also several from the electronic databases. Overall, I found 22 references to crabapples collected on Indigenous reserves, or at abandoned Indigenous village sites. In addition, four specimens were collected close to abandoned European settlements.

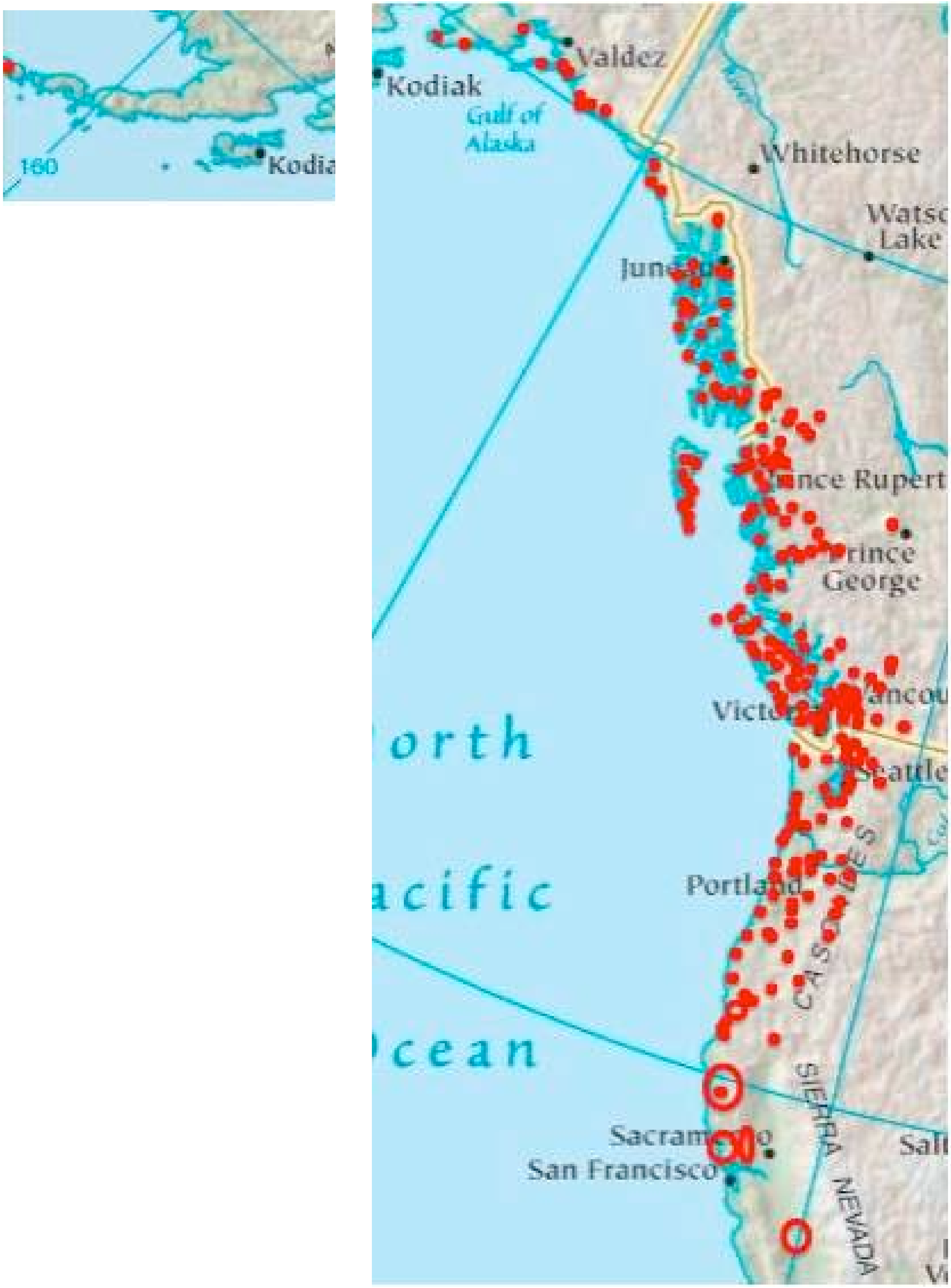

Figure 1.4. Map showing the distribution of *Malus fusca* based on herbarium specimens. The red circles in the southern area (California) indicate that a precise location was not listed for the specimen, only the county of collection.

1.6.2 Ethnobotany of Pacific crabapple

To elucidate the recorded ethnobotanical references to Pacific crabapple, I examined the ethnobotanical and ethnographic literature and extracted any mention of its use from Alaska to California. I concentrated on historical interactions with this species by Indigenous Peoples in North America, but also found some casual references to its use by settlers, and modern-day uses.

Overall, I was able to identify 37 indigenous groups for which crabapple knowledge had been recorded, for a total of 200 use entries throughout the area represented in the literature (Table 1.1). While this literature review is relatively comprehensive, there are many grey literature reports and oral histories that I did not have access to, and thus am not able to report on. Most of the literature references to crabapple ethnobotany and ethnoecology come from the Northwest Coast Cultural Area (Burton, 2012; Compton, 1993; Johnson, 1997; Turner, 1995; Turner, 2004; Turner, 2007). References to use of crabapple further north in the vicinity of Prince William Sound, Alaska, and along the surrounding island archipelagos pertain mainly to three indigenous groups: Tlingit, Kaigani Haida and the Chugach (Moss, 2005; Norton, 1981; Turner 2004; Wennekens, 1985). Literature sources for Coast and Straits Salish peoples and the southern Wakashan peoples were not as numerous as for the central and northern Northwest Coast region, but there were several from the Puget Sound and Olympic Peninsula regions (Gill, 1983; Gunther, 1973; Reagan, 1934; Theodoratus, 1989; Turner, 2007; Turner *et al.*, 1983). South of the Puget Trough I found only two ethnobotanical reference to crabapple: for the Chinook from the juncture between Washington and

Oregon at the mouth of the Columbia River (Gunther, 1973), and the Nehalem (Tillamook) people on the north coast of Oregon (Deur, 2008). I was not able to find any information from the indigenous groups of southern Oregon and all of California. Crabapples were also used by some European settlers historically. The wood was used for fuel or making tool handles, and the fruits were eaten, although some people considered them to be "too sour" (Theodoratus, 1989).

The uses of crabapples were fairly consistent throughout its range. Its cultural significance can be seen through its widespread use geographically, the diversity of uses (food, technology, medicine) and the frequency of its mention in traditional narratives. As noted earlier, some peoples also distinguished and named different varieties of crabapples. I found evidence of three groups that recognized these subtleties – the Gitga'at, the Haisla/Hanaksiala and the Kitasoo (Compton, 1993; Turner and Thompson, 2006). This will be discussed in more detail in Chapter 2.

Table 1.1. Indigenous groups for which ethnobotanical information on Pacific crabapple was documented. References include the First Peoples' Language Map (http://maps.fphlcc.ca/), Native Languages of the Americas (http://www.native-languages.org/) and A guide to the Indian Tribes of the Pacific Northwest by Robert H. Ruby, John A. Brown and Cary C. Collins (2010).

Indigenous group	Language (major dialects)	Language family	Approximate territory	References
Chinook, Lower	Lower Chinook	Chinookan (Penutian)	Washington coast and mouth of the Columbia River	Gunther, 1973
Chugach	Chugach	Yupik (Eskimo-Aleut)	Western Alaska and islands	Wennekens, 1985
Coast Salish	Straits, Hul'qumi'num	Salishan	SE Vancouver Island	Turner and Bell, 1971
Ditidaht (Nitinaht)	Diitiid7aatx̱	Wakashan	Southwest coast of Vancouver Island	Gill, 1983; Sproat, 1868; Turner et al., 1983
Cowlitz, Lower	Lower Cowlitz/Stl'pulimuhkl	Salishan	Cowlitz River, southwestern Washington	Gunther, 1973
Gitga'at	Coast Tsimshian (Smalgya̱x)	Tsimshian	Douglas and Grenville Channels through to Caamano Sound	Turner and Thompson, 2006; Hartley Bay School, 1997
Gitxsan (Gitksan)	Gitsenimx̱	Tsimshian	Upper Skeena and Bulkley Rivers, just interior to northern coast	Johnson, 1997; Smith, 1929; Smith 1997; Turner, 2007
Haida	X̱aaydaa Kil (Skidegate)/X̱aad Kil (Masset)	Haida (language isolate)	Haida Gwaii	Turner, 1974 and 2004
Haida (Kaigani)	Alaska dialect of Haida	Haida (language isolate)	southeast Alaska, bordering coastal BC	Norton, 1981; Turner 2004
Haisla	X̱a'islak'ala	Wakashan	Kitamaat, and vicinity, northern Coast	Compton, 1993; Davis *et al*., 1995
Halkomelem	Halkomelem	Salishan (Coast)	se coast of Vancouver Island, Gulf	Turner, 1995 and 2007;

(specifically Cowichan; see Coast Salish)	(Halq'eméylem/Upriver; Hənqəminəm/Downriver; Hul'qumi'num/Vancouver Island)		Islands, and lower Mainland and Fraser Valley region	Turner and Bell 1971; Turner and Hebda, 1990
Hanaksiala	X̲enaksialak'ala	Wakashan	Kitlope valley and vicinity, central Coast	Compton, 1993
Heiltsuk (Bella Bella)	Hailhzaqvla/Bella Bella,	Wakashan	Bella Bella and vicinity	Rath, 1985
Hesquiat	Nuu-chaah-nulh (Central Nuu-chaah-nulh)	Wakashan	Clayoquot Sound, west Coast Vancouver island	Turner and Efrat, 1982
Hoh	Hoh dialect of Quileute/Quillayute	Language isolate	Centre of the area from Cape Flattery to Grays Harbor	Reagan, 1934
Kitasoo	Ski:xs	Tsimshian	Klemtu and vicinity, northern Coast	Compton, 1993
Klallam (See Coast Salish)	N∂x^{w}stly'∂'mu'c ∂n	Salishan (Coast)	North shore of Olympic Peninsula of Washington State from the Strait of Juan de Fuca inland into the mountains	Gunther, 1973
Kwakwak'wakw	Kwak'wala (many different subgroups speak a range of dialects)	Wakashan	northeastern Vancouver Island, adjacent mainland and island between; central and southern Coast	Boas, 1921; Turner, 1995; Turner, 2007; Turner and Bell, 1973
Lushootseed (Skagit; see Coast Salish)	Lushootseed	Salishan (Coast)	Central part of Whidbey Island and on the mainland, including the mouth and North fork of the Skagit river	Theodoratus, 1989
Lushootseed (Swinomish; See	Lushootseed	Salishan (Coast)	Portions of Whidbey Island and all of the islands in Simlik Bay and	Gunther, 1973

Coast Salish)			northern Skagit Bay, including Hope, Skagit, Kiket, Goat and Ika, as well as Smith Island on the west coast of Whidbey and Hat Island in Padilla Bay	
Makah	Makah/Qwiqwidicciat	Wakashan	Northwest corner of Washington, between the Olympic mountains and the coast	Gill, 1983; Gunther 1973; Turner at al., 1983
Nehalem (Tillamook)	Tillamook	Salishan	Northern Oregon coast	Deur, 2008
Nisga'a	Nisga’a	Tsimshian	Nass Valley, northern BC	Turner, 2007; Burton 2012
Nlaka’pamux (Thompson)	Nlhe?kepmxcin	Salishan (Interior)	Along the Fraser River from Spuzzzum to Lytton, around the Thompson River and in the Nicola Valley	Turner et al., 1990
Nuu-chah-nulth (Nootka)	Nuu-chaah-nulh (many different tribes speak a range of dialects)	Wakashan	West coast of Vancouver Island	Turner, 1995; Turner et al., 1983; Drucker 1951
Nuxalk (Bella Coola)	Nuxalk	Salishan	Bella Coola Valley and westward, central Coast	McIlwraith 1948; Nuxalk Nation, 1985; Smith, 1929; Turner, 1973; Turner, 1974; Turner, 2007
Ooweekeno	Oowekyala/lhuwk’al, x̱íx̱ís	Wakashan	Oweekeno are in Rivers Inlet vicinity	Compton, 1993
Quileute	Quileute/Quillayute	Quileute (language isolate)	Northwest corner of Washington, between the Olympic mountains and the mouth of the Quillayute River	Gunther, 1973; Reagan, 1934; Turner, 2007

Quinault	Quinault	Salishan	Northwest corner of Washington, Quinault River valley and the coast between Raft River and Joe Creek	Gunther, 1973
Saanich (See Straits Salish)	Lhéchelesem (Semiahmoo, Malchosen, SENĆOŦEN/ Saanich, Lekwungen, T’Sou-ke)	Salishan (Northern Straits)	southern Vancouver Island, Gulf Islands	Turner, 2007; Turner and Bell, 1971; Turner and Hebda, 1990; Turner and Hebda 2012
Samish (See Straits Salish)	Lhéchelesem (Semiahmoo, Malchosen, SENĆOŦEN/ Saanich, Lekwungen, T’Sou-ke)	Salishan (Northern Straits)	southern Vancouver Island, Gulf Islands	Gunther, 1973
Sechelt (See Coast Salish)	Sheshashishalhem/ Shashishalhem	Salishan (Coast)	Sechelt Peninsula, Sechelt Inlet and vicinity	Turner, 1995; Turner and Timmers, 1972
Squamish (See Coast Salish)	Sk̲wx̲wú7mesh sníchim	Salishan (Coast)	Squamish Inlet to northern Vancouver and vicinity	Turner, 1995; Turner, 2007; Turner and Timmers, 1972
Stl’atl’imx (Lillooet)	St’át’imc, Lillooet, Statimc, Stl’atl’imx, Stal’atl’imc, Stlatliumh, Slatlemuk, S[’a[’imx∂c	Salishan (Interior)	North to Churn Creek and South French Bar, northwest to the headwaters of Bridge River, north and east toward Hat Creek Valley, east to Big Slide, south to the island on Harrison Lake and west of the Fraser River to the headwaters of the Lillooet River, Ryan River and Black Tusk	Turner, 1974; Turner et al., 1987
Straits Salish (Specifically	Lhéchelesem (Semiahmoo,	Salishan (Northern Straits)	southern Vancouver Island, Gulf Islands	Gunther, 1973; Turner, 1995; Turner, 2007;

Saanich, Samish)	Malchosen, SENĆOŦEN/ Saanich, Lekwungen, T'Sou-ke)			Turner and Bell, 1971; Turner and Hebda 2012
Tlingit	Łingít	Dene (Athabaskan)	Northwest coast of BC, adjacent areas in Yukon and Alaska	Moss, 2005
Witsuwit'en	Witsuwit'en	Dene (Athabaskan)	Bulkley Valley, around Broman Lake, in the vicinity of Skins Lake, northern interior BC	Gottesfeld, 1994

1.6.2.1 Food Use of Crabapple

The edible fruits are the part used by the highest number of groups; they were recorded as used for 33 indigenous groups[2] including Chinook (Lower), Cowlitz, Chugach, Ditidaht, Gitga'at, Gitxsan, Haida, Haida (Kaigani), Haisla, Halkomelem (specifically Cowichan), Hanaksiala, Hesquiat, Hoh, Kitasoo, Kwakwak'wakw, Makah, Nehalem, Nisga'a, Nlaka'pamux, Nuu-chah-nulth, Nuxalk, Ooweekeno, Quileute, Quinault, Saanich, Samish, Sechelt, Sooke-Songish, Squamish, Stl'atl'imx, Swinomish, Tsimshian and Witsuwit'en. In general, people had very similar ways of harvesting the fruits, but most groups had their own variations on preparing, storing and eating them. Despite these different preparation methods however, it was universal that crabapples were picked as the fruit was ripening in the fall, often between September and October, although this depended on seasonal and latitudinal variability. It was most commonly described that the crabapple fruits were picked as a whole bunch.

Crabapples were often cited in the literature as an important feast and ceremonial food, usually stored in water or oil, and most frequently eaten with eulachon grease, at least in the central and northern coastal areas. Despite the similarities in the general use of crabapples as food almost universally across their range, one interesting aspect is the variations noted from the literature in preparing the fruit for storage and consumption. As noted previously, many people mixed crabapples with eulachon grease for storage, although some simply stored them under water, and one of the northern-most groups

[2] Boas, 1921; Burton, 2012; Compton, 1993; Davis *et al*., 1995; Deur, 2008; Gill, 1983; Gottesfeld, 1994; Gunther, 1973; Johnson, 1997; Norton, 1981; Nuxalk Nation, 1984; Reagan, 1934; Smith, 1997; Sproat, 1868; Turner 1973; Turner, 1995; Turner, 2004; Turner and Bell, 1971; Turner and Bell, 1973; Turner and Efrat, 1982; Turner and Hebda 2012; Turner and Thompson, 2006; Turner and Timmers, 1972; Turner *et al*., 1983; Turner *et al.*, 1987; Turner *et al*., 1990; Wennekens, 1985

stored them in seal grease (Wennekens, 1985). The crabapples might be cooked by steaming or boiling. The Kwakwak'wakw, Haisla and Hanaksiala and Gitga'at generally destemmed the crabapples after cooking and before storing them, whereas the Haida often destemmed them just before a feast (Compton, 1993, pg. 266; Hartley Bay School, 1997; Turner, 1995). The Halkomelem and Nuu-chah-nulth – and probably other groups as well – picked the crabapples while still green and stored them in cattail bags until they ripened (Compton, 1993, pg. 107; Turner, 1995). The Kwakwaka'wakw, Ooweekeno and others would sometimes leave them on the branches until after the first frost, when they became very soft and brown, somewhat over-ripe, but with a special taste. Some people mixed crabapples with other berries (usually either salal (*Gaultheria shallon*), blueberries (*Vaccinium* spp.) or highbush cranberries (*Viburnum edule*)) before serving.

Crabapples are still eaten by both indigenous and non-Indigenous Peoples, but use has changed from earlier times. Most people, both indigenous and non-indigenous, instead of preparing the fruit by cooking and whipping with eulachon grease and serving it at meals and feasts, make jams and jellies from it as condiments (Nuxalk Nation, 1984; Turner, 1995; Turner and Thompson, 2006). Boas (1921) gives a detailed description of the picking and processing of crabapples by the Kwakwa̱ka̱'wakw, including eating them with eulachon grease and mashed up (pgs. 213-216, 286-289, 593-596). He also mentions their role as a food in feasts (pgs. 762-775).

1.6.2.2 Use of Crabapple in Technology

Pacific crabapple wood is tough and hard, similar to yew wood (*Taxus brevifolia* Nutt.) (Turner and Bell, 1971; Turner *et al.*, 1983; Turner, *et al.*, 1987), and was sometimes made tougher by heating it through scorching or burning (Turner and Bell, 1973; Turner 2007). It was used by at least 20 indigenous groups[3] (Table 1.2). The main use of the wood was for tools, such as handles for axes and adzes, and for digging sticks and mauls, as well as for making various types of fishing equipment. Burton (2012) reported a technological use for a non-wood portion of crabapple: dried roots were used to sew birch bark baskets.

[3] Compton, 1993; Davis *et al.*, 1995; Gunther 1973; McIlwraith 1948; Nuxalk Nation, 1984; Smith, 1997; Sproat, 1868; Theodoratus, 1989; Turner, 1973; Turner, 2004; Turner, 2007; Turner and Bell, 1971; Turner and Bell, 1973; Turner and Efrat, 1982; Turner and Hebda 2012; Turner and Thompson, 2006; Turner *et al.*, 1983; Turner *et al.*, 1987; Wennekens, 1985

Table 1.2. Technological uses of Pacific crabapple wood: A summary from literature sources.

Use	Cultural groups	References
arrows	Stl'atl'imx	Turner et al., 1987
bows	Gitxsan, Haisla, Halkomelem, Halkomelem (Cowichan), Hanaksiala, Kwakwak'wakw, Nitinaht, Nuxalk, Saanich, Sooke-Songish, Straits Salish	Compton, 1993; Sproat, 1868; Turner, 2007; Turner and Bell, 1971; Turner and Bell, 1973; Turner and Hebda 2012
digging sticks	Ditidaht, Gitxsan, Haida, Haisla, Halkomelem, Halkomelem (Cowichan), Hanaksiala, Kwakwak'wakw, Nuxalk, Saanich, Sooke-Songish, Straits Salish	Compton, 1993; Davis *et al*., 1995; Turner, 2004; Turner, 2007; Turner and Bell, 1971; Turner and Bell, 1973; Turner and Hebda 2012; Turner *et al*., 1983
fishing floats	Halkomelem (Cowichan), Saanich, Sooke-Songish	Turner, 2007; Turner and Bell, 1971; Turner and Hebda 2012;
fuel	Settlers in Washington	Theodoratus, 1989
gambling sticks	Gitxsan, Halkomelem, Kwakwak'wakw, Nuxalk, Straits Salish	McIlwraith 1948; Turner, 1973; Turner, 2007; Turner and Bell, 1973
halibut hooks (and sometimes other fish)	Gitxsan, Halkomelem, Halkomelem (Cowichan), Kwakwak'wakw, Nisga'a, Nuxalk, Saanich, Sooke-Songish, Straits Salish	Burton, 2012; Davis *et al*., 1995; Nuxalk Nation, 1985; Turner, 2007; Turner and Bell, 1971; Turner and Hebda 2012
handles for tools (axes, sledgehammers, mauls and adzes)	Gitxsan, Haida, Haisla, Halkomelem, Halkomelem (Cowichan), Hanaksiala, Hesquiat, Kwakwak'wakw, Stl'atl'imx, Nuxalk, Quileute, Settlers in Washington, Saanich, Sooke-Songish, Squamish, Straits Salish	Compton, 1993; Smith, 1997; Theodoratus, 1989; Turner, 2004; Turner, 2007; Turner and Bell, 1971; Turner and Bell, 1973; Turner and Efrat, 1982; Turner and Hebda 2012; Turner et al., 1987
harpoon shafts	Kwakwak'wakw	Turner and Bell, 1973
hook to pull down crabapple branches	Tsimshian (Gitga'at)	Turner and Thompson, 2006

hoops to secure eulachon nets, and the hammers used to drive the hoops in	Nisga'a	Burton, 2012
mallet (head)	Haisla and Hanaksiala	Compton, 1993
mallet (head and handle)	Haisla and Hanaksiala	Burton 2012
noisemakers	Haisla	Davis *et al*., 1995
paddles	Nitinaht	Sproat, 1868
pegs to hold house boards in place	Nisga'a	Turner, 2007; Burton 2012
propeller blades	Tsimshian (Gitga'at)	Turner and Thompson, 2006
salmon gaff	Ditidaht	Turner *et al*., 1983
sea bass lures	Quileute	Turner, 2007
seal-spear prongs	Quileute	Gunther, 1973; Turner, 2007
smoking fish (burning)	Chugach	Wennekens, 1985
spoons	Gitxsan, Halkomelem, Kwakwak'wakw, Nuxalk, Ooweekeno, Straits Salish	Compton, 1993; Turner, 2007
salmon spreaders	Kwakwak'wakw	Turner and Bell, 1973
tongs	Gitxsan, Haisla, Halkomelem, Hanaksiala, Kwakwak'wakw, Nuxalk, Straits Salish	Compton, 1993; Davis *et al*., 1995; Turner, 2007
Walking sticks	Nisga'a	Burton, 2012
wedges	Gitxsan, Halkomelem, Kwakwak'wakw, Nisga'a, Nuxalk, Squamish, Straits Salish	Burton, 2012; Turner, 2007; Turner and Bell, 1973

1.6.2.3 Medicinal Use of crabapple

Pacific crabapple was also important as a source of medicine, with at least 22 indigenous groups using different parts of the tree medicinally (Table 1.3). The most common part used was the bark (most likely from the trunk and/or branches), prepared either as a tea or decoction, or as juice scraped from the bark[4]. There were also a few references to medicinal use of the leaves (Gunther, 1973; Turner *et al.*, 1983) or the bark from the roots (Reagan, 1934). The medicinal applications of *M. fusca* were quite varied, ranging from use for skin troubles to treatment of many internal ailments. The Makah considered crabapples to be 'a complete medicine all in itself' (Gill, 1983). One interesting use reported was that eating the fruit 'killed poison in the muscles after long hours of hunting' (Compton, 1993: p. 266). Crabapple bark was noted as being used to make "you hungry when you are sick" and also that Elsie Claxton would use crabapple bark as one of the ingredients in her "10-barks" medicine (Turner and Hebda, 1990; pg. 64 and Turner and Hebda, 2012, pg. 74).

[4] Compton, 1993; Deur, 2008; Gill 1983; Gunther, 1973; Johnson, 1997; Smith, 1929; Turner 1973; Turner, 2004; Turner and Bell, 1971; Turner and Timmers, 1972; Turner *et al.*, 1983; Turner *et al.*, 1990

Table 1.3. Medicinal uses of Pacific crabapple as mentioned in literature sources.

Use or ailment treated	Indigenous groups	Plant part used	Preparation	References
blood purifier (said to reduce clots)	Makah	Bark	Decoction/tea	Gill, 1983;
	Quinault	Bark	Decoction/tea	Gunther, 1973
consumption (tuberculosis)	Gitxsan	Bark (inside)	Decoction/tea	Smith, 1929;
	Kwakwak'wakw	Tree	Cedar bark placed in crack in tree – spiritual use	Turner and Bell, 1973;
	Makah	Bark	Decoction/tea	Gill, 1983
coughs	Gitxsan,	Branches, stems or bark scrapings	Decoction/tea	Johnson, 1997;
	Nuu-chah-nulth	Bark	Decoction	Turner et al., 1983
cure-all	Halkomelem (Cowichan)	Bark	Decoction/tea	Turner and Bell, 1971
	Saanich	Bark	Decoction/tea	Turner and Bell, 1971; Turner and Hebda 2012;
diarrhoea	Makah	Bark	Decoction/tea	Gunther, 1973
dysentery	Makah	Bark	Decoction/tea	Gunther, 1973
eyewash	Gitxsan,	Peeled trunk	Juice	Johnson, 1997; Smith, 1929;
	Klallam,	Bark	Infusion	Gunther, 1973
	Nisga'a	Bark (peeled trunk)	Juice	Burton, 2012
	Nuxalk,	Bark and roots	Unknown	Smith, 1929; Turner, 1973
	Quinault	Bark	Infusion	Gunther, 1973

	Squamish	Bark	Decoction	Turner and Timmers, 1972
fractures	Makah	Bark	Decoction/tea	Gill, 1983
gonorrhea	Hoh	Bark (roots, also limbs and stem)	Tea	Reagan, 1934
	Quileute	Bark (roots, also limbs and stem)	Tea	Reagan, 1934
hunters chew to suppress thirst	Ooweekeno	Bark	Chewed	Compton, 1993
kills poison in muscles	Haisla	Fruit	Eating	Compton, 1993
	Hanaksiala	Fruit	Eating	Compton, 1993
laxative	Gitxsan	Bark	Decoction/tea	Smith, 1929
	Nisga'a	Bark (inner)	Decoction	Burton, 2012
	Makah	Bark from larger trees	Peeled and used	Gill, 1983
lung troubles	Makah	Leaves	Soaked in water and chewed	Gunther, 1973; Turner et al., 1983
	Quileute	Bark	tea	Gunther, 1973
physic and diuretic	Gitxsan	Bark	Decoction/tea	Johnson, 1997; Smith 1929
	Nisga'a	Bark (inner)	Decoction	Burton, 2012
respiratory problems	Nisga'a (TB)	Bark (inner)	Decoction	Burton, 2012
	Witsuwit'en	Bark	Unknown	Gottesfeld, 1994
rheumatism	Gitxsan	Bark	Decoction/tea	Johnson, 1997; Smith, 1929
	Nisga'a	Bark (inner)	Decoction	Burton, 2012
skin troubles (including sciatica, eczema)	Kwakwak'wakw	Tree	Person wiped with cloths, placed in cracks	Turner and Bell, 1973;
	Nlaka'pamux	Bark	Decoction/tea	Turner et al., 1990
stomach and	Makah	Bark	Decoction/tea	Gill, 1983; Gunther, 1973

intestinal disorders (including kidneys)	Saanich	Bark	Infusion/tea	Turner and Hebda, 1990; Turner and Hebda, 2012
	Samish	Bark	Decoction/tea	Gunther, 1973
	Swinomish	Bark	Decoction/tea	Gunther, 1973
tonic	Gitxsan	Bark	Decoction/tea	Johnson, 1997;
	Nisga'a (to fatten sick or weak people)	Bark (inner)	Decoction	Burton, 2012
	Makah	Bark	Decoction/tea	Gill, 1983; Turner et al., 1983
	Nitinaht (for young men in training)	Bark and roots	Decoction/tea	Gill, 1983
undetermined use	Haida,	Bark	Unknown	Turner, 2004;
	Hoh	Bark (roots, also limbs and stem)	Tea	Reagan, 1934
	Nehalem,	Bark	Unknown	Deur, 2008
	Nitinaht,	Bark	Infusion/tea	Turner et al., 1983
	Quileute	Bark (roots, also limbs and stem)	Tea	Reagan, 1934
washing out cuts and wounds	Makah	Bark	Chewed and placed on wound	Gunther, 1973
	Samish	Bark	Decoction/wash	Gunther, 1973
	Swinomish	Bark	Decoction/wash	Gunther, 1973
washing sores, boils and bleeding piles	Makah	Bark	Decoction/tea	Gill, 1983; Turner et al., 1983

There was also mention of the entire tree being used for "medicine," but as more of a spiritual use. Cloths with either spit-up blood or having been wiped on eczema or skin troubles were placed in a crack in the tree and sealed up, which was then said to make the disease disappear (Turner and Bell, 1973). Other spiritual uses for the trees were both the Haisla and Hanaksiala people believing that if they tied a child's afterbirth to a young crabapple tree, that child would grow up to be strong (Compton, 1993) and the Haida people believing that if 'a girl at puberty or a woman in mourning was rubbed with soft cedar bark, which was then wedged into the cleft of a crabapple tree, it would make her strong and enduring' (Turner, 2004); or if she was washed with water with crabapple bark steeped in it (Swanton, 1905).

1.6.2.4 Crabapples in Indigenous Narratives

Pacific crabapple is mentioned in the narratives of at least nine indigenous groups, the Haida, Hanaksiala, Kwakwak'wakw, Nlaka'pamux, Nuxalk, Ooweekeno, Squamish, Stl'atl'imx and several Tsimshianic peoples that were not differentiated[5] (Table 1.4). Turner (1995) also states that crabapples are "the most frequently mentioned fruit in Coast Tsimshian mythology." The Stl'atl'imx people believed that crabapples were "a kind of magic plant" (Turner *et al.*, 1987), although no further clarification is given, and they are mentioned in the story "The Woman in the Canoe" (Turner *et al.*, 1987). The Hanaksiala people have the story "The Girl who Married a Frog", where it was 'one of

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[5] Boas, 1902; Bouchard and Kennedy, 2002; Compton, 1993; Cove and MacDonald, 1987a; Cove and MacDonald, 1987b; McIlwraith, 1948; Seguin, 1984; Teit, 1912; Turner, 2004; Turner and Bell, 1973; Turner, *et al.*, 1987

several fruits collected for the frog village' to pay them for their help in attacking an enemy village (Compton, 1993, from Olson, 1940); the Kwakwak'wakw have a story that a group of people, escaping raiders, threw a comb behind them and it grew into a thicket of crabapple trees (Turner and Bell, 1973); the Nlaka'pamux people have a story that has several people going to pick crabapples throughout the narrative (Teit, 1912). A Squamish story includes Seal's daughter going to pick crabapples before Raven kills her (Bouchard and Kennedy, 2002); the Tsimshianic peoples have a number of stories that incorporate picking crabapples, eating them with grease, or gambling with crabapple sticks, and in one story a pregnant girl names one of her children after a wedge of crabapple wood that she finds (Boas, 1902; Cove and MacDonald, 1987a; Cove and MacDonald, 1987b). Boas (1902) also mentioned that Txa'msEm camped at a place with a crabapple tree, called "Graveyard Point". The Nuxalk have a number of stories that feature crabapples – several stories about gambling with crabapple sticks, a story about a feast that presents imitations of different foods (including crabapples) for the guests to guess, which they will then be lucky in harvesting the next season, and at least two stories that involve the participants in the story picking crabapples at some juncture (McIlwraith, 1948). The Haida tell a story of Butterfly getting to eat a dish of crabapples and grease by tricking Raven into telling the chief's wife that he didn't know how to eat them (Turner, 2004, from Swanton, 1908). The Haida believed that crabapple trees used to be humans in ancient times (Turner, 2004, Dawson 1880). Similar to the Haida, the Kwakwak'wakw believed that the 'crabapples of the mythical animal spirits were really human eyes' (Turner and Bell, 1973).

Table 1.4. List of mythologies and stories found in the literature.

People	Story premise (sometimes story name)	Reference
Coast Tsimshian	Picking crabapples (numerous stories)	Cove and MacDonald, 1987a and 1987b
Coast Tsimshian	gambling with crabapple sticks (numerous stories)	Cove and MacDonald, 1987a and 1987b
Coast Tsimshian	"Most frequently mentioned fruit"	Turner, 1995
Coast Tsimshian	Mixed with grease and eaten by chief, gift/dowry, "She-who-has-the-labret-on-one-side"	Boas, 1902 (pgs. 188-199)
Coast Tsimshian	Pregnant girl finds a wedge of crabapple wood, names one of her children 'Little-crab-apple-tree'; "Rotten Feathers"	Boas, 1902 (pgs. 90-101)
Coast Tsimshian	Camping place for Txa'msEm (Raven), 'little crabapple tree' or 'Graveyard point'	Boas, 1902 (pgs. 17, 34)
Coast Tsimshian	Eaten with grease, "The Grizzly Bear"	Boas, 1902 (pgs. 200-210)
Coast Tsimshian	Txa'msEm (Raven) ate crabapples in grease	Boas, 1902 (pgs. 39-40)
Coast Tsimshian	Crabapples provided in feast between villages	Seguin, 1984
Haida	Trees were human beings in ancient times	Turner, 2004 (from Dawson 1880)
Haida	Eaten with highbush cranberries and soapberries as food for supernatural beings	Turner, 2004 (from Swanton, 1908)
Haida	Crabapples and grease eaten	Turner, 2004 (from Swanton, 1908)
Hanaksiala	One of several fruits collected for payment, "The Girl who Married a Frog"	Compton, 1993, from Olson, 1940
Kwakwak'wakw	Comb turned into crabapple thicket, escape	Turner and Bell, 1973 (from Boas, 1910)
Kwakwak'wakw	Crabapples of the mythical animal spirits actually human eyes	Turner and Bell, 1973 (from Boas, 1935)
Nlaka'pamux	Picking crabapples, "Fisher's Wife; or Marten and Fisher"	Teit, 1912 (pgs. 236-241)
Nuxalk	Gambling with crabapple sticks (described, 54 smoothed sticks, called	McIlwraith, 1948

	xwosan-i), “The Gambler’s Success”, “The Man who married Wolf”	
Nuxalk	One of many foods at a feast, participants guess right, and good luck for next year harvesting	McIlwraith, 1948
Nuxalk	Kitkatla chief that owned some crabapple trees at Kitlope, sent wife to pick “The Wife who was Sold as a Slave”	McIlwraith, 1948
Nuxalk	Picking crabapples, “Raven and QtaisEtł”	McIlwraith, 1948
Ooweekeno	Fruit eaten in story, mixed with water and human eyes, “Me’maotlEme”	Compton, 1993 (from Boas 1895 – pg 458-459)
Squamish	Seal’s daughter picked crabapples, climbed really high, Raven shook her down and she died and Raven ate her, “Raven”	Bouchard and Kennedy, 2002 (from Boas 1895)
Stl’atl’imx	A magic plant	Turner *et al*., 1987 (from Turner and Bouchard, 1974)
Stl’atl’imx	“The Woman in the Canoe”	Turner *et al*., 1987 (from Bouchard, pers. comm.)

1.6.3 Ownership of crabapples

Crabapple trees, both individually and in groups, are recorded in the literature as being owned, usually by a single family or clan, in a number of Indigenous groups These groups are – but are surely not limited to – the Haisla/Hanaksiala (Compton, 1993; McIlwraith 1948:1-133; Turner *et al*. 2005), the Kwakwa̱ka̱'wakw (Turner and Peacock, 2005; Turner *et al*. 2005) and the Tsimshian (including the Gitga'at) (Downs, 2006; McDonald, 2005; Turner and Peacock, 2005). These ownership rights were expressed through marking the trees, often with pegs placed around the area (Turner and Peacock, 2005; Turner et al. 2005) and passed down to future generations through an appropriate inheritance line (McDonald, 2003; McDonald, 2005; Turner and Peacock, 2005). The concept of ownership relates back to management at a broader scale, as it creates additional incentives for people to manage and take care of important resources, such as crabapples. If a person or group is responsible for a resource area, and they are using this area to feed or clothe themselves, they will want to take care of the region so that it will provide for them. Conversely, an area or resource into which time and energy have been invested to increase production is more likely to have the rights to the foods or other resources produced claimed or "owned" by those who undertook the work (Turner et al. 2005).

Expressions of ownership can also be seen through some crabapple "gardens" belonging to the Tsimshian even having unique, specific names that only referred to crabapples in that location (McDonald, 2005). I also found references to geographical places being named after crabapples, for both English and Indigenous place names.

Compton (1993) reported a Kitasoo place name which references crabapple trees in the word, and Johnson (1997) has the name for a flat near the village of Galdo'o (Gitxsan) listed as being called '***Milkst***', the name for crabapple fruits in the local language. For another example, one of the herbarium specimens I referenced in the biogeographical review was collected at a place called 'Crabapple Lake", near Sooke, BC.

1.6.4 Management of crabapples

Specific references in the literature I uncovered refer to the Tsimshian (including the Gitga'at), the Kwakwaka'wakw and the Haisla/Hanaksiala practicing management techniques, although they are probably not limited to these groups. Management strategies on crabapple trees and patches include weeding (Compton, 1993; Turner and Peacock, 2005), pruning (Davis *et al*., 1995; Downs, 2006; McDonald, 2005; Turner and Peacock, 2005) and, it is highly suspected, transplanting (Downs, 2006; McDonald, 2005). Weeding was done around the base of the trees to limit competing vegetation and allow the crabapple to absorb more nutrients. Pruning was done in two ways. First, the trees were pruned to strip away old spent branches and to stimulate new growth. "Old people would cut the branches from the top…this would ensure that there were lots next year…just cut the ones that had lots of fruit, not all of them" (Davis *et al*., 1995: 29; Turner and Peacock, 2005). In addition the tops were pruned when the tree was getting too large to be picked effectively. In these cases I reviewed from the literature, the trees would 'topped' by either removing the top of the tree to make it shorter, or by partially cutting through the leader so that the top of the tree was bent over but stayed alive (McDonald, 2005).

It can be seen from the above accounts of both management and ownership that pre-contact practices are often extrapolated from current elders' knowledge, which was also the case in my study. According to Deur and Turner (2005), early records on the coast often omit references to any manipulation of resources by Indigenous Peoples, either because they were not noticed or perhaps because their significance was not appreciated. However, for several years now, researchers in ethnobotany and ethnoecology are realizing that the evidence of many cultural practices are engrained on both people's worldviews and the landscape, as I also demonstrate later in this thesis, and that biases in how explorers and settlers viewed the landscape and people in the Pacific Northwest account for the erroneous assumption that people did not cultivate in the region (Lepofsky 2009).

1.6.5 Translocation of crabapples

One way possible translocation can be looked at is by examining the expected range of a species (as defined by plant geographers) and other features of its habitat, and determining if the population you are studying fits an expected pattern or not. Black (1994) extensively explored how botanical traits can be associated with the translocation of plants by people. She defined these traits as: plants growing in an atypical habitat or habit, with an unexpected assemblage of associated plant species, in an unusually high density, or close to prehistoric or historic sites of human habitation. Along with these factors, she also emphasized populations that would probably not have arrived at their current location via natural dispersal techniques. Traits evidenced by plants that have been translocated by people (Black, 1994) can be applied quite well to the biogeographical range and characteristics of some *M. fusca* populations, as populations that occur inland from their expected range could represent sites possibly influenced by trade and plant translocation. It makes sense that if a vitally important resource such as crabapples were not common in a group's territory, or in a particular region of the territory, people would want to concentrate this valuable resource around a prime camp, versus camping near the crabapples. Crabapples may not be growing in a sheltered location, or other resources might not be plentiful near the crabapples, so creating a concentration of resources near a camp, either through trade or local transplanting, would make harvesting easier.

Taking the biogeographical information about the habitat and extent of Pacific crabapple populations, and the information from the ethnobotanical literature about isolated populations of crabapple, there are several examples that I, and others, conclude are cases of crabapple transplantation. Such transplantation has also been suspected because many ethnoecologists and anthropologists have linked the presence of several species, including crabapples with evidence of now-abandoned communities (McDonald, 2005). McDonald (2005) was told that, "wherever the [Tsimshian] old people camped, there were crabapples" (pg 250). Moss (2005) observed crabapples trees growing in close proximity to fish camps of the Tlingit. For a documented case of reported transplantation, Burton (2012) noted that when Nisga'a people moved to a new village site, they would bring saplings with them from the old location. They did this to provide themselves with an important resource, and to measure the time spent in a new area, "based on how much it had grown" (Burton, 2012).

Several specific examples of Pacific crabapples occurring outside its typical habitat in northern British Columbia have been identified. In Spuzzum, BC, Annie York

(Nlaka'pamux) was quoted as having "one large tree growing in her garden, but she said this was planted" (Turner *et al*., 1990) and Johnson (1997) noticed that crabapples were found "far inland of their usual coastal range, up the Skeena and Kispiox Valleys" (p. 103), into the territory of the Gitxsan. Also, Downs (2006) and McDonald (2003) report crabapples markedly growing outside their typical range at the historic village site of Robin Town, Kitsumkalum River (***Dałk Gyilakyaw***) near Terrace, BC, in Tsimshian territory. As was seen above, the label information from several herbarium specimens of crabapple mentioned that the specimen had been collected near an old village site.

1.6.6 Crabapple orchards

In addition to practicing the translocation of crabapple plants a long distance from its original habitat, there is also evidence that people have increased the density of crabapple trees in areas where it already occurs, potentially either by moving in additional trees, or leaving fruit behind while harvesting. Crabapple trees that occur in this clustered density growth pattern are often referred to 'orchards'.

Downs' (2006) concentrated his Masters thesis work in the Kitsumkalum area, particularly the Kalum Canyon and the abandoned village of Robin Town, looking at physical markers of the Tsimshian people's cultivation on the landscape (Figures 1.5 and 1.6). At Robin Town, not only do crabapple trees occur outside of their typical range, but they also have a higher density per unit area, and an appearance of order to each tree's location within the entire crabapple orchard. Downs (2006: p. 38) noted when he entered the area it "opens into what can only be described as a crabapple orchard."

Figure 1.5. The orchard at Robin Town, showing that despite not being tended for many years and overgrown with moss and dead branches, there is still a feeling of order amidst the chaos. (Source: Robin Town, Living Landscapes, Royal BC Museum, Jim McDonald, used with permission).

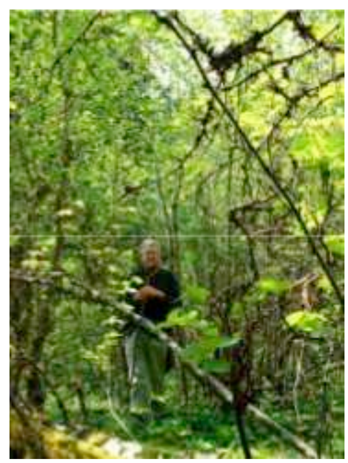

Figure 1.6. The orchard at Robin Town, showing the openness of the area, and the way the trees appear to be in rows. It can also be seen that crabapples are not in their usual habitat (Source: Downs, 2006, used with permission).

From these figures it can be seen that the concentration of trees (you can also see some hazelnut trees (*Corylus cornuta*) mixed in) is not only quite high, but is also ordered and well-spaced. In addition to the diagnostic features of being located next to a historic village site and a higher concentration of trees per unit area, these trees are also associated with a unique assemblages of species (Downs, 2006), all traits of translocation (Black, 1994). The second example is from Haida Gwaii (Figure 1.7), where Turner (2004) documented some locations that illustrate the density and spacing characteristics I described above.

Figure 1.7. A crabapple orchard at Cumshewa, on Haida Gwaii. The area is lacking in undergrowth because of severe deer browsing, but the size of the trees can be observed, as well as the ordered appearance (Source: Turner, 2004: P. 56).

1.6.7 Harvesting timing and protocols for crabapples

Harvesting time and protocols for crabapples and other fruits were often overseen by clan chiefs (Turner and Peacock, 2005), as seen in Olson's (1940) description of Haisla crabapple harvesting: "It is customary however at crabapple time for the ranking chief to test the berries and to give the word when they are ripe enough. No one may gather them before this." Areas with crabapples were often called 'crabapple gardens,' which is indicative of their managed state and importance to the people using them, as seen with Haisla/Hanaksiala accounts (Compton, 1993; Olson, 1940; Turner and Peacock, 2005). Harvesting of crabapples for the Haisla/Hanaksiala could only commence after the clan chief deemed they were ripe (Olson, 1940; Turner and Peacock, 2005), similar to many other foods for numerous group, as was seen anecdotally when conducting this literature review. Ownership privileges of many resources would be confirmed at potlatches and feasts, which not only made sure that everyone was aware of ownership rights, but also renewed the people's connection to their land (Turner and Peacock, 2005). Because people knew that they owned certain resources, they knew it was their duty to take care of them, and they took pride in this. One of McDonald's (2005) interviewees (Lucy Hayward, Tsimshian) described all the lands owned by a family (the *laxyuup*) as a "storage box of food". If you didn't take care to store your food well, then your box would be empty and you would starve.

1.6.8 Trade of crabapples

There were several references to the role of crabapple in trade in the literature reviewed. Crabapple fruits as a trade item were considered quite valuable for the Kwakwak'wakw (Turner and Bell, 1973: p. 290) and other northern groups (Turner, 1995: p. 118), and one box could be worth as much as "10 pairs of Hudson's Bay blankets", about $10 (Turner and Bell, 1973: p. 290). One dowry was described as including "10 boxes of crabapples and five boxes of oil to put on them" (Turner and Bell, 1973: p. 290). Burton (2012) reported that crabapples were an important trade and gift item for the Nisga'a and neighbouring groups. Not only was there trade between neighbouring groups, there was also a whole network of trade trails from coastal to interior BC called the 'grease trails' (Turner and Loewen, 1998), because the trade of eulachon grease was an important commodity along them, although this was by no means the only product traded.

Considering the close association between crabapples and grease for several coastal groups as seen earlier in this literature review, the grease trails would have provided a pathway for trading not only crabapples as food, but also, potentially, transplanting crabapple trees to the anomalous areas reported earlier in this literature review (Turner and Loewen, 1998). Also supporting these ideas of crabapple trade along the grease trails is that the uses documented for crabapples were quite consistent throughout its biogeographical range, such as the spread of groups that ate crabapples with grease, from the Haida (Kaigani) to the Nehalem (Tillamook) (Compton, 1993; Deur 2008; Johnson, 1997; Norton, 1981; Nuxalk Nation, 1985; Smith, 1997; Turner, 1995; Turner, 2004; Turner and Bell, 1971; Turner and Bell, 1973; Turner and Thompson, 2006; Turner *et. al*, 1990). Because of the consistent use despite the geographic location of the Indigenous group, it is likely that ethnoecological knowledge would have been traveled along these routes with these valuable resources as well.

Chapter 2: The ethnoecology of *moolks* (Pacific crabapple, *Malus fusca*) by the Gitga'at people in Hartley Bay, British Columbia

"We used to have fun, see who was going to pick the most…climbing up the ***moolks*** trees" – Elizabeth Dundas

2.1 Introduction

Pacific crabapples (*Malus fusca*, (Raf.) C.K. Schneid.), as shown with my literature review in the first chapter of this thesis, have been an important resource for Indigenous Peoples throughout the coastal regions of western North America where this species occurs. The fruit was widely eaten (Turner, 1995; Turner and Thompson, 2006) and was historically an important trade item (Turner, 1995; Turner, 2004; Turner and Bell, 1973). The hard wood was used for making tools and implements (Turner, 2007) and the bark (and sometimes leaves and root bark) was an important medicine (Gunther, 1973; Turner and Hebda, 1990). Throughout the rest of this chapter I will often refer to Pacific crabapple as ***moolks***[6], its name in ***Sm'algya̲x***, the language traditionally spoken by several Coast Tsimshian peoples, including the Gitga'at.

As stated in chapter 1, ***moolks*** can be considered a "cultural keystone species" for the Gitga'at. Historically, crabapples were not only widely used and traded, but there are suggested and documented cases of anthropogenic translocation reflected in crabapple trees growing in atypical habitats and outlying locations (Burton, 2012; Downs, 2006; Johnson, 1997; Turner *et al*., 1990), and of people managing crabapple 'orchards'

[6] Occasionally I will also refer to the fruit of the ***moolks*** as berries, particularly in quotations, as this is a colloquial term the interviewees often used. While the elders often called ***moolks*** fruits 'berries', botanically they are not morphologically similar to fruit types commonly considered berries, such as blackberries (*Rubus* spp.) or blueberries (*Vaccinium* spp). Botanically, apple fruits are considered to be a pome.

(Downs, 2006; Turner, 2004). Furthermore, several Indigenous groups, including the Gitga'at, recognize different named varieties of crabapple, based mainly on the characteristics of their fruit (Compton, 1993; Turner and Thompson, 2004). While the number of groups that recognize named varieties documented in this literature review is restricted, anecdotal evidence indicates that recognition of varieties may be more widespread then is represented in this literature review, both with regards to the number of Indigenous groups that recognize varieties, and the number of varieties that are recognized (Douglas Deur, pers. comm.; Chief Adam Dick, pers comm.; Nancy Turner, pers comm.). This was also seen Marjorie Hill's comment (from this study) that there were many ***moolks*** varieties in Gitga'at territory, but she didn't know the names for all of them.

In addition to the Gitga'at, Compton (1993) recorded that the Hanaksiala, Haisla and Kitasoo all also differentiate between a regular sour variety and a sweet-fruited variety, as well as the Haihais and Heiltsuk being aware of differences but not specifically differentiating varieties. The Haisla and Hanaksiala people commented that the sweet crabapples are distributed sparsely compared to the regular crabapples, and they only grow in areas relationally distant from the regular crabapples (such as at Kildala and the head of the Kitlope River). The Kitasoo recognized their sweet variety because the fruit was smaller than regular crabapples (Compton, 1993), a feature that the Gitga'at also recognize with the sweet variety they have. Based on Compton's (1993) linguistic analysis, the Kitasoo term for 'sweet crabapples' is ***ga səsí***, similar to the Gitga'at term, since they also speak a Tsimshianic language, and the term for the sweet crabapple for the Hanaksiala and Haisla people is ***qemq°ec***. Both of these terms are differentiated from the terms for regular crabapples. One of Compton's (1993) interviewees identified the sweet variety as being Indian Plum (*Oemleria cerasiformis*), but as this species does not grow this far north (Klinkenberg, 2010), it was likely mis-identified.

This fine level of Indigenous varietal differentiation has been noted for other species as well (Deur, 2000; Garibaldi 2009; Peroni *et al.*, 2007). Deur (2000) noted that some highly cultivated plant species on the Northwest coast appear to produce larger, sometimes sweeter fruits, and some plant populations that have had a history of intense or prolonged cultivation appear to be distinct from populations not exposed to this. As can be seen in the results of this thesis, and throughout the literature I presented earlier, when management practices and human selection cease, varietal differentiation has frequently diminished. These varieties may be disappearing either because management was allowing specific varieties to flourish (Deur, 2000), or because people do not recognize these varieties anymore due to knowledge loss. Deur (2000) suggests that some of these domesticates, or proto-domesticates, may have disappeared relatively recently after contact, and thus have not been recorded. While these ideas are largely conjecture at this point, with studies such as this one, and others, we may be able to elaborate on the possibility of species that have been culturally influenced to adopt unique varieties, by recording TEK and conducting morphological, ecological and genetic surveys.

Currently crabapples are not used as frequently as in the past in Indigenous Peoples' diets, and much of the knowledge about the different varieties that were recognized, and about harvesting, processing and serving techniques for the fruits, is disappearing, as is knowledge about the management of the trees and key locations of crabapple populations (Turner and Turner, 2008). One of the reasons I was interested in studying this species is that the different varieties recognized by some Indigenous groups, lead to a more differentiated classification scheme for this plant than is reflected in western science (Klinkenberg, 2010).

Ethnoecology is often defined as a multidisciplinary study examining the relationship of how humans interact with the environment around them, both with regards to biotic and abiotic factors (Nazarea, 1999). Here I present knowledge shared by Gitga'at elders during interviews and conversations, and from my own participation, regarding ethnoecological details about how they recognized and used different crabapple varieties, traded these fruits to other indigenous groups, tended the trees and recognized harvesting rights.

2.2 Methods

Ethnoecological and ethnobotanical studies examine the complex links between humans and their environments, creating a multidisciplinary approach that includes concepts and methods from a range of social and natural sciences (Alexiades, 1996; Martin, 1995; Nolan and Turner, 2011; Schultes and von Reis, 1995). In this particular study, I collected and analyzed my data using a mix of methods that included interviewing, participant observation, taxonomy and ecology.

2.2.1 Introduction to the community

The groundwork for this project was started several years ago. Throughout my undergraduate degree, I have visited several Indigenous communities, but in particular I spent time with the Gitga'at in Hartley Bay, and the Kwakwa̱ka̱'wakw in Kingcome Inlet, under the guidance of Drs. Nancy Turner and Doug Deur on my committee.

Through these experiences, and my reading of the literature, I realized that crabapples are an important resource for many Pacific Northwest Indigenous Peoples, and these people exhibit similar relationships to this species. This comparative perspective led me to recognize the broader question of the regional and local importance of this species.

I was originally introduced to the Gitga'at community at Hartley Bay in August of 2007, when I visited the community with my supervisor, Dr. Nancy Turner, as an undergraduate student. At the time, the community members I talked with seemed receptive to the possibility of a project documenting their knowledge of crabapples, so when I started an M.Sc. degree at the University of Victoria in September 2010, I continued to explore this research opportunity.

In January 2011, I emailed a letter to Chief Albert Clifton (***Wamoodmx***, head chief of the village, Killer Whale), Chief Ernie Hill Jr. (***Snaxe'et***, head Eagle chief) and Killer Whale matriarch Mrs. Helen Clifton with a more detailed project outline. After an appropriate time interval, I called Chief Albert Clifton and received verbal permission to proceed with the planning of this research, in particular applying for grants and completing an application for Human Subject Research Ethics approval through the University of Victoria.

2.2.2 Interviewee recruitment

In May 2011 I visited the community and was re-introduced by Nancy to matriarch Mrs. Helen Clifton and Chief Ernie Hill Jr., to discuss my planned fieldwork season for the fall of 2011. In late August 2011, I returned to Hartley Bay to become more familiar with the community and commence interviews, and stayed until the middle of December 2011. I interviewed elders and adults (aged about 60-90 years old) in the community who either currently harvested and preserved ***moolks***, or had knowledge of past experience with this fruit. This group of people not only knew about the cultural importance of ***moolks***, but also hold knowledge to varying degrees of the different varieties and techniques of management, ownership of stands, and harvesting and processing of fruit. I interviewed people who had agreed to share this knowledge, not only to be preserved in the written records, but also to convey it to the younger generations of the Gitga'at community. Mrs. Helen Clifton's guidance in the beginning of this research was extremely important. She provided suggestions of people to talk to, and helped me learn which questions to ask. This study includes information from interviews with seven Gitga'at participants, with comments from two additional people.

2.2.3 Ethics consent

As a part of my commitment to securing approval from the Human Research Ethics Board at UVic (Ethics Protocol Number 11-262), before commencing an interview, all participants were given a letter of information about the project and a consent form to sign if they had agreed to participate, outlining constraints around ongoing consent, anonymity of data, confidentiality, rights to withdraw from the study, potential risks, dissemination of results and disposal of data, which is required when learning about cultural information (Appendix 1). I obtained verbal consent from all of the elders that I interviewed to go to the harvesting locations and collect fruit, leaf and branch samples for morphological measurements and genetic profiling. Some community members and leaders raised concerns, both when I initially re-contacted the community in January 2011, and during my fieldwork in the fall of 2011, that I should not disclose the locations of particular ***moolks*** trees I might learn about in my research. Therefore, although I recorded the sites and locations of these trees on maps with the assistance of elders, I agreed not to release these maps outside the community. However copies of these maps are archived at the Hartley Bay Band Office. Specific ***moolks*** tree locations are therefore not disclosed in this thesis, and neither these locations nor even the general fall harvesting camp location are delineated here.

2.2.4 Interview process

I conducted initial interviews with Gitga'at participants between September and December of 2011, using a semi-structured interview format. Interviews were conducted in English, but all interviewees also knew the local indigenous language of ***Sm'algyax***, so could contribute words and phrases pertaining to ***moolks***. Interviews typically lasted one to two and a half hours, and occurred in the participant's home. Interview questions can be found in Appendix 2. Through responses to these questions, I learned basic ethnobotanical information about ***moolks*** (focusing on fruit use, but also on uses of other parts of the tree) specific to the Gitga'at, including how and where the ***moolks*** are collected, the timing of the harvest, processing techniques (including tools used), how each different variety was and is recognized and used and the cultural significance and linguistic terminology specific to ***moolks*** and its varieties. I also asked questions about ownership practices, translocation events, management or tending of crabapple trees, and the significance of ***moolks*** in a Gitga'at worldview.

In my first field season I was not able to take elders up to traditional crabapple harvesting locations. However, Ken Josephson, Department of Geography, UVic, created four poster-sized maps from composite images of Gitga'at territory taken from www.bing.com/maps. I asked participants to point out locations of ***moolks*** varieties and other cultural information on these maps during interviews. In my second field season, August-September 2012, I conducted follow-up interviews to capture elements or questions I had missed the first time and provide clarification on certain points. I also arranged to take one of the elders to the location where ***moolks*** were traditionally harvested, to provide on-the-ground-knowledge and insights.

2.2.5 Interview analysis

I recorded the interviews, when given permission, using a Zoom H1 recorder, and I transcribed them by listening to them with the help of ExpressScribe and typing them into a Microsoft Word document, creating a transcript record for each interview. I coded my interviews by copying my interview questions into a blank Microsoft Word document, and then, for each interview, inserting the relevant interview paragraph under the question that it answered. After using this broad sort, I continued to refine the interview paragraphs, and synthesized similar data between interviews, until I succinctly answered the interview questions with the collected data. Through this refinement, I identified themes, outliers and gaps in the interviews to address the research questions.

2.3 Results

2.3.1 Interviewee background

As noted, I interviewed seven elders, two men and five women in the Gitga'at community. I also had a casual conversation with one adult man, but did not conduct a formal interview; additionally, Lynne Hill, the wife of Ernie Hill, Jr., assisted in a group interview with him and Marjorie Hill. All but one of the participants grew up in the village of Hartley Bay (the one who didn't had married into the community). While all the elders interviewed spoke ***Sm'algyax*** as well as English, nuances of accent and words could vary depending on where one or both of their parents had originally come from. The elders mostly learned their knowledge about ***moolks*** from grandparents, aunts and uncles. Much of this knowledge about ***moolks*** had been passed down to the participants by two very influential people in the community: Lucy Clifton (***No'o***) and Heber Clifton (***Hadi'ix***), the grandparents of several of the elders and the founders of the current village site in Hartley Bay, during the early to middle twentieth century (Turner *et al*., 2012). The names of the participants who so graciously helped me in this research are Hereditary Chief Albert Clifton (***Wamoodmx***), Hereditary Chief Ernie Hill, Jr. (***Snaxe'et***), Helen Clifton, Elizabeth Dundas, Belle Eaton, Marjorie Hill, Margaret Semigool ('Goolie') Reece, Lynne Hill and Rufus Reece. I learned unique stories from everyone, and a range of details on ***moolks*** harvesting and use. Much of the knowledge I recorded was told to me by multiple interviewees and so is not attributed to certain people here, but in some cases, when only one or two people reported some detail, I have attributed it to them. This research could not have been done without the help and knowledge from every single one of the elders with whom I worked. The quotes in the tables below are from single interviewees, but the sentiments represented in each quote were often expressed by more than one person.

2.3.2 General Gitga'at Knowledge of *moolks*

All of the participants interviewed in this study knew about and used ***moolks*** as an edible fruit. In addition, Hereditary Chief Ernie Hill, Jr. had heard of a man using the tough wood of the ***moolks*** tree to substitute for a broken propeller on the engine of his boat in an emergency situation. No other uses of the wood, or medicinal uses of ***moolks*** were noted, nor did anyone share stories or legends that mentioned ***moolks***.

Overall, people recognized five distinct varieties of ***moolks*** (Table 2.1), as well as having a category for over-ripe fruits of any variety (***dickwan***). However, Marjorie Hill also noted "there's lots of different kinds up at Old Town, but I wouldn't know what to call them." The fruit of the five varieties was recognized as being different both visually and in taste, and were often used for different purposes. The physical descriptions and usage patterns of each of these varieties are further delineated later, in Section 2.3.10.

Table 2.1. *Moolks* varieties, as identified by Gitga'at interviewees. English translations from Turner and Thompson (2006).

Variety name	English translation	Brief description
1. ***Gasasii***	"long legs"	small sweet tasting crabapples with long stems on the fruit
2. ***Bu'uxs***	A word referring "to a move in the game of marbles"	larger crabapples that stay green when ripe; very sour tasting
3. Auntie Edith's or Grandma ***Dawɫ***'s ***bu'uxs***	The patch of ***bu'uxs*** belonging to a certain individual	Crabapples slightly smaller than ***bu'uxs***; sour tasting
4. ***Moolks sigawgaaw***	"crow's crabapples"	crabapples red on one side when ripe; sour tasting
5. ***Sm-moolks***	"real crabapple"	a residual category of crabapples; the most common type, not belonging to one of the other varieties, sour tasting
6. ***Dickwan***	over-ripe fruits	skin brown, flesh soft (almost liquid)

2.3.3 Location of *moolks* harvesting

Moolks are common throughout the entire Gitga'at territory, but they were mostly harvested in the estuary and river system where the Gitga'at fall harvesting camp has traditionally been located, an approximately 45-minute power boat ride away from Hartley Bay. The fact that this is a traditional ***moolks*** harvesting locale is partly due to the fact that the people would have been living there in the fall, when the ***moolks*** fruits are ripe, as they were harvesting other foods as well. Marjorie Hill also noted, however, that "they don't pick ***moolks*** around here [Hartley Bay], they [are] wild" and that the area around the fall camp has "the best ***moolks***". Due to the need to protect these harvesting locations, they will not be named in this thesis, nor will a specific map of the area be provided. A map of the Gitga'at territory in its entirety is provided in Chapter 1 (Figure 1.2). Location was an important identifying characteristic when people were determining the variety. Each variety was said to grow in different parts of the estuary and river system at the fall harvesting camp, but several of these variety-specific areas were located relatively closely to each other (i.e. within 100 m). ***Moolks*** found outside these specific harvesting locations were often classified as the ***sm-moolks*** variety, since ***sm-moolks*** refers generally to any ***moolks*** not classified as being in one of the other four varieties.

During my fieldwork at the fall harvesting camp, I observed that the ***moolks*** trees tend to have a clumped distribution (higher concentration of trees per unit area) and a somewhat ordered appearance in some locations, which is structurally different from wild populations I have encountered in my personal observations in many different geographical areas through British Columbia. Through these observations and records in the literature, areas with a history of intensive historic occupation tend to exhibit the characteristics described above. At the Gitga'at fall harvesting camp, the locations were crabapples were found clustered where also areas where the river was edged with a wide swath of grasses and sedges (Figure 2.1). While my interviewees did mention the transplantation of ***moolks*** trees, which I describe in detail below, these were isolated incidents. No description was provided as to why the trees are arranged in this growth pattern, which I refer to as 'orchards', although it could be hypothesized that this is an unintended result of management practices, such as inadvertently leaving fruit behind while harvesting. As well, while this growth pattern may reflect the natural spread of crabapples by sucker shoots, some trees are widely spaced, which indicates other (perhaps human assisted) factors may also be at play in some locations.

Figure 2.1. Two *moolks* "orchards" along the riverbanks at the fall harvesting camp, in their natural habitat, showing how the trees are grouped together, 30 August 2011.

2.3.4 Ownership of *moolks*

There were some locations where ***moolks*** could be harvested by anyone and everyone in the Gitga'at community. The entire river and estuary system of the fall camp, plus the area along Douglas Channel between the camp and present-day Hartley Bay is the traditional territory of the chief of the head clan, the ***Gispwudwada*** (Killer Whale) clan. When Hartley Bay was resettled, ***Hadi'ix*** (Heber Clifton) led this clan. The position was later held by ***Hadi'ix***'s youngest son, Johnny Clifton, ***Wahmoodmx*** (the late husband of Helen Clifton), and the current chief is Hereditary Chief Albert Clifton, Johnny and

Helen's son, who now holds the name ***Wahmoodmx***. Under traditional protocol, people of all clans could harvest throughout the whole area, but they would give some crabapples, salmon, or other harvested resources to this chief as a tribute, before harvesting for themselves in this area.

While ***moolks*** throughout the majority of the fall camp estuary and river system did not fall under the care of any particular individual, there were two specific ***moolks*** locations in this region that belonged to identified individuals, women in the generation or two earlier than that of the elders to whom I talked (mid-late 1800's). The first of these, already mentioned, are the ***moolks*** trees that belonged to Grandma ***Dawƚ***, or Auntie Edith Robinson. Edith (***Dawƚ***) Robinson (*neé* Clifton) was ***No'o*** and ***Hadi'ix's*** daughter and Johnny Clifton's sister. I was told that she was given rights to this harvesting spot from her mother-in-law. Edith was a member of the ***Laxsgiik*** (Eagle) clan, but she was married to William Robinson, who belonged to the ***Ganhada*** (Raven) clan through his mother's lineage. Edith's mother-in-law, Agnes Robinson, was married to the ***Gispwudwada*** (Killer Whale) hereditary chief, Ambrose Robinson (***Inta'wii Waap***). Edith was adopted into the ***Ganhada*** clan by her mother-in-law, through which she received the name "***'Wii Sawgm Gyemk***", and the ***moolks*** harvesting site that came with this name, plus any other associated resources, despite being born into the ***Laxsgiik*** clan through her mother (***No'o***, Lucille Clifton). Other people could not pick these ***moolks*** without express permission from Edith. Another owned patch of ***moolks*** close to Grandma's ***Dawƚ***'s patch, was a harvesting spot belonging to ***Jiis-um-gil-howly***, Flora Bates (***'Wii Hanax***, Killer Whale), wife of James Bates (***Yellam***, Eagle), but I did not learn any more details about this instance.

2.3.5 Management of *moolks*

When asked directly if they managed ***moolks*** trees to increase the quantity or quality of their fruit, several of the interviewees said no. It seems that some elders do not consider their practices to officially be "management" techniques. However, when they were asked for more details, several of the practices and guidelines they described (Table 2.2), including monitoring the trees and harvesting the fruit in a sustainable way, could be considered to constitute management strategies. These practices could be so engrained in their view of resource care that they would not consider them to be specific management practices associated with ***moolks***.

People followed several guidelines when picking ***moolks***. One of these was that you shouldn't break the branches, or cut the trees down when you were picking. I was told of one instance where someone did cut the trees down, for easier picking (supposedly in the last 20 years or so), and, it was said, they didn't grow back. Many people were not happy when this happened. Another guideline people followed was to pull out small non-***moolks*** trees and bushes that were growing around the base of the ***moolks*** trees, and generally clean up or clear the area of brush.

This reportedly reduced competition for nutrients, and possibly increased sunlight levels as well, for the ***moolks*** trees, and allowed people to spot the wild animals (particularly bears) that also love picking ***moolks***, before they approached too closely. Since women were the main harvesters of ***moolks***, they also did most of the "managing", but occasionally men would as well. Another common theme running through people's interviews was also that the ***moolks*** aren't nearly as plentiful as they used to be, which is said to be because people are not picking them anymore. It was also said that the fruit are of poorer quality than formerly, at least in the current memory of the elders to whom I talked.

Through the practice of clearing and cleaning up around the trees, people would have created a more open landscape than would likely have occurred without this human intervention. As well, when both humans and bears picked fruit, they would be pruning the trees, creating opportunities for new growth and opening up the canopy. Fruit would also likely be forgotten and left behind in the ground (or in the case of bears, deposited in their excrement) which would increase the density of crabapples trees when the seeds germinated. As I discuss in section 2.3.13 concerning the current state of the ***moolks***, it was obvious to me that the landscape had been influenced by human interference, as described, but that when I visited, the trees were looking overgrown and unhealthy (see Figure 2.12). Both the photographic evidence, and the interview quotes from the elders in Table 2.2 supports the idea that this landscape evolved in conjunction with the management practices described above, but they have fallen into disuse in recent times, which has greatly reduced the quantity and quality of ***moolks*** trees and fruit.

Almost everyone said that ***moolks*** were managed in the fall, just before people picked the fruits. Albert Clifton added to this that they would prune and clear away before they started picking in the fall, but would also go up in the early spring to care for the ***moolks***, after visiting the spring camp. As Elizabeth Dundas described with her quote in the table below, ***moolks*** trees themselves were not manipulated during phenological events such as blooming or sprouting. This made the fall season the obvious time of year to manage, coincidentally the time of the year when people were also inhabiting the area. Since management practices involve time and energy, not all trees were managed.

Elizabeth Dundas mentioned that only the special varieties in localized regions were taken care of; since the ***sm-moolks*** variety can be found everywhere, these trees would have been too numerous to practice frequent management on, especially when they occurred outside of region surrounding the fall harvesting camp.

Table 2.2. Quotes from Gitga'at elders relevant to the quality of *moolks*.

Context	Quote	Interviewee
Moolks aren't growing as well as they used to	"You're just…clipping them off, but, like I say…I think the ***moolks*** fields up there grew so well because the people were picking them all the time and it's just like any…plant, you're taking [the] shoots off, and so then it grows well".	Helen Clifton
Moolks are bad quality	"They're ***gwe'a*** [poor] looking now… cause they're not picked…because nobody picks it anymore."	Marjorie Hill
Timing of management	"You can't touch them while they're still blooming…or early in the spring…,cause they're starting to sprout"	Elizabeth Dundas

2.3.6 Transplanting *moolks*

I was told about three instances of ***moolks*** being transplanted. In the first instance, several people told me about ***gasasii*** trees being moved from where that particular variety grows at the traditional fall harvesting camp to behind 'the big house' in Hartley Bay. 'The big house' was the name for the house where ***No'o*** and ***Hadi'ix***, along with several of their adult children and their families lived. I heard differing stories about whether Herbert and Mabel Ridley (Belle Eaton's parents) or Bob and Mary Clifton moved these tree, but either way, Belle Eaton commented that they were moved down because people wanted "to see if they'll grow here…to see if they'll grow good." Several ***gasasii*** trees were planted in this location. The exact date of when these trees were brought down was not known, but Helen Clifton said that when she moved to Hartley Bay in 1942, they were already growing behind the house. In fall, 2011, I found one small tree behind the big house (Figure 2.2), which several elders identified as being of the ***gasasii*** variety based on its fruits (see Figure 2.11, Section 2.3.10). However, when I looked again in fall 2012, the tree was gone. It appears that when maintenance crews were removing invasive Himalayan knotweed (*Polygonum polystachum*) in the summer of 2012, they also took out the tree by accident.

Figure 2.2.The *gasasii* tree planted behind 'the big house' in Hartley Bay, BC, now gone, 29 November 2011.

At the same time these ***gasasii*** trees were moved down to Hartley Bay, a few other ***gasasii*** trees from this same original location were moved to a different spot within the general harvesting area, behind the smokehouses that were next to the camp houses where people lived while they were harvesting at the fall camp. The elders said that the trees aren't there anymore. It was thought they were taken out when the old smokehouse was torn down. Goolie Reece said that they moved trees to this place because they "just wanted to do it". When I was visiting the fall camp in the fall of 2012, I did not notice any ***moolks*** trees growing around the houses, which supports the elders' worry that they have been taken out.

Elizabeth Dundas described the third case of transplanting. Her father moved a few trees down from an unknown location at the fall camp to the area behind her old house in Hartley Bay (which has since burned down) because "he just wanted to see how it would be…in Hartley Bay", and Elizabeth remembered the fruit tasting sweeter from the transplanted trees. Elizabeth remembered them growing well at first; "It started to grow, but…it's dying off now". Somehow, she said, the variety appears to have changed too. She wasn't sure which variety he moved, but she thought it was ***sm-moolks***, or maybe ***gasasii***. When we went to look at trees still present in the area, she said that it seemed that the variety had changed and she thought it was either ***sm-moolks*** or ***moolks sigawaaw*** now. However, this could be due to different trees now occupying this area than were originally transplanted here.

In all of these cases, the interviewees said that the trees would have been moved in the fall, after the fall harvesting was finished.[7] All said that small ***moolks*** trees were dug up and moved to the new locations. ***Gasasii*** was the most common variety moved, most likely as it has sweet fruit, and people preferred to eat that one, particularly raw. Helen Clifton told me that there used to be a lot more ***moolks*** trees around the village of Hartley Bay, but they were chopped down as the village was developed. In addition to ***moolks*** being transplanted, several people also talked about highbush cranberries (***ɫaaya****, Viburnum edule*) and stink currants (***waakyl****, Ribes bracteosum*) being moved between various parts of the fall camp and Hartley Bay (Helen Clifton, Elizabeth Dundas).

[7] As mentioned, Elizabeth Dundas told me that you "couldn't touch them" when they are blooming, or in the spring, which would include transplanting them.

In all of the above cases, the transplanting incidents described to me were fairly isolated, involving only a few trees, and occurred fairly recently (approximately in the last 100-125 years). However, as I talk about in this chapter (particularly in sections 2.3.5 and 2.3.13), crabapple trees cluster in pockets of high stem density along the banks of the riverine and estuarine systems that are proximally located to the fall harvesting camp where the Gitga'at not only harvested ***moolks***, but also other berries and animals. When this is compared to the pattern crabapple trees grow in outside of areas with a history of management (Wyllie de Echeverria, pers. obs.), it can be seen that theoretically unmanaged trees are much more widely scattered, and have a lower stem density per unit area.

Several people suggested that ***moolks*** grew so much better at the fall camp because the soil composition is different – the areas where the sweet ***moolks*** grow are quite sandy: "I guess it likes the river…they just don't grow here [Hartley Bay]" (Marjorie Hill). Helen Clifton noted that transplanted ***moolks*** may have been in a less productive environment at Hartley Bay since where they grow near the fall harvesting camp is an extremely rich riverine/estuarine system, fertilized by rotting salmon moved around by bears, which might have enhanced their growth; "This river system, [is] what made those berries grow so good". It could be seen from the elders' comments that they believe the ***moolks*** grow quite well up at the fall camp in part due to an optimum soil composition and lots of fertilizer. However, I do not believe that this would solely count for the high density pattern. In Chapter 1, I reviewed several descriptions in the literature of crabapple growing near old (even possibly abandoned at the present time) camps (Downs, 2006; McDonald, 2005; Moss, 2005), and Burton (2012) even reported that the

Nisga'a people would bring crabapple trees with them when they moved to a new camp. I believe that the growth and density pattern we are seeing with regards to ***moolks*** on the landscape at the fall camp demonstrate the interactions between people and ***moolks*** for many generations, creating these orchard-like landscapes.

2.3.7 Timing of harvest

2.3.7.1 Season

In times past, people would usually go up to the fall harvest camp in June or July, and live there until they returned to Hartley Bay in late October or early November. According to Helen Clifton, they knew it was time to return to Hartley Bay when there was snow on the highest mountain across the channel, named '***Hali la mootk'***. During this time, ***moolks*** were usually collected between late August and mid-October, depending on seasonal variability. People told me that as they were already residing at the fall camp, fishing for salmon, they would monitor all species of berries until they were ripe and ready to pick. Some of the different ***moolks*** varieties ripened sooner or later than others, but in general the ripening timeframe for ***moolks*** is relatively short. There appeared to be considerable overlap in ripening times, and there was not total agreement on the order in which the varieties ripened, however this was probably due to external factors such as where people were harvesting, which of their elders were directing them, and inter-year seasonal variability. It is likely that ***moolks*** would have potentially been harvested at different times and in a different order depending on how the weather that year had affected the fruit ripening times. Chief Albert Clifton thought the ***gasasii*** ripened the first of any other ***moolks***, at the end of August, Elizabeth Dundas said ***sm-moolks*** were ripened "later on" compared to ***moolks sigawaaw*** and ***gasasii*** and that ***bu'uxs*** may have been collected last, at the end of September (Helen Clifton, Elizabeth Dundas), however Belle Eaton and Goolie Reece said ***gasasii*** ripened at the end of September, which would make ***gasasii*** the last variety of ***moolks*** to be harvested.

2.3.7.2 Indicators for start of harvest

There were several different ways to tell that the ***moolks*** fruits were ripe. Chief Albert Clifton noted that all the ***moolks***, including sour varieties, would become slightly sweeter when ripe. This could in part be explained by the levels of stored sugar increasing throughout the growing season as fruit ripens, also seen in other fruits (Minore and Smart, 1975). Almost everyone also mentioned that most of the varieties would change colour as the fruit ripened, to varying degrees. Depending on the variety, the fruits would have a red-yellowish tinge to them, with even the green ***bu'uxs*** becoming more yellowish. In addition, several elders commented that ripeness was indicated through the colour of the seeds, as they would change from white to brown with maturity.

The condition of the fruit itself was the only indicator of ripeness. Since people were already at the fall camp, they would be monitoring the ***moolks*** visually, but they would stay busy harvesting other resources in their seasonal round (Section 2.3.7.5).

2.3.7.3 Level of ripeness preferred for harvesting

The ***moolks*** fruit were picked when they were almost ripe, "…because it doesn't take long for them to turn [become over-ripe, or ***dickwan***] when it starts to rain" (Helen Clifton). ***Moolks*** fruits could be a bit harder and not fully ripe when they were picked because they would soften during the cooking process. Sometimes, however, people would allow some fruits to become very soft, dark brown and over-ripe, either on or off the trees, a stage called ***dickwan*** (described in section 2.3.10).

2.3.7.4 Rules about picking

The interviewees noted several general rules around picking ***moolks***, although these were more similar to guidelines than firm rules (Table 2.3). For example, pregnant women wouldn't be allowed to pick because they might fall and hurt themselves. Another general rule was that the harvest would be shared with people who were not able to harvest anymore, such as some of the elders. In many of the interviews, it was mentioned that in the early days, the timing of when people would move to different areas throughout the seasonal round was organized by ***No'o*** and ***Hadi'ix***. They would coordinate the rest of the village as they moved around, as they were responsible for providing for the village. ***Hadi'ix*** would organize the transportation and ***No'o*** would tell everyone when it was time to move. Another rule was that since not everyone owned a canoe, if you were invited to join someone else's canoe, such as ***Hadi'ix***'s, you would give them some portion of your harvest in exchange for food and transportation (Chief Ernie Hill, Jr.). As well, if you contributed to someone's harvest beyond this, they would give a feast, or honour you with a gift (Turner *et al.*, 2012).

Although the ***Gispwudwada*** clan did not own individual ***moolks*** trees, because they were responsible for the entire area, all the people would pick for the ***Gispwudwada*** clan first when they were harvesting food at the fall camp. In return, ***No'o***, as the head ***Gispwudwada*** chief's wife and ***Laxsgiik*** Matriarch, customarily gave a big feast in the fall "to feed all the people." Thus, everyone would help contribute towards this feast with their first harvest of the year for ***moolks*** and many other foods (Turner *et al.*, 2012). All interviewees described this tradition:

> If the chief, or the chief lady had planned to have a fall feast, then the women would go and pick the ***moolks***…for the chief lady…for the amount that she required, because she's gonna use that for her dessert…So then as soon as she has enough, then the ***moolks*** are free to anybody to pick (Helen Clifton)

Table 2.3. Quotes in context for harvesting rules

Context	Quote	Interviewee
Pregnant women don't pick ***moolks***	"I guess sort of a known fact, pregnant women don't go…and pick…the ***moolks***, you can work on them when they bring them back."	Helen Clifton
Share resources with those not able to harvest anymore	"They all worked together…and the sharing, there was no, sort of individual… you know… I got this, this is for me…[we] shared with elders that weren't physically fit. Our people say that it is returned to you"	Helen Clifton
Hadi'ix provided transportation	"He's the only one that had the big boat, and all the other people just had little canoes. When he's gonna go to ***Kiel*** [spring harvest camp], then the whole, he tows the whole bunch back"	Marjorie Hill
No'o plans seasonal movement	"Whatever ***No'o*** does, the whole village does it, as long as she doesn't move, nobody goes…So the whole village will have their share"	Marjorie Hill

2.3.7.5 Other resources harvested at the same time

The region around the fall camp produces a plethora of resources used by the Gitga'at people. Harvesting ***moolks*** was part of the seasonal round, along with other fruits (Table 2.4) and species of fish, mammals, birds and marine invertebrates (Table 2.5). The ripening and hunting/harvesting times of all these species would fit together, and people would move seamlessly between resources. As Helen Clifton said:

> Berry picking is just part of doing the salmon. Yeah, there'd be salmon, they're doing coho and hump [humpies]… when the fishing's sort of over, the fishing is at a certain part [they have enough, and the berries are ripe], then it's time to… go for those berries…. And it just fits… into what they're doing there.

Table 2.4. Plant resources collected at the fall harvesting camp, in approximate order of ripening.

Sm'algyax name	English name	Latin binomial
mak'ooxs	Salmonberry	*Rubus spectabilis*
miháał	dwarf mountain blueberry	*Vaccinium caespitosum*
xwooksil	Oval-leaved blueberry	*Vaccinium ovalifolium*
smmaay	Alaska blueberry	*Vaccinium alaskaense*
k'apk'oop	Canadian bunchberry	*Cornus unalaschensis*
dzawes	salal	*Gaultheria shallon*
dahdee	bog cranberry	*Vaccinium oxycoccos*
waakyil	gray stink currant	*Ribes bracteosum*
łaaya	highbush-cranberry	*Viburnum edule*

Helen Clifton noted that salmonberries ripen in different locations throughout the Gitga'at territory at different times. The salmonberries at the fall harvesting camp were a late ripening variety generally harvested between the end of July and the middle of September. Chief Albert Clifton mentioned that "huckleberries" (probably including red huckleberry, *Vaccinium parvifolium* and blueberries, *Vaccinium* spp.) were harvested at the camp as well[8].

[8] Since the term 'huckleberries' is used colloquially to refer to both ***maay*** (black mountain huckleberry, *Vaccinium membranaceum*) or ***wüłeéxs*** (red huckleberry, *Vaccinium parvifolium*) it was unclear to me which species is present, but due to a higher prevalence of ***wüłeéxs*** in the region (Turner and Thompson, 2006), I hypothesize he is talking about this species.

Table 2.5. List of fish, mammal, bird and marine invertebrate species, gathered at the fall harvesting camp. Salmon species are listed in approximate order of harvesting.

Sm'algyax name	English name	Latin binomial
stmoon	Pink (humpback) salmon	*Oncorhynchus gorbuscha*
gyi'iɫ	Sockeye (red) salmon	*Oncorhynchus nerka*
wüüx	Coho (silver) salmon	*Oncorhynchus kisutch*
gayniis	Chum (dog) salmon	*Oncorhynchus keta*
nanaat or ***ɫgümiik***	Ducks (either mallard or sawbill)	*Anas platyrhynchos* or *Mergus* sp.
ha'ax or ***ɫii'wn***	Geese (either Canada or Snow)	*Branta canadensis* or *Chen caerulescens*
gaboox	Cockles	*Clinocardium nuttallii*
wan	Blacktailed deer	*Odocoileus hemionus*
o'ol	Black bear	*Ursus americanus*
mati	Goat	*Oreamnos americanus*
sts'ool	Beaver	*Castor canadensis*
awta	Porcupine	*Erethizon dorsatum*
ɫioon	Moose	*Alces alces*

Chief Albert Clifton and Goolie Reece both said that moose have appeared in the area only more recently. Clams were also dug towards the end of the fall, but they were not found near the harvesting camp: they were dug closer to Hartley Bay after people left the fall camp, in middle to late November. A condensed version of the Gitga'at yearly seasonal harvesting round can be found in Appendix 3, including how ***moolks*** and other fall resources fit in.

As well as harvesting wild foods during the late summer and fall, many of the elders referred to their grandparents having gardens either around their houses, or in nearby locations at the fall camp, often growing root vegetables such as potatoes, carrots and beets. While domesticated plants have been around since contact, such as potatoes, from information gathered in my literature review, and through interviews, I believe that ***moolks*** orchards would predate contact. Part of what leads me to believe this is that people did not specifically state that they left fruit behind, or specifically plant ***moolks*** sprouts near the already existing trees when picking to increase density. The examples of transplanting learned about in interviews all referred to moving a few trees to a new location as an experiment. Therefore, the movement and planting of ***moolks*** trees and seeds as people were harvesting to create these 'orchards' was so ingrained in their world view, that it was not specifically realized and commented upon.

2.3.8 Harvesting *moolks*

2.3.8.1 Collection

It was not considered proper etiquette to break off ***moolks*** branches, but since they are quite "strong and flexible" (Helen Clifton), it is relatively easy to either pull the branches down or climb up into the tree to pick the ***moolks*** (Helen Clifton, Elizabeth Dundas). Chief Ernie Hill Jr. described using a gaff hook from a boat to pull down branches, to bring the fruit into reach. When people picked ***moolks***, they would pick off the entire cluster of apples together, including attached leaves, which were left on the fruit bunches "if you're going to keep it for a few days" (Marjorie Hill), partly to protect them from bruising in the containers. They would then place the ***moolks*** bunches in cedarbark baskets strapped to their backs or, more recently, in burlap sacks or plastic buckets or pails. In these containers the ***moolks*** were transported to the boat, and then to the fall camp, and finally to Hartley Bay, where they were processed. ***Moolks*** could be transported more easily and needed less pre-preparation than some of the other berries because they were picked while still hard, and protected during transport by the leaves left attached to the bunches.

As noted, black bears really like ***moolks***, so people had to listen and watch carefully for bears while they were picking. Helen Clifton commented that bears look like humans when they are picking: "They're up on their hind legs and…their front paws…or they're pushing the branch down just like we do, down to the cub." To scare the bears away from the areas where people were picking, women would bang pot covers together and whistle, both before disembarking from the boats and while they were picking. Goolie Reece also mentioned that she remembers the older women commenting that the smoke from their pipes scared animals away. As a further precaution, whoever was in the boats (often men, or the older women) would usually carry a gun. People would always go to pick ***moolks*** in groups: "You never go alone when you pick ***moolks***. The whole village goes, a canoe with all the women, to pick ***moolks***" (Marjorie Hill). This was, in part, to protect each other from accidents and threats, such as bears.

All the elders talked about how they used to pick huge quantities of ***moolks***. "They used to…come home, [with] big baskets full of berries" (Elizabeth Dundas), and "***No'o*** picked lots…there's so much ***moolks*** up at Old Town" (Marjorie Hill) were common sentiments. As noted previously, people are harvesting less today both in frequency and quantity, and some people say the ***moolks*** appear to be decreasing in quality, perhaps because they are not being picked regularly. The elders also recall fond memories from the time their childhood days: "We used to have fun, see who was going to pick the most…climbing up the ***moolks*** trees" (Elizabeth Dundas).

As was stated in the timing section above (2.3.7.1), some varieties were harvested at different times, but even when different varieties were being picked at the same time, people recalled that ***No'o*** told them to keep each variety separated. Belle Eaton said that they would try to pick just one kind into each basket so that they didn't have to sort them later, since different varieties would be used for different purposes. People would pick systematically throughout the harvesting area, going to a different place each day, depending on what was ripe and when (including ***moolks*** and other fruits). Goolie Reece explained:

> They pick them [***moolks***] at a certain place one day, and the next day they go to another different place…the next day, they were up there to pick that, and they go out every day…We go up the high tide in the morning, and high tide at night, is the best place to go, the best time to go is in the morning, go up in the morning, and we stay up there all the time, the tides low, you can't get down…Sometimes we just pick certain things a day, the next day we'd go for something else…Just about the one day, they'd go out for ***moolks***, and the next day maybe for blueberries or something, but just one kind at a time…Yeah, maybe two days in a row they'd be going out for, until they get enough, then they'd go for blueberries and the same thing.

People stayed up the river for a whole tidal cycle because the higher reaches of the river can only be accessed at high tide, and the tidal fluctuations are so extreme that the water is too shallow to go down the river at low tide (Goolie Reece).

2.3.8.2 Who picks

It was mostly women who were responsible for the ***moolks*** trees. The younger women, and sometimes boys, would climb the trees and do the majority of the picking and carrying, and the elders (***No'o*** and the other women of her generation) would oversee the work, sorting the different kinds to keep them separate, and making sure everything was going smoothly (Turner *et al.*, 2012). The men would be spending more of their time salmon fishing, but they, or one of the older women (such as ***No'o***), would usually be in charge of the boats, taking the women to the different harvesting sites in the vicinity of the fall camp. Marjorie Hill mentioned that young boys would usually be responsible for running the baskets from the trees down to the boat. Each age group of women had her own role in ***moolks*** harvesting:

> So, a long time ago the women would take pots or pot covers and clang them… as they're getting off [the boat], and then somebody, a younger woman, would get off to go check around to see if there's any…bears around, somebody's watching the boat, somebody's banging lid covers… together, the noise, you just don't…go…and pick. And so sometimes older women would sit and look after the canoe, and then the younger women are the ones going up to pick the berries, and then you'd have a stronger woman that would push that branch down and hold it down while the other women are picking…so you gotta make sure the older woman in the canoe, and…you've got these…young, I guess, strong, adult women below the bush and then you've got the younger ones putting their weight on and pushing that, that loaded [branch] down… (Helen Clifton).

2.3.8.3 Containers used in harvesting ***moolks***

Because ***moolks*** fruits are relatively hard when they are picked, people could use a variety of containers for harvesting. As noted previously, today it is common to use plastic pails or buckets, or some kind of burlap or cotton flour sacks, but before the prevalence of plastic and metal containers, women used to make baskets out of strips of inner western redcedar bark. The general term for baskets is ***ts'ilaa***. Helen Clifton noted that they would use a special type of weaving to create an open mesh, and that after the baskets were made, they would "put it into a creek, fresh water, that…strengthens it, it dries back up again, it renews the whole… thing." Either animal sinew or old cloth rags would be used to make tumplines[9] or shoulder straps and the baskets could be carried easily. The exact size varied, but the baskets fell into two general size categories. The smaller ones were called ***'yuusl*** and measured approximately 15cm by 15cm, but were sometimes slightly larger. From the photo (Figure 2.3), it can be seen that this basket measures about 15cm^2 at the bottom, but flares slightly at the top. Based on this basket, with a height of approximately 25cm, the volume would be just over 5600 cm^3. These

[9] A tumpline refers to a strap which is placed across the top of the head, with both ends attached to the container it is being used to carry. This lets the weight of the container be supported by the carrier's back and spine

baskets were usually carried on a woman's front, with the straps going over her shoulders (Goolie Reece). People would pick from the ***moolks*** tree directly into the ***'yuusl*** basket, and when it was full they would empty it into a larger basket until the larger basket was full. These larger baskets were said to range in size from 30cm by 30cm to about 46cm by 30cm, to an un-remembered depth. The large basket is called a ***duuƚk***, but the term ***g<u>a</u>ltsa*** was used when a person wanted to indicate that they were carrying the large basket. Belle Eaton mentioned that for the bigger baskets they would sometimes line the inside of the basket by sewing in recycled fabric. These large baskets were either carried on the picker's back, hung from a branch, or placed on the ground, and they were the ones that were carried down to the boat:

> That's where you fill that, that little basket up, you dump it in the big one…and you'd have to be pretty strong to lift that basket up…that bigger basket off…the branch (Elizabeth Dundas).

Figure 2.3. (a) Top and (b) side views of a *'yuusl* basket from Helen Clifton's collection, 12 September 2012).

2.3.9 Preparation of *moolks*

From time to time children would enjoy climbing trees and eating the fruits straight off the tree (Goolie Reece, Rufus Reece), sometimes dipping them into small bags of sugar, but in general ***moolks*** were very rarely eaten raw with no preparation. Chief Albert Clifton said that sometimes they would eat them fresh when they were at the fall camp, but it would have only been the ***gasasii*** variety. The only time they regularly ate ***moolks*** raw was when they were at the ***dickwan*** (very soft, over-ripe) stage.

Moolks were cooked and preserved in at least five different ways (Table 2.6), and all interviewees made all types of preserves. These preservation techniques for each variety are further investigated in Section 2.3.10. If the ***moolks*** had not finished ripening between the time when they were picked and when the people returned to Hartley Bay and were ready to preserve them, sometimes the fruits were allowed to sit for a while to finish ripening (Chief Albert Clifton). After they had started to ripen, if the people had not returned to Hartley Bay yet, or if they did not have time to preserve them, they could be kept in water to halt the ripening process (Helen Clifton, Marjorie Hill). Goolie Reece noted that they would try to preserve ***moolks*** that didn't have "spots" (possibly rotten bits) on them.

Table 2.6. Preservation techniques for *moolks* fruits and the varieties used.

Preservation techniques	Description	Varieties used
1. ***Moolks*** and grease	whole fruits mixed with grease and sugar	***bu'uxs*** and Grandma ***Dawƚ***'s ***bu'uxs***
2. Thick jam	whole fruits preserved with a thick syrup to make jam	***moolks sigawgaaw*** and ***sm-moolks***, occasionally ***gasasii***, ***bu'uxs*** and ***dickwan***
3. Preserves	whole fruits preserved in a watery syrup	***gasasii***, occasionally ***moolks sigawgaaw*** and ***sm-moolks***
4. Mashed jam	fruits mashed up to make a jam	unknown, but potentially ***moolks sigawgaaw*** and ***sm-moolks***
5. Jelly	juice from boiling fruits strained to make jelly	***moolks sigawgaaw*** and ***sm-moolks***, occasionally ***dickwan***

In all of the above cases, the leaves were removed before the fruits, with stems still attached, were simmered in hot water – "steamed" – for about five minutes (Elizabeth Dundas), or just long enough so that they became soft enough to pull the stems out easily – but not so much that they would be squashed between the fingers when they were held, and until the fruits were "sort of…yellowy" (Helen Clifton) and translucent. Several people noted that, after simmering, the fruits were drained and run under cold water to cool them down quickly, an essential step to stop their continued cooking. Once the stems were removed, through a process called '***buldax***' ("when you take them off the stems", Marjorie Hill), people would continue with whichever recipe they were going to use. When I assisted Belle Eaton in making thick jam in the fall of 2011, I noticed that after this simmering and de-stemming process, the ***moolks*** smelled very lightly of applesauce. If people just wanted to keep the cooked fruit and not continue with one of the preservation techniques after removing stems, they would again cover them with water and keep them in a cool place, such as a smokehouse, changing the water periodically to keep it fresh, until they were ready to make jam, mix ***moolks*** with eulachon grease, or any of the other preparations (Belle Eaton, Goolie Reece).

During interviews, I asked about the differences between how ***moolks*** are prepared now, versus in the past. The elders found this question hard to answer, as preparation methods have been fairly similar in the living memory of the elders interviewed. Some differences include stainless steel pots and freezers being used more now instead of crocks and smokehouses, but canning techniques have been used this whole time. However, answers hinting at this question can be seen as faint threads running through this discussion. Before contact with fur traders and the Hudson's Bay Company (late 1700s-early 1800s), the Gitga'at would not have had canning jars, ceramic crocks, wooden barrels, enamel pots, stoves or sugar. According to Nancy Turner (pers. comm.), canned fish became widely available in the 1880's, so people would likely have been canning since then, first with metal cans, and then with glass jars. Helen Clifton noted that people use glass jars more now since metal cans have become more expensive. Marjorie Hill explained that before people had stoves, they would cook the fruit by dropping hot rocks from the fire into containers holding the fruit and water. These containers were most likely bentwood boxes before contact, and enamel pots after. Mixing ***moolks*** with eulachon grease was the traditional way of eating the fruit at feasts, but while all the elders I interviewed remembered ***moolks*** and grease being served at feasts, they had also been jarring ***moolks*** since they were young.

Sugar and canning methods have been around for a long time: "When jars and sugar came about, then they preserved them, made jelly and jam…from them, it was adapting to…the new ways of the day" (Helen Clifton). Today ***moolks*** are cooked in stainless steel pots and stored in glass canning jars, but before these came into use, they would have been cooked in enamelware pots. Aluminium pots are never used because the ***moolks*** are highly acidic and would dissolve some of the aluminium (Helen Clifton). ***Moolks*** were formerly stored in ceramic crocks, and sometimes wooden barrels, after steaming (Helen Clifton, Belle Eaton, Marjorie Hill Goolie Reece). Each variety of ***moolks*** would have been kept in its own separate crock (Helen Clifton, Belle Eaton). All preserving began with the above process, including removing the stems following steaming. Since the introduction of sugar (which has been available for as long as several of the elders could remember), it has also been a vital ingredient in all these recipes. None of the elders I talked to knew what had been used as additional sweeteners before sugar was introduced. Helen Clifton did not think that they would have used molasses as a sweetener, although it was apparently introduced even before refined sugar. Marjorie Hill said, "Oh, sugar, they just didn't use [any] sugar [for sweetening before refined sugar]", so I hypothesize they were likely more used to the natural sweetness of the fruits and berries around them. Also, Elizabeth commented that the jams, jellies and ***moolks*** and grease never had any other preservatives other than sugar, but sometimes people use pectin nowadays. ***Moolks*** can be kept much longer before being made into preserves now that there are freezers. For a very different kind of use, Rufus Reece told me that he had placed ***moolks*** inside a fish when baking it, also including ***maay*** (blueberries) and ***dzawes*** (salal).

2.3.9.1 Preparation Methods

Mixing ***moolks*** with grease[10] was how people generally served the fruit traditionally, and this is the way they would serve them as a dessert at feasts and other important gatherings (Turner *et al*., 2012). "They used to have it [***moolks***] in the wintertime…when they're at the feasts" (Belle Eaton). Sometimes ***moolks*** would be served in the grease by themselves and sometimes mixed with ***ɬaaya*** (highbush cranberries) and ***sm-maay*** (blueberries). Almost all the elders described this method of preservation, but Belle told me that she particularly loves it like this.

Before the ***moolks*** were added to eulachon grease, they were simmered and de-stemmed, as described above, and then they were "really cook[ed]…before you put it in the grease" (Elizabeth Dundas). After the ***moolks*** were cooked, it was important to dry out the 'belly button' of the fruit (the small indentation on the opposite side of the fruit from the stem), called the ***t'i'ik***. If moisture was left in this indentation the ***moolks*** would mold when they were in the grease. "You know when you are putting [the fruit] in whipped grease, they had to be dry, you know, the little, little [***t'i'ik*** – belly button]…you have to really dry, otherwise the mold develops there [***yeenk***, mouldy]" (Marjorie Hill). After the ***moolks***, including the ***t'i'ik***, were entirely dry, the grease would be whipped to

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[10] 'Grease' is the oil rendered from a small fish native to the waters of the Pacific Coast of North America, eulachon or candlefish (*Thaleichthys pacificus*). This fish was important as a food source for Indigenous People all along its range, and the oil, or 'grease' was an important source of fatty acids, and was widely traded between groups (Lloyd, 2011; Turner and Loewen, 1998). Eulachons are harvested, and the oil pressed out, as the fish travels up the major coastal rivers to spawn, so it was not harvested by the Gitga'at people, who did not have eulachon rivers in their territory (Turner *et al*., 2012). Every place where grease is made has a distinctive taste to its grease (Chief Ernie Hill, Jr.), probably due to different techniques in processing. The grease was formerly stored in wooden barrels or casks. Several elders agreed the they would use grease from the Nisga'a people for mixing with their ***moolks***, since it whips better, so you didn't need as much, and it has a stronger taste, as compared with the grease from Kemano and the Kitimat, in which they used to dip their dried halibut (Turner *et al*. 2012).

make it frothy. First, some water was added to it, and then the mixture was whipped by hand. Marjorie Hill demonstrated this in her interview. You have to hold your hand in a special position: flat, with the palm facing down towards the bowl, and then your fingers curved up to make the back of your hand into a concave shape. This is quite a difficult position to hold without lots of practice. The grease is whipped up with the water until it starts to become thick and foaming, and turns white. At this stage, the ***moolks***, any other berries, and sugar are added, and then whipping continues until the right consistency is reached (Hartley Bay School, 1997; Turner *et al*., 2012). Chief Ernie Hill Jr. noticed that they were having problems whipping the grease one year when they wanted to treat everyone at a feast, and the grease wasn't whipping properly. So they tried using rainwater instead of tap water and it worked much better. He surmised this was because the chemicals now found in tap water prevented the grease from whipping properly.

After the grease was whipped to satisfaction, the ***moolks*** and grease would be kept either in the pottery crocks described previously (Helen Clifton, Belle Eaton, Goolie Reece) or in wooden barrels like those in which un-whipped grease was stored (Marjorie Hill, Goolie Reece). Goolie Reece remembered the barrels sometimes being lined with cloth, old cloth flour sacks or the leaves of ***w'nax*** (skunk cabbage, *Lysichiton americanus*). These containers for ***moolks*** and grease would then be stored in a cool place, such as in a smokehouse. Sometimes the ***moolks*** would be stored in the whipped grease for a long time before it was eaten, and at other times the ***moolks*** would be added just before eating. At a feast, they would serve this delicacy as a dessert in shared bowls in the middle of the table, and would eat it with mountain goat horn spoons called ***adaweek*** (Chief Ernie Hill, Jr.). Since the women of the clan are responsible for preparing and serving at feasts, they would also be in charge of preparing the ***moolks*** and grease dishes.

The “thick jam” consists of the whole cooked fruit, including the seeds and skins, but no stems. Helen Clifton suggested that ***maay*** (blueberries) or ***dzawes*** (salal) could be added, but people also just ate straight ***moolks*** jam. Helen Clifton didn’t like “thick jam” as much as the strained preserves because you have to spit the seeds out, but it was Belle Eaton’s favourite kind of preserved ***moolks***. Her process of making it is documented in Figures 2.4-2.8, from the preliminary boiling to remove the stems (done before all preparation methods), until the jam was placed in jars. After the stems are removed, the ***moolks*** are covered with water, to about 2.5 cm above them, and the cooking pot (in this case, the soup pot was approximately 6L) brought to a ‘roiling’ boil for 20 minutes. Sugar is then added, enough to make a really thick syrup (about 1 litre of sugar for a pot of ***moolks***), and the clean jars are sealed immediately.

Figure 2.4. a) close-up photo of the *moolks* fruit before boiling, compared to b) after boiling. At this stage, the *moolks* would have been covered with water and boiled for about 5 minutes, or until soft enough to remove stems, and then run under cold water, 16 September 2011.

Figure 2.5. a) Photo of Belle Eaton removing the stems from the *moolks* fruit after they have been boiled, and run under cold water, with b) a close-up of the stringy bits that attach the stems inside the fruit, 16 September 2011.

Figure 2.6. a) fruit in the pot after the stems have been removed and b) a close-up. Belle let the *moolks* sit overnight, before completing the next step, which was to cover (plus about 2.5 cm) with water and the fruits boiled for about 20 minutes, before about 1 quart of sugar is added (17 September 2011).

Figure 2.7. a) *moolks* after the sugar was added, and b) a close-up view. The fruits are boiled for about another 20 minutes to make a really thick syrup, 17 September 2011.

Figure 2.8. a) the *moolks* after the sugar has been added and they have been boiled for the requisite amount of time. b) While the jam is still hot, it is poured into canning jars and the heat helps seal the lids, 17 September 2011.

To make ***moolks*** 'preserves' (Helen Clifton, Elizabeth Dundas, Belle Eaton, Goolie Reece), a process similar to that of preserved peaches, pears, etc. is used, where the fruit sits in a more watery syrup than when making thick jam (Figure 2.9). After destemming, the ***moolks*** are boiled for approximately 15 minutes, and then placed into jars and a hot water/sugar syrup was poured over them in the jar, "like [in] canned fruit" (Belle Eaton). The preserves are served in a little dessert dish, "just the way you'd eat preserved peaches, without it being a thick jam" (Helen Clifton). Helen further noted, "…it'd be like a fruit salad, because you could add any other wild fruit to it." For example, Elizabeth Dundas described that ***maay*** (blueberries) could be added and sometimes these two were also mixed with ***ksiiw̤***, the cambium from *Abies amabilis*, silver fir or *Tsuga heterophylla,* western hemlock (Turner *et al.*, 2012).

Figure 2.9. Preserved moolks from Helen Clifton, two different fruit sizes.

For mashed jam, the preparation method is similar to that of thick jam, but the cooked ***moolks*** are mashed up with the hands, and the pulp is left in, instead of keeping the fruit whole. After the stems are removed, the ***moolks*** are covered with water, reheated on the stove and allowed to boil for about 20 minutes. Once the fruits are soft, they are mashed up and sugar is added, in equal parts to the quantity of ***moolks***. After mashing, the fruits are then boiled again, and the mixture immediately put into clean jars while still hot; the jars seal right away, so they can be kept for a long time (Elizabeth Dundas, Rufus Reece). Boas (1921) also described crabapples being eaten mashed by the Kwakawa̲ka̲'wakw, but he said they ate it with eulachon grease after mashing.

The majority of the elders described the preparation of jelly to include cooking the fruits 'really well' after removing the stems, and then draining the resulting mixture through cloth flour sacks, sugar bags, or some other kind of mesh bag to capture the juice, which is then used to make the jelly. Both Chief Albert Clifton and Helen Clifton preferred this jelly to the other types of preserves.

Moolks in grease would have been eaten typically in the fall or winter as a dessert at large feasts. ***Moolks*** prepared through one of the canning methods (thick jam, preserved, mashed jam, jelly) would have been eaten at any time of the year, as long as the preserves lasted. Belle Eaton said that one of her sons enjoys eating thick jam so much that she has to make a large amount each fall to keep him in supply.

2.3.9.2 Tools and containers

Several types of containers were described for use in the preparation and storage of ***moolks***. 'Crocks' made of pottery, or ceramic, were about 0.5m tall with straight sides, with mouths about 0.3m wide, and with a fitted lid (Figure 2.10). Helen Clifton estimated the thickness of the ceramic to be about 1.5 cm thick on the bottom, and 1 cm thick on the sides. They were used only after contact, and came either from the Hudson's Bay Company (Helen Clifton) in the early 1800s (Gitga'at Nation, 2004) or from Father William Duncan (Marjorie Hill), a missionary in the region in the late 1800's (Gitga'at Nation, 2004). Helen Clifton said that these crocks would mostly have been used to store grease, ***moolks***, and other berries (such as highbush cranberries), and, once filled, they were kept in a cool place, such as a smokehouse. They are not used anymore, although there are still a few buried in people's basements.

Wooden barrels were also used for storing food items at least in the time of the elders memory (from the early 1900's), but are not currently used. Helen Clifton suggested the barrels, or casks were used more for holding salted meat, fish and caviar. Goolie Reece mentioned that these barrels vary in size and both she and Marjorie Hill said that “stink eggs”[11] were commonly stored in them, but ***moolks*** and grease were occasionally as well. Goolie Reece added that even when people had access to barrels, most preferred to use the ceramic crocks.

Marjorie Hill also mentioned the use of enamel pots, described as being large and grey, for storing ***moolks*** and grease, and the use of ‘metal cans’ for storing jammed ***moolks***. ***No’o*** would use the enamel pots instead of barrels, and as Marjorie Hill explained, “She [***No’o***] was happy when she got those!” The metal cans were obtained from the loggers who were felling trees at the fall harvesting camp, during the recent past (within the last hundred years).

Before the wooden barrels and ceramic crocks were introduced, most likely in the early-mid 1800’s, people would have stored ***moolks*** in pits in the ground and in cedar boxes (Helen Clifton). Currently people tend to use glass canning jars for storing the jam and jelly (Goolie Reece).

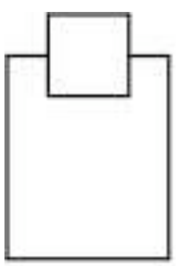


Figure 2.10. A line drawing demonstrating how the lid fits into the ceramic crock.

[11] “Stink eggs” or ***üüskm laan*** are salmon egg caviar. They are soaked in water until all the blood is leached out, and then fermented. If it is not prepared properly, very bad cases of food poisoning may result (Turner *et al*., 2012, interviewees in this research).

2.3.10 Morphology and Uses of Specific Varieties

1. ***Gasasii***

This variety was only one that the Gitga'at elders described as being small and sweet. As Helen Clifton said, it's "the one that our people would eat off the vine, it is sour, it is acidic…but it's chewable." Elizabeth Dundas said that ***gasasii*** and ***sm-moolks*** look the same: the biggest difference between them is the taste – ***gasasii*** being sweet and ***sm-moolks*** being sour. Belle Eaton said that ***gasasii*** have brown around the base, or on top (opposite the stem). Another distinguishing feature are its long stems, about as long as a person's finger, 4-5 cm. Goolie Reece told me that the name '***gasasii***' means 'legs,' referring to the stems being long like legs. Figure 2.11 shows fruit identified as being ***gasasii***. Elizabeth Dundas observed that ***gasasii*** trees like growing in sandy soil, since the harvesting location where you find it has sandy soil, and it grows well there.

Gasasii fruits were mostly either eaten raw or made into preserves, but Chief Albert Clifton and Belle Eaton mentioned that they had made jam with them occasionally. When the ***gasasii*** was eaten raw, it was either eaten directly off the tree (Chief Ernie Hill, Jr.), or stored until the fruits became ***dickwan***. Goolie Reece remembered, "They used to fill…a pillowcase full,…bring it home and…keep until Christmas." However, in general, the main method of preparation was as preserves, and this variety was the one most commonly preserved in this way, according to most of the elders. As Belle Eaton said: "You could preserve the ***gasasii***, they're good for preserving… because the ***gasasii***, they're sweet… they're really good, and they taste really good… when… you preserve them… but I've never, I think that's the only one they used to preserve… and thick jam, yeah". Chief Ernie Hill, Jr. said that you wouldn't use ***gasasii*** for feasts.

Figure 2.11. *Gasasii* fruits from the tree in Hartley Bay that was identified by several elders as being of this variety, 12 November 2011.

2. ***Bu'uxs***

The ***bu'uxs*** variety is said to have the largest fruit. The ***moolks*** were variously described as being about the size of quarters, or grapes or approximately 2 cm in diameter. Elizabeth Dundas drew an image of the size on my interview notes from memory, and it measured 1.25 cm. In general ***bu'uxs*** are ***tsook*** (which means that they stay green even when they are ripe), but both Helen Clifton and Marjorie Hill said that in some places they just turn slightly red ("kinda rust") on one side (Marjorie Hill). ***Bu'uxs*** are said to be very sour.

The most common way that ***bu'uxs*** fruits were eaten was in grease, as a dessert at feasts. Both Elizabeth and Belle said that ***bu'uxs*** was the only variety used for this purpose: "That's what they use for their dessert when there's a feast" (Belle Eaton). They were not usually eaten raw due to sourness (Helen Clifton), but sometimes they were used to make thick jam. However, this was not common, and it was thought that this only happened when people were low on grease.

3. Grandma ***Dawƚ***'s ***bu'uxs***

Grandma ***Dawƚ***'s ***bu'uxs*** were also known as "Auntie Edith's ***bu'uxs***", since Edith was ***Dawƚ***'s English name, and these trees were owned by her. Grandma ***Dawƚ***'s ***bu'uxs*** appear to be very similar to ***bu'uxs***; Belle Eaton said that they were "a part of ***bu'uxs***". Goolie Reece mentioned they were slightly smaller than ***bu'uxs***, and coloured like the regular ***moolks*** (***sm-moolks***), and Chief Albert Clifton told me that they were almost spherical. Marjorie Hill said that they also have red on one side and that "Grandma ***Dawƚ***'s got the best ***moolks***". These ***moolks*** are also said to be sour.

Most of the elders mentioned that Grandma ***Dawƚ***'s ***bu'uxs*** were also eaten in grease, so perhaps this variety was interchangeable with ***bu'uxs*** for this method of preparation. However, Goolie thought that maybe only Grandma ***Dawƚ***'s ***bu'uxs*** were served with grease: "I know they used to pick big ones, that was grandma ***Dawƚ***'s owns good for that…for mixing with grease."

4. ***Moolks sigawgaaw***

The ***moolks sigawgaaw*** variety was described as being quite small, having lots of fruit on the stem, being red on one side, and sour tasting. Marjorie Hill described them as "real pretty… those pretty little red ones". Goolie Reece said that they are similar to ***sm-moolks***, just more red. ***Moolks sigawgaaw*** were never used in the grease (Marjorie Hill) and hardly ever preserved (Belle Eaton), although it could be done "if you want to"

(Elizabeth Dundas). Overall, most elders said this variety was used for making thick jam and jelly.

5. ***Sm-moolks***

Trees that were not specifically classified as one of the above varieties were often called ***sm-moolks***. Most of the elders said that this variety was the most widespread, and grew “all over”. The prefix “***sm-***” is a term for ‘real’ or ‘authentic’ (Ts’msyeen Sm’algyax Authority, 2001). Due to this variability, different people described it in different ways. It was variously described as “medium-sized”, “big”, “round” and “looking like ***gasasii***” (but not sweet tasting). These ***moolks*** were also said to be sour. ***Sm-moolks*** could be preserved (Elizabeth Dundas), but most elders used the fruit to make either thick jam and jelly.

6. ***Dickwan***

As noted previously, the term ***dickwan*** means ‘over-ripe’, and it was only used to refer to ***moolks***. The skin turns brown, and the flesh becomes very soft, almost liquid. All of the elders I consulted greatly enjoyed eating ***moolks*** in this state when they could get it. Despite tasting acidic, the ***dickwan moolks*** would become slightly sweeter in this over-ripening process, and it was easy to suck the liquid out, leaving the skins and seeds behind, although people said you couldn’t eat too many because “…you’ll get cracked, cracks in your tongue because of the acidity… of the ***moolks***… it’s just like eating real sour, sour apple… you could only take so many bites of it, well [that’s] the way with ***moolks***, even ***dickwan***” (Helen Clifton). The elders told fond stories about eating the

dickwan, either straight off the tree, or by letting them ripen after picking – "if it's been raining, they're over-ripe, that's when they go ***dickwan*** like… then you eat it before they go too far… you eat it, you know, and it cuts you on the tongue too… if you eat too much" (Belle Eaton).

All the varieties would be eaten when they were ***dickwan*** (Helen Clifton, Elizabeth Dundas), but most people preferred the ***gasasii*** variety, because even when they were in the ***dickwan*** stage, the other varieties were still sour. Almost all the elders reported that the ***dickwan*** fruits were favoured for eating fresh and raw, they were generally not preserved at that stage. As Helen Clifton described "just like a berry that's starting to rot, or parts of… that's the way that the ***dickwan*** is. So you wouldn't let them get that far [over-ripe] if you were going to process them." However, Elizabeth Dundas did describe some occasions when ***dickwan*** would be preserved. Albert Clifton and Elizabeth Dundas both mentioned making jam or jelly from ***dickwan*** fruits, but Belle Eaton said that she had never heard of either preserving them or making jam.

7. Miscellaneous

No particular variety was noted as being used for mashed jam, however, based on the other types of usage, I would expect that they would have used either ***moolks sigawgaaw*** or ***sm-moolks***. In any case, there is some overlap in the use of each variety. Using different varieties differently was a general trend, but most people did use varieties interchangeably to some extent.

2.3.11 Words specific to *moolks*

One way in which the Gitga'at's special connection to ***moolks*** is reflected was through language. In these interviews, two ***Sm'algyax*** words emerged as relating almost solely to ***moolks***. The term ***t'i'ik***, which means a belly button or navel on humans, was used to refer to the small dimple found on the bottom of ***moolks*** fruits opposite the stem. This term was only used in reference to ***moolks*** and ***łaaya*** (highbush cranberry). The term ***dickwan*** refers to when the fruit is at an 'over-ripe' stage, and the ***moolks*** are the only fruit that was eaten at this stage of ripeness, since no other fruit ripens this same way, they simply rot, even store-bought apples.

2.3.12 Trade

The Gitga'at traded both seaweed and ***moolks*** to the Kitimat Haisla people in return for grease (Chief Albert Clifton), and sometimes they sold watermelon boxes (about 0.3m x 0.3m x 1m in size) full of ***moolks*** to the Kitkatla people for $20 each (Marjorie Hill). The Gitga'at ***moolks*** were highly prized; the Gitga'at were known for having "the best ***moolks***", particularly the ones they harvested from the fall camp. The ***moolks*** from Kitkatla and Kitimat were not as highly regarded (Chief Ernie Hill, Jr., Marjorie Hill). Marjorie Hill commented that based on morphological characteristics, ***moolks*** could be identified to the precise region they were from: "By looking at the ***moolks***, you know where they are from, you know which part they picked it from."

2.3.13 Changes in *moolks* use

While the general techniques of how ***moolks*** are harvested, processed and served have stayed relatively constant across the generation of the elders I talked to and their parents', and grandparents', generations (Elizabeth Dundas) (mid 1800's – early 1900's), some of the technology has changed, such as using plastic buckets instead of cedarbark baskets, and stainless steel pots instead of enamelware pots, and before that, cedar boxes. However, all the elders agreed that the use of ***moolks*** has declined drastically over the last few decades. They noted that people's palates are changing, and that ***moolks*** aren't as important a food as they have been in past times (Helen Clifton, Belle Eaton); the younger generations have lost the taste for it (Helen Clifton). Helen Clifton said that ***moolks*** are now considered "like a specialized food, a specialized berry, because you don't get that much of it anymore." In the last 15-25 years, people have been going to the fall harvesting camp only for weekend or day trips mostly for hunting and fishing (Chief Albert Clifton, Helen Clifton). Berries of all kinds are not being harvested in large quantities anymore, even though people are now harvesting in locations other than the traditional fall camp. Some food, like grease, is not as readily available anymore either (Helen Clifton), and this has changed how ***moolks*** are processed. Also, because people aren't picking as many ***moolks*** as formerly, and they have not been visiting the fall camp lately, almost all the elders have noted a decreasing abundance of ***moolks***.

All the elders interviewed mentioned the importance of looking after the trees to ensure proper growth patterns and fruit production. When ***moolks*** are picked, the elders say they are more productive in subsequent years. As Elizabeth Dundas said, "I believe that's why they're…dying off, because the more you pick them, the more they grow." Since management of this special resource was done through simple acts such as taking off some shoots and picking the fruit bunches with attached leaves, if the fruits are no longer being harvested the trees, people fear, will fail to grow to their full potential, and the quality and quantity of the fruits will suffer. I believe that I saw evidence of this on the landscape. During this research I noticed many of the crabapple stands (orchards) in Gitga'at territory were looking unkempt, and the trees appeared to have broken trunks and to be overgrown (Figure 2.12). My observations of current orchard growth reinforces the elders' opinions that because people are not picking the fruit very much anymore, the ***moolks*** are not doing as well as when they were picked and tended.

Figure 2.12. Pictures from Gitga'at territory showing (a) fallen trees and an unkempt landscape, 2 October 2011 and (b) dead, broken off main trunks with re-sprouted smaller side shoots, 31 August 2012.

Bad weather, possibly be due to a changing climate, is another factor identified as influencing ***moolks***. The majority of the elders commented that in the last decade or so the weather has been unpredictable (Turner and Clifton, 2009) and this has been bad for the harvesting of many foods, including ***moolks***, as can be seen in Marjorie Hill's lamentation that "they're [the ***moolks***] not the kind I used to know." In the fall of 2011 when I was at Hartley Bay, there were very heavy rains, and this greatly affected all types of berries and fruits, including ***moolks***, as they were not ripening at all (Goolie Reece) or were rotting before they could be harvested (Helen Clifton).

The last concern a few elders mentioned to me was their worry that, in addition to the lack of fruit picking and bad weather leading to a reduced amount of fruit, the ***moolks*** trees were also being affected by a rising sea level. Albert Clifton mentioned that he though the tide height had risen by 38-40 cm in his memory, and he thought it was a strong possibility that the ***moolks*** would all disappear over the next 10 years if the water keeps rising. Elizabeth Dundas said that "***No'o***'s own is dying off," suggesting this was partly because of lack of picking, and partly "because of the water level" of the salt water is coming up too high, apparently a portent of changing sea levels. Goolie Reece mentioned that "the ones [***gasasii***] that were closer to the beach all died off. There was some more ***gasasii*** there, but they were shorter trees. But they're all wiped out, there's nothing there." She thought the taller ***gasasii*** trees were still there, but said that the ***moolks sigawgaaw*** were gone as well. I did not investigate this further, but if the ***moolks*** trees are in fact dying off because of a rising sea level, this would be quite worrying, and it would further impact the availability of an already limited resource. If however, they are merely declining in quality because they are not being picked and managed any more, then these observations could potentially be reversed if people revitalized the ***moolks*** harvest.

2.4 Discussion and Conclusion

Moolks, as used by the Gitga'at and other Northwest Coast Peoples, has all the characteristics of a highly important cultural plant. The fruits have been a very important food for the Gitga'at, to the extent that they have extremely in-depth knowledge about the varieties and the subtleties of their use, and that people still use this fruit to this day, albeit in not as great quantities. The Gitga'at people have a long-standing and close association with ***moolks***, and the elders I interviewed shared much detailed familiarity with ***moolks***, expressed through their ownership, management and trade patterns, harvesting protocols, and folk species classification as seen through the interviews analyzed earlier. This type of knowledge is very important to record because as we have been seeing throughout this thesis, and in other studies, elders are growing older and not all of this knowledge is being passed down to the younger generations. With my recording of this data, I hope to help store and record this knowledge for future generations. There has been some evidence that culturally recognized varieties (and possibly even domesticates or proto-domesticates) may disappear over time, as management practices cease (Deur, 2000), so by recording historical knowledge, we can apply this to the current landscape. Since the elders had a hard time identifying some of the sampled trees in the ecological part of this study to variety, this knowledge may already be becoming lost and blurred.

My research not only highlights the historical and modern day cultural importance and usage of this species, but also addresses concerns that elders and other members of the community have expressed recently. I have noted throughout this chapter that the use of ***moolks*** has been considerably reduced in the last few decades. While ***moolks*** are still harvested and eaten, people's diets have evolved with the introduction of store-bought food, and ***moolks*** have become a less important component in the Gitga'at nutritional regime. The influx of non-traditional food has led to the youths' taste in preferred food to change, and several of the elders mentioned that the youth don't favour many of the traditional foods, including ***moolks***, anymore (Turner and Clifton, 2009). Because ***moolks*** are being harvested less frequently, and people are visiting the fall camp less often, this reduces the extent of care and management that was traditionally practiced on ***moolks*** trees. The management techniques that were described throughout this chapter by interviewees relate to what they remember doing in their lifetimes. There is no specific data either from this study or from the background literature I researched pointing to a specific timeline of management techniques. However, it is reasonable to assume, based on other groups practicing similar techniques, and on the way the Gitga'at elders incorporated management techniques seamlessly into their worldview, that management techniques have been practiced for a greater depth of time than since contact. Another key concept relating to management as described in the interviews was that people often described crabapple trees as producing more fruit because people picked the bunches of fruit, as a form of pruning. This is important to mention, as it showed that people were aware that by using a specific technique, they could increase the amount of fruit they would be able to harvest. This is similar to statements by Nuu-chah-nulth berry pickers that picking salalberries by the cluster increased the production of berry clusters for that plant in the future (Turner and Peacock 2005).

Bad weather is another key factor in this reduction in ***moolks*** harvesting. Even if a changing palate was not leading to a change in the traditional foods that are harvested, the reduced ability to harvest due to lessened resource access is vital. During the fall of 2011, I experienced first hand the impacts of a surfeit of rain in the region. Several of the elders noted that many fruits and berries were either not ripening or were rotting on the bush, which limits the amount that could be harvested, and attributed this to the heavy rain. Not only was there inordinately heavy rainfall, but the weather in general was very unpredictable. Both 'bad' and unpredictable weather have been frequent over the last decade and more (Turner and Clifton, 2009). In fact, the preparation of seaweed, a spring resource (Turner and Clifton, 2006) was greatly impacted by the lack of sun in the summer of 2011. The final step in the seaweed processing happened in September that year, which was the latest Helen Clifton (pers. comm., 2011) had ever remembered it happening, as it is normally dried in June.

In addition, Helen Clifton (pers. comm., 2011) stated that an influx of rain also makes the water levels on the rivers in the area rise, flooding low banks and making it dangerous to travel along the river. She noted that it can take four or five days for the river to return to its normal level, so frequent rain will cause the rivers to stay higher longer. Several elders expressed concerns that some of the specific ***moolks*** harvesting locations, and maybe even whole varieties, could be disappearing. They surmised that this was due to rising water levels, possibly due to the increased rain flooding the rivers more. But this could also be attributed to a rising level of the ocean, an indication of broader climactic change. It has been predicted that sea levels may rise by as much as 50 cm in this century, and that these rates have been accelerating recently (IPCC, 2001; Kirwan and Murray, 2008). In Northern British Columbia specifically, Abeysirigunawardena and Walker (2008) documented an increase in sea level near Prince Rupert, BC, and as mentioned in the results of this chapter, Chief Albert Clifton recalled a rise of 38-40 cm in tidal height in his memory.

The coastal river system where the Gitga'at people traditionally harvested ***moolks*** is heavily influenced by tidal fluctuations, and this type of habitat is particularly at risk (Abeysirigunawardena and Walker, 2008). If a salt wedge moves further upriver with rising sea levels or increased wave action from large tides or surges, the water table and surrounding soils will develop increased salinity, and the riverbanks could be in danger of greater erosion. This physical feature can change the plant species composition of the landscape depending upon the salt tolerance of the plants living on the edge of the river, leading to a change – most likely a reduction – in harvestable resources, including ***moolks***.

Moolks also play an important role in the ecosystem and foodwebs, including the seasonal food cycle of many non-human animals, particularly black bears. The fruits are ripe in the fall when the bears come down to rivers and estuaries to catch and eat salmon, so ***moolks*** fruits provide an important additional food source, as evidenced by the fruit-filled scat I saw firsthand, the Gitga'at warnings and discourse about being watchful for bears when harvesting ***moolks***, and suggested management techniques such as clearing around the trees, to increase visibility and prevent surprise encounters with bears in the ***moolks*** orchards. If ***moolks*** are disappearing, whether due to rising salinity, soil erosion or other factors, this will alter the functioning of coastal estuarine ecosystems to the detriment of bears, humans and other species that use them as food. Bears are not only responsible for the transference of nutrients between the aquatic and terrestrial systems (Hocking and Reimchen, 2009), but if they do not consume enough food, they will not be able to hibernate and survive their winter sleep (Turner and Clifton, 2009).

Thus, there are many factors contributing to a reduced availability of ***moolks*** for the Gitga'at community, and all of these have led to ***moolks*** being a less important component in contemporary Gitga'at and other Indigenous Peoples' diets (Turner and Turner, 2008). Indigenous People have had to adjust to variation in resource availability for millennia (Turner and Clifton, 2009), and have retained their resilience by using techniques such as harvesting alternate resources, or trading. Now, however, they are being faced with a much greater challenge. As we enter a future that will probably involve drastic changes in species composition and environmental characteristics due to a changing climate (IPCC, 2007), it is vital to involve the Indigenous People that have lived in a close-knit relationship with the land they inhabit for centuries (Turner and

Clifton, 2009) in scientific and governmental management and policy decisions. As I showed through recording knowledge specifically about ***moolks*** from Gitga'at elders, Indigenous People hold much detailed knowledge, not only about specific species, but about how whole systems interact with each other. Learning detailed ecological knowledge from Indigenous People is vital to the current dilemma we as a species face, and creating links of collaboration between western scientific knowledge systems and traditional ecological knowledge systems is going to be necessary as we move into the future. However, despite all these changes at cultural and ecological levels, it could be seen through the elders engagement with this subject that ***moolks*** remain a vitally important component in both the ecosystem and for the Indigenous People that use it.

Chapter 3: Ecological and Morphological Variability in Pacific crabapple (*Malus fusca*) trees from Hartley Bay and Gitga'at First Nation territory, British Columbia

3.1 Introduction

In this chapter, I present the ecological and morphological results from my masters research on Pacific crabapple (*Malus fusca* (Raf.) C.K. Schneid.). Using morphological characteristics from a sub-sample of trees and their associated fruits and leaves, combined with ecological characteristics of the local environment around each tree, I describe the variability seen in *M. fusca* populations located at the fall harvesting camp of the Gitga'at, near Hartley Bay, BC (A map of the area can be seen in chapter 1, Figure 1.2). This work was a component of an overall investigation into the folk varieties of Pacific crabapple, namely whether these varieties, as named and recognized by members of the Gitga'at Nation, could be differentiated botanically through ecological and morphological characteristics. In this chapter, I first provide a literature review on the genetic relationships, morphological classification schemes, genetic variability and diversity, reproduction strategies, pollination and fruit dispersal and species migration patterns of *M. fusca*.

There are four native *Malus* spp. described from North America: *M. angustifolia* (Aiton) Michx., *M. coronaria* (L.) Mill., *M. ioensis* (L.) Mill. and *M. fusca*. The first three occur in the middle to eastern part of North America, and are thought to be closely related to each other (Dickson *et al.*, 1991), with *M. fusca* being the sole geographical, morphological, genetic and chemical outlier (Routson *et al.*, 2012). Its unique traits all contribute to its taxonomical classification. In chapter 1, I presented the biogeographical range of *M. fusca* based on accessions in herbarium collections. The naturally occurring range of *M. fusca* is to the west of the coastal mountain ranges of western North America, extending from southern Alaska to central California. *Malus fusca* is the only crabapple native to the West, and is geographically separated from the other three North American species by over 3000 kms (Dickson *et al.*, 1991).

Genetically, *M. fusca* is more closely related to several Asian *Malus* species than to the other North American species, which are more closely related to the European species. The genus *Malus*, family Rosaceae, has been further divided into sections and series (Qian *et al.*, 2006). Based on molecular evidence, the most recent classification scheme places *M. fusca* in Section Sorbomalus, Series Kansuensis (Forte *et al.*, 2002; Pereira-Lorenzo *et al.*, 2009; Qian *et al.*, 2006; Robinson *et al.* 2001; Routson *et al.*, 2012). This series also includes the species *M. kansuensis* (Batalin) C.K. Schneid., *M. toringoides* (Rehder) Hughes, and *M. transitoria* (Batalin) C.K. Schneid. (Robinson *et al.*, 2001), all of which are native to Asia. The further division of *Malus* into sections and series are based primarily on molecular characters, but also on morphological characteristics, in particular: the persistence of calyces, types of vernation (young leaf emergence) and lobe pattern on the leaves. Series Kansuensis typically has small fruits with a deciduous calyx and lacking (or having very few) stone cells; leaves with palmate veins and 1-2 lobes on each side; and flowers with 2-3 styles (Qian *et al.*, 2006). Because *M. fusca* is more closely related to Asian species, and is a geographic isolate, it is thought to have spread across the Bering Sea (Routson *et al.*, 2012; Williams, 1982) and reached its current range, presumably in approximately the last 10,000 years, since the retreat of continental glaciers (Routson *et al.*, 2012). Routson *et al.* (2012) surveyed the genetic variability in *M. fusca* throughout its range. They found very few genetic differences and a high admixture between populations, from which they conclude that the genetic variability of this species is influenced by mix of "continuous habitat distribution, effective pollen and seed dispersal mechanism[s]…trade or movement of *M. fusca* plant material by humans…." There are several other plant species, not all of which are of cultural significance, which have similar disjunct distributions (Björk, 2012; Qian and Ricklefs. 2004). Thus while human mediated dispersal is possibly a significant factor in this case, both for the initial introduction to North America and for interior translocation events, using translocation evidence from the literature presented in Chapter 1, there are probably other mechanisms at work here as well.

Much of the research on genetic variability of apples has been done on the domesticated apple (*Malus* x *domestica* Borkh.), because it is such an important world food crop. It is thought that *M.* x *domestica* descended from the crossing of two or more of the following wild crabapples: *M. sylvestris* Mill., *M. sieversii* (Ledebour) M. Roemer, *M. pumila* Miller, *M. dasyphylla* Borkh. and *M. praecox* Borkh. (Robinson *et al.*, 2001). Domesticated apples are highly polymorphic (Pereira-Lorenzo *et al.*, 2009), and hundreds of domesticated cultivars have been identified and have been propagated vegetatively by grafting (Robinson *et al.*, 2001). As is the case for many crops worldwide, domesticated apples, have been declining in genetic diversity, particularly in recent times, due to the loss of many cultivars as breeding programs focus on the few commercially important cultivars, ignoring many heritage cultivars that are not widely spread (Hokanson *et al.*, 2001). This has led to an increased interest in re-crossing *M.* x *domestica* with wild *Malus* species, including *M. fusca*, to reintroduce wild-type genes to better counteract pest and disease susceptibility and increase genetic diversity (Hokanson *et al.*, 2001;

Pereira-Lorenzo *et al.*, 2009; Robinson *et al.*, 2001; Routson *et al.*, 2012). Routson *et al.* (2010) also reported that *M. fusca* was less genetically variable than *M.* x *domestica*, but they were unsure if this was due to a possible founder effect when the species was translocated across the Bering Sea, or if the sample size in the study was too low.

Malus spp. are mostly obligately outcrossed, each individual tree requiring pollen from a different tree in order to set fruit (Das *et al.*, 2011). However, some wild species and domesticated varieties have been known to have incomplete self-incompatibility (gametophytic control of pollen tube growth), and so exhibit selfing in some cases (Guerro-Prieto *et al.*, 2009; Larsen *et al.*, 2008; Pereira-Lorenzo *et al.*, 2009). In these cases, though, fruit yield is not usually high (Campbell *et al.*, 1991). In addition, apples also reproduce vegetatively and via apomixis (Campbell *et al.*, 1991). Because most apples are self-incompatible, they need external pollination vectors. Apple blossoms are pollinated by a wide variety of generalist pollinators, including insects and even birds (Campbell *et al.*, 1991; Larsen *et al.*, 2008; Larsen and Kjaer, 2009; Pereira-Lorenzo *et al.*, 2009; Reim *et al.*, 2012; Sheffield *et al.*, 2005). Fruit is distributed by animal vectors (Larsen and Kjaer, 2009; Traveset *et al.*, 2004), including humans. I saw evidence of both bears and crows eating, and thus spreading, *M. fusca* fruit during my two field seasons in Hartley Bay.

As mentioned above, morphological characteristics of the fruits and leaves can be good taxonomic indicators for *Malus* spp. In studies of both *M.* x *domestica* and *M. sylvestris*, many fruit traits were found to be linked with a molecular marker, including, but not limited to, colour, shape, acid content, columnar growth, diameter, conicity (a measurement of the amount the shape of a fruit differs from being the shape of a cone), squareness and length (Currie *et al.*, 2000; Sun *et al.*, 2012). However, most studies found that more than one trait was needed to differentiate between species or cultivars, as most of the variability was described by multiple traits (both molecular and non-molecular influenced traits), based on PCA analyses (Currie *et al.*, 2000; Jacques *et al.*, 2009; Reim *et al.*, 2012). In addition, many traits can be influenced by environmental conditions (Sun *et al*., 2012), as well as position on the tree (De Silva *et al.*, 2000).

As stated in my objectives and research questions in Chapter 1, I was interested in describing the variation within and among *M. fusca* trees near Hartley Bay, B.C. To do this, I identified ecological and morphological (leaf, fruit and tree traits) characteristics to measure in a *M. fusca* population. As recounted in Chapter 2, the Gitga'at people recognize five distinct folk varieties of *M. fusca* based mostly on fruit size (including length of stem), colour, taste and location. By using methods from natural science to collect these botanical characteristics, I framed my research questions to see if the recognized folk varieties could be described through ecological and/or morphological characters, and if so, which of these characters were diagnostic.

3.2 Methods

3.2.1 Field observations and sample collection

In my first field season I used four large poster maps of the field site in Gitga'at territory, created by Ken Josephson in the Department of Geography (University of Victoria) from composite images taken from bing.com/maps, to assist participants in identifying locations of general crabapple harvesting, and locations of specific varieties, as it was not possible to have the elders participating in the study come out to the field site personally. These noted map locations were than transferred to electronic databases at bing.com/maps, and Google Earth. After recording locations, I made several short trips out to the field site in 2011. However, without direct participant input at the site, I was not able to locate the specific varieties on my own, nor, due to inclement weather, was I able to spend enough time at the site to take adequate samples. I was, nevertheless, able to collect samples for genetic analysis. Sites of crabapple harvesting locations, including specific varieties, are being kept confidential to the Gitga'at community of Hartley Bay, and will not be divulged in this thesis. Instead, to safeguard these important resources, they will be referred to without exact locations.

During my second field season in 2012, I spent four days (30 August - 2 September 2012) at the estuarine and river system where the crabapples are mostly harvested, and where the specific varieties are found. I sampled 25 trees for complete ecological and morphological (including fruit and leaf) characteristics, and an additional two trees for just fruit and leaf characteristics, recording specific latitude and longitude locations from each tree. From each of the 27 trees sampled, I collected approximately 10 bunches of fruit, selected in a haphazard method. Fruits were collected within arms length height in the canopy, and were collected around the entire circumference if possible. If this was not possible, this was recorded in the field notes. Numerous leaves were collected from each of the 27 trees as well, from which 10 leaves were randomly selected after preservation. Herbarium specimens and leaf samples for future genetic work were also collected from each tree.

In 2011, interview participants gave verbal consent that samples could be taken for genetic analysis as part of this study. Samples collected in the 2011 field season were taken randomly from trees around Hartley Bay itself and at the field site and sent to Kanin Routson, who was examining the genetic variability in *Malus fusca* throughout its entire geographical range (Routson, 2012). Samples collected in the 2012 field season have been archived with the University of Victoria Herbarium for use in future projects.

For the 25 trees fully sampled, in addition to the fruit, leaves, herbarium and genetic sampling described above, I also recorded various characteristics of the tree and surrounding habitat at the harvesting location. For each of these trees, I recorded tree and canopy height using clinometer readings (%) of canopy top and bottom and base of tree, diameter at breast height (DBH), distance (m) and cardinal direction to closest body of water, estimated abundance of fruit (3 categories - low, medium or high), canopy width in all four cardinal directions (N, E, S, W), aspect of water direction, slope of ground, exposure to weather (3 categories - sheltered, semi-sheltered, exposed), approximate moisture levels in soil (3 categories - dry, moist, standing water) and associated species found under the canopy area, with approximate percentage cover.

Collected fruits were kept cool in a refrigerator or cooler from time of returning from sampling until all measurements were taken, and they were then pressed in a plant press. Leaves and herbarium specimens were pressed as soon as I returned from the field, and measured after they were dried. Genetic samples were dried using a fast-acting indicator desiccant (silica gel) and samples were stored in labelled paper envelopes, inside sealed plastic bags. The culturally recognized variety of each sampled tree was identified by several of the interview participants.

3.2.2 Measurements and data analyses

Fruit, leaf, tree and habitat field measurements were entered into an excel spreadsheet. For the fruit, I assigned numbers to individual bunches and to fruits within bunches, and measured traits using analog calipers and a Denver Instrument MXX-123 scale (accurate to 0.001 g). For the leaves, I assigned a number to each leaf sampled on each tree and measured traits using ImageJ (Version 1.47f, published by Wayne Rasband, National Institutes of Health, USA, http://imagej.nih.gov/ij). Traits measured can be found in Table 3.1.

Table 3.1. fruit and leaf characteristics measured

Fruit traits	Leaf traits
Length (mm)	Length (from leaf tip to start of petiole) (mm)
Width (mm)	Width (at maximum width point) (mm)
Stem length (mm)	Distance to width measurement from base of leaf (mm)
Weight (g)	Number of teeth (right and left side of leaf)
	Size of largest tooth (sinus to tip for the largest tooth on the left and on the right side of the leaf)

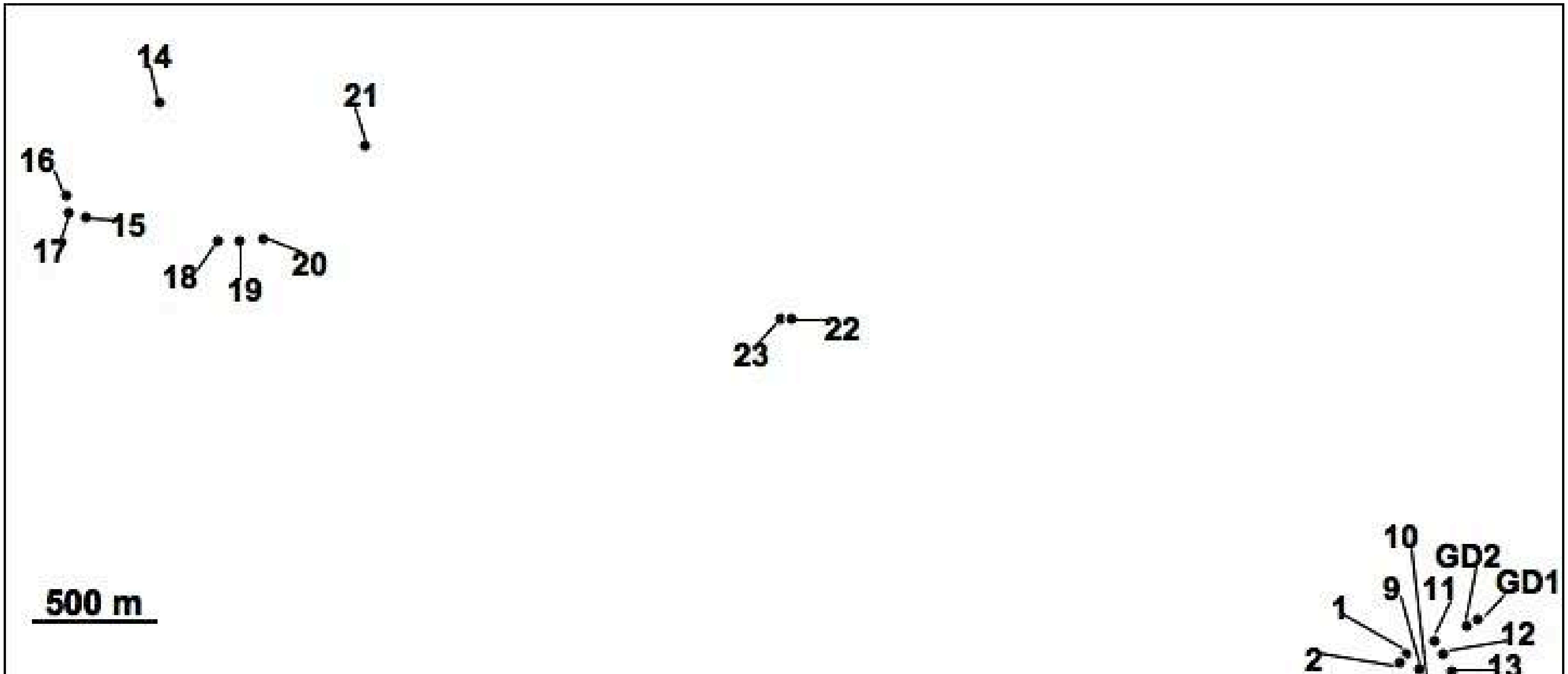
Using fruit length and fruit width measurements, I divided each measurement in half to obtain the radius (r). Using radius and π (pi, 3.14) I calculated fruit volume (mm^3), using the formula $4/3\pi r$. Leaf area (mm^2) was calculated automatically by ImageJ.

Initial data® analyses were done in Excel. Using Statistix (Version 8.1, 2006, Analytical Software, support@statistix.com), Principal Components Analysis (PCA) was done on associated species data for habitat characterization and on total fruit and leaf traits to assess overall differences among sampled trees. Pearsons Correlation comparisons and Single Variable ANOVAs were also conducted to examine variation of individual fruit and leaf characters among and within trees at the sampling location. Using Sigma Plot (Version 9.01, 2004, Systat Software, Inc.), XY scatter plots of means and confidence intervals, and PCA values were created. Data from this study were also compared to data collected by the author from *M. fusca* individuals located in Bamfield, BC (Wyllie de Echeverria, 2008).

3.3 Results

3.3.1 Habitat

A map was created to show the spatial relationships among collection locations, without showing GPS coordinates, as *M. fusca* harvesting locations are being kept confidential (Figure 3.1). Trees were labelled by geographic cluster, and individual tree within cluster, starting from the mouth and going to the head of the river system. Geographic labels were used for PCA associated species and trait scatter plots and when investigating division of samples into varieties, while sample (tree) number was used on XY scatter plots of means and CI of individual traits. Habitat differences among sampled trees were assessed by recording the associated plant species growing under each tree. These associated species data were used for the principal components analysis shown in Figure 3.2. Trees from the upper and lower parts of the river are separated into two spatial groups (indicated with overlaid circles). The overlap of these circle indicates little differentiation between the associated species, and thus probably the habitats, of the two spatial groups.



Collection number	Tree 1	Tree 2	Tree 3	Tree 4	Tree 5	Tree 6	Tree 7	Tree 8	Tree 9	Tree 10	Tree 11	Tree 12	Tree 13	Tree 14	Tree 15	Tree 16	Tree 17	Tree 18	Tree 19	Tree 20	Tree 21	Tree 22	Tree 23	Tree 24	Tree 25	GD1	GD2
Geographic grouping	B-4	B-3	B-2	B-1	A-3	A-4	A-5	A-6	C-1	B-5	C-2	C-3	C-4	E-4	E-1	E-3	E-2	D-6	D-5	D-4	D-3	D-1	D-2	A-1	A-2	C-5	C-6

Figure 3.1. Map showing spatial relationships and distances between sampled *M. fusca* trees from Hartley Bay, BC.

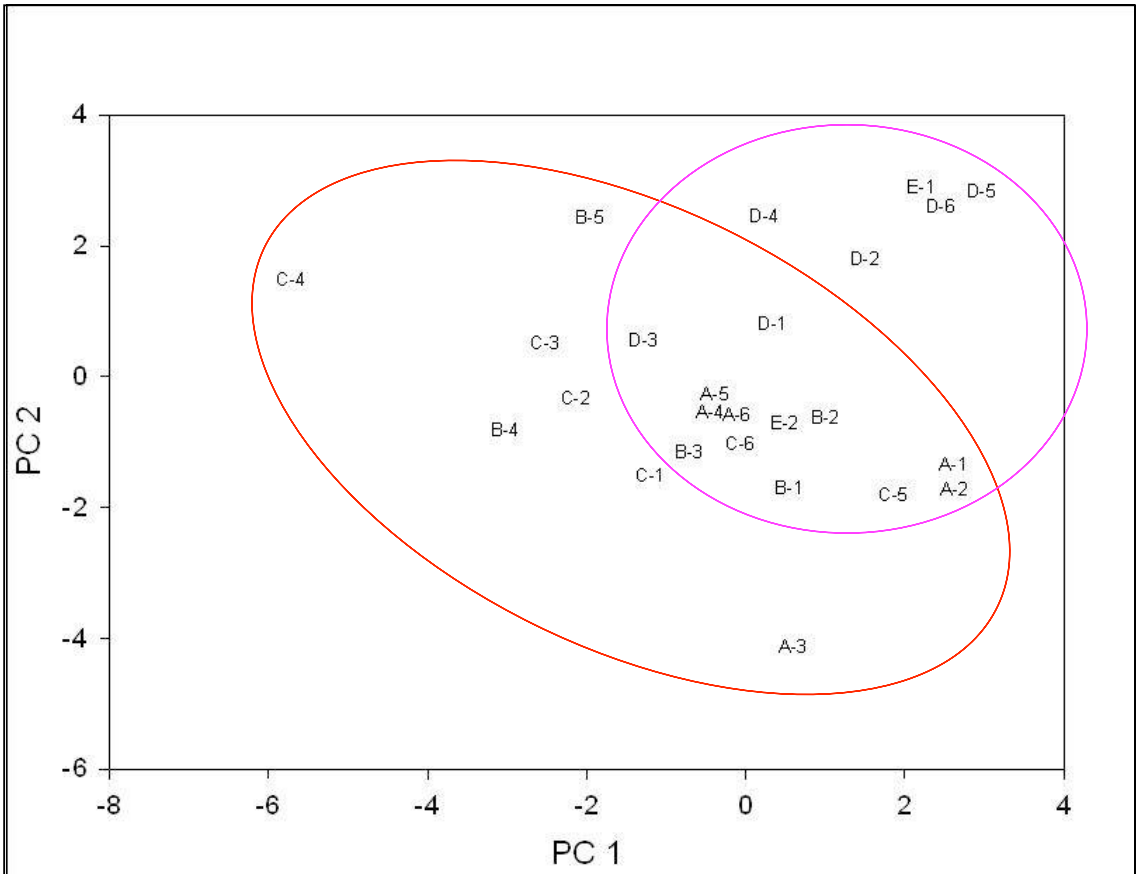


Figure 3.2. Principal components analysis (PCA) of *M. fusca* habitats, showing similarity between habitats of individual sampled trees in the vicinity of Hartley Bay, BC, based on associated species data. Labels are geographic identifiers used in Fig 3.1. The red circle indicates trees located near the mouth of the river in Gitga'at territory, and the purple circle indicates trees located up the river.

3.3.2 Fruit

Means and standard deviations were calculated for all fruit traits including fruit length, fruit width, fruit volume, stem length, and fruit weight (Appendix 4, Table A4.1). Correlations between fruit characters of interest were calculated with Pearson's correlation coefficient, r (Table 3.2). Correlations and p-values were calculated for all traits except fruit length and width, with volume, which were excluded as volume was derived from fruit dimensions.

Table 3.2. Pearson's correlation coefficients for pairs of fruit traits, with p-value. * indicates P-value < 0.05.

	Fruit length (mm)	Fruit width (mm)	Fruit volume (mm^3)	Fruit stem length (mm)
Fruit width (mm)	0.7494 **0.0000***			
Fruit volume (mm^3)	--------	-------		
Fruit stem length (mm)	-0.1145 **0.0001***	-0.0290 0.3299	-0.0678 **0.0224***	
Fruit weight (mm)	0.8589 **0.0000***	0.9329 **0.0000***	0.9629 **0.0000***	0.0039 0.8966

Fruit dimensions (length, width and volume by weight) were highly correlated in all the combinations examined – an expected result, indicating that large fruit are larger in all their dimensions. The high correlation between fruit length and fruit width is shown here (Figure 3.3).

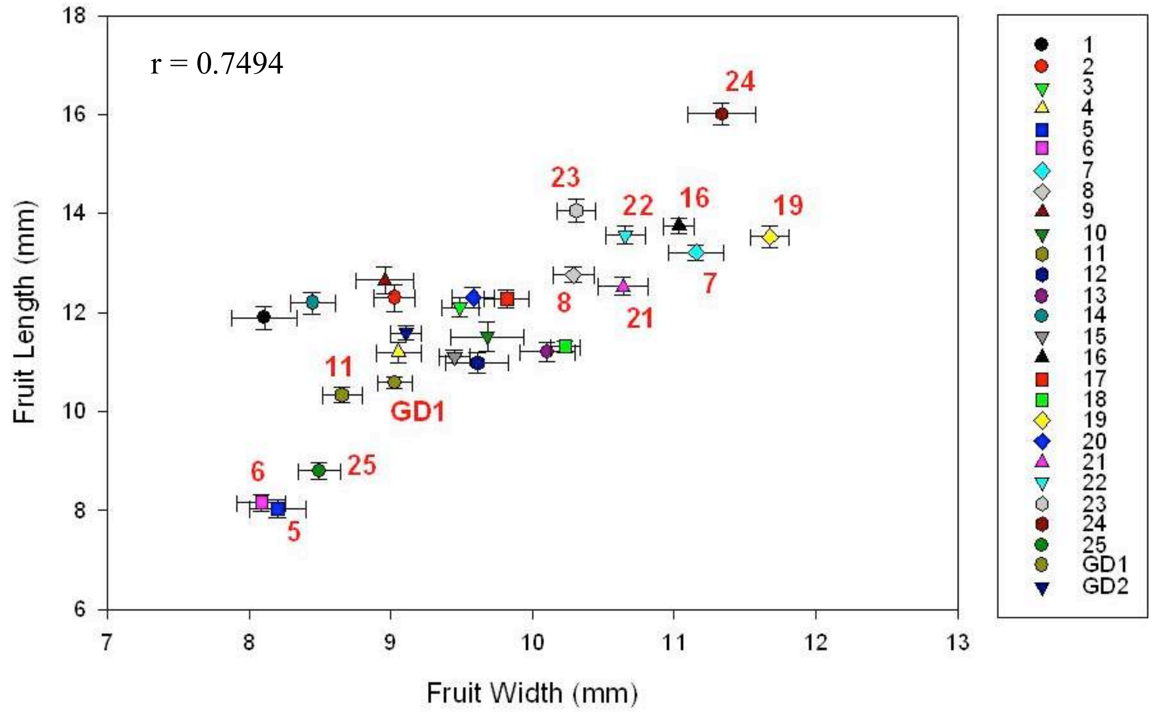


Figure 3.3. The relationship between fruit width and fruit length, plotted as tree averages with confidence intervals. Individual trees that are significantly different than others are numbered on the graph in red.

Stem length showed a weak, but statistically significant, negative correlation with both fruit length (Figure 3.4) and fruit volume (Figure 3.5), indicating that longer stems tend to be associated with smaller fruits. However, the fruits from trees 5 and 6 are obviously much different from the rest of the samples. When I tested this correlation without these two samples, I found a positive relationship, but it was still quite a weak correlation.

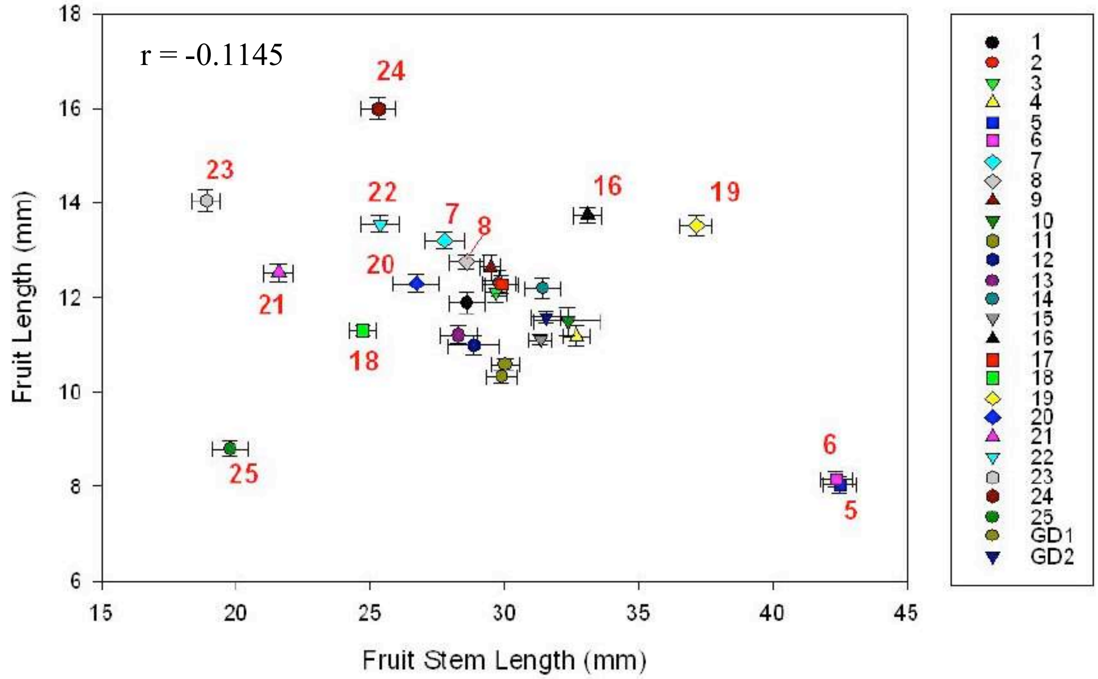


Figure 3.4. The relationship between fruit stem length and fruit length, plotted as averages from each tree with confidence intervals. Individual trees that are significantly different from others are numbered on the graph in red.

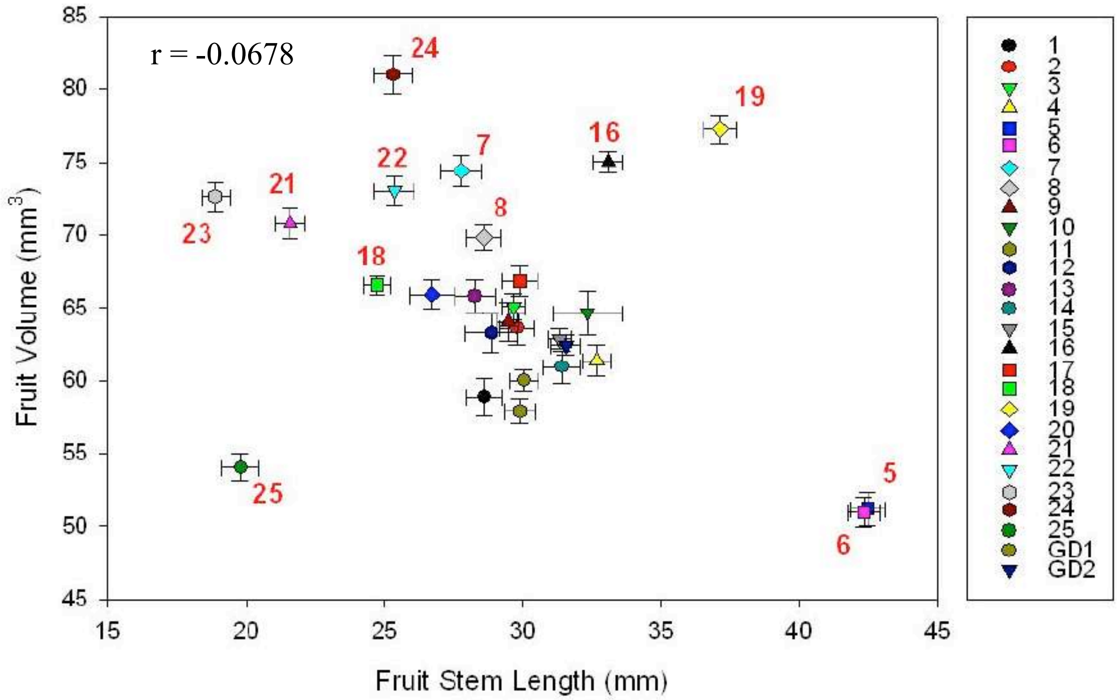


Figure 3.5. The relationship between fruit stem length and fruit volume, plotted as averages from each tree with confidence intervals. Individual trees that are significantly different from others are numbered on the graph in red.

A series of one-way ANOVAs were carried out on individual fruit traits (length, width, stem length and weight) to compare differences among trees for each trait. Significant differences among trees were found for all these traits. However, which trees in particular were significantly different was not able to be determined through this test (Tables 3.3, 3.4, 3.5, and 3.6).

Table 3.3. ANOVA for fruit length by tree.

Source	SS	DF	MS	F	P-value
Tree	2737.38	26	105.284	70.4	0.0000
Error	1654.07	1106	1.496		
Total	43.91.45	1132			

Table 3.4. ANOVA for fruit width by tree.

Source	SS	DF	MS	F	P-value
Tree	1136.65	26	43.7172	39.4	0.0000
Error	1228.07	1106	1.1104		
Total	2364.72	1132			

Table 3.5. ANOVA for fruit stem length by tree.

Source	SS	DF	MS	F	P-value
Tree	26958.3	26	1036.86	58.2	0.0000
Error	19717.1	1106	17.83		
Total	46675.4	1132			

Table 3.6. ANOVA for fruit weight by tree.

Source	SS	DF	MS	F	P-value
Tree	47.7191	26	1.83535	44.9	0.0000
Error	45.2442	1106	0.04091		
Total	92.9632	1132			

3.3.3 Leaves

Means and standard deviations were calculated for all leaf traits including leaf length, leaf width, leaf area, and numbers of teeth and largest tooth size on the right and left side of the leaf (Appendix 4, Table A4.2). Pearson's correlation coefficients and p-values were calculated for all traits except leaf length and width by area, which were excluded as area was derived from these leaf dimensions (Table 3.8). Also excluded are trait comparisons between opposite sides of the leaf for different traits (number compared to size), and the same side of the leaf for both tooth number and tooth size.

Table 3.7. Pearson's correlation coefficient for pairs of leaf traits, * indicates P-value ≤ 0.05.

	Leaf length (mm)	Leaf width (mm)	Leaf area (mm^2)	Number of leaf teeth (L)	Number of leaf teeth (R)
Leaf width (mm)	0.6487 **0.0000***				
Leaf area (mm^2)	-------	-------			
Number of leaf teeth (L)	0.5251 **0.0000***	0.5153 **0.0000***	0.5751 **0.0000***		
Number of leaf teeth (R)	0.5280 **0.0000***	0.4825 **0.0000***	0.5566 **0.0000***	---------	
Largest tooth (L)	0.2162 **0.0003***	0.4650 **0.0000***	0.3555 **0.0000***	0.1352 **0.0263***	--------
Largest tooth (R)	0.1364 **0.0250***	0.3764 **0.0000***	0.2428 **0.0001***	--------	0.0774 0.2050

Nearly all leaf traits are significantly correlated with each other, though some correlations were stronger than others. It was found that leaves were asymmetrical, so the largest tooth for each leaf varied between both the left and right sides of the leaf, and also between trees. Thus, if a leaf had a large tooth on one side, it wasn't necessarily matched with a large tooth on the other side (Figure 3.6).

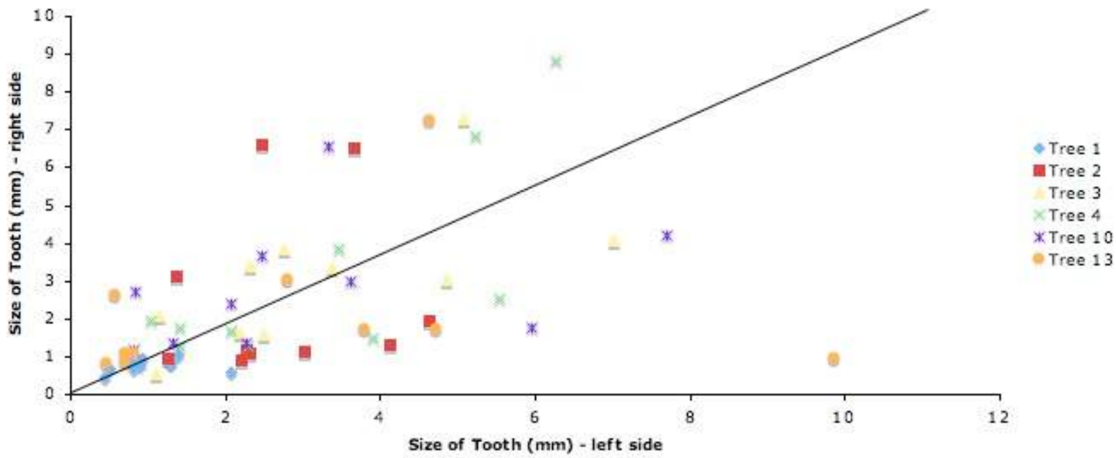


Figure 3.6. One example of the relationship between largest teeth on left and right sides of leaves. This demonstrates the asymmetry mentioned in the text. A symmetrically toothed leaf would have a point that falls on the x = y line.

The relationship between leaf width and leaf length (Figure 3.7) was statistically significant, but despite being the strongest correlation out of the leaf trait comparisons, this correlation was only of a medium strength. When compared to the fruit trait figures presented in the section above, there is much greater variation in the leaves than in the fruits, as seen in the confidence intervals around the mean for the comparison of leaf length and leaf width.

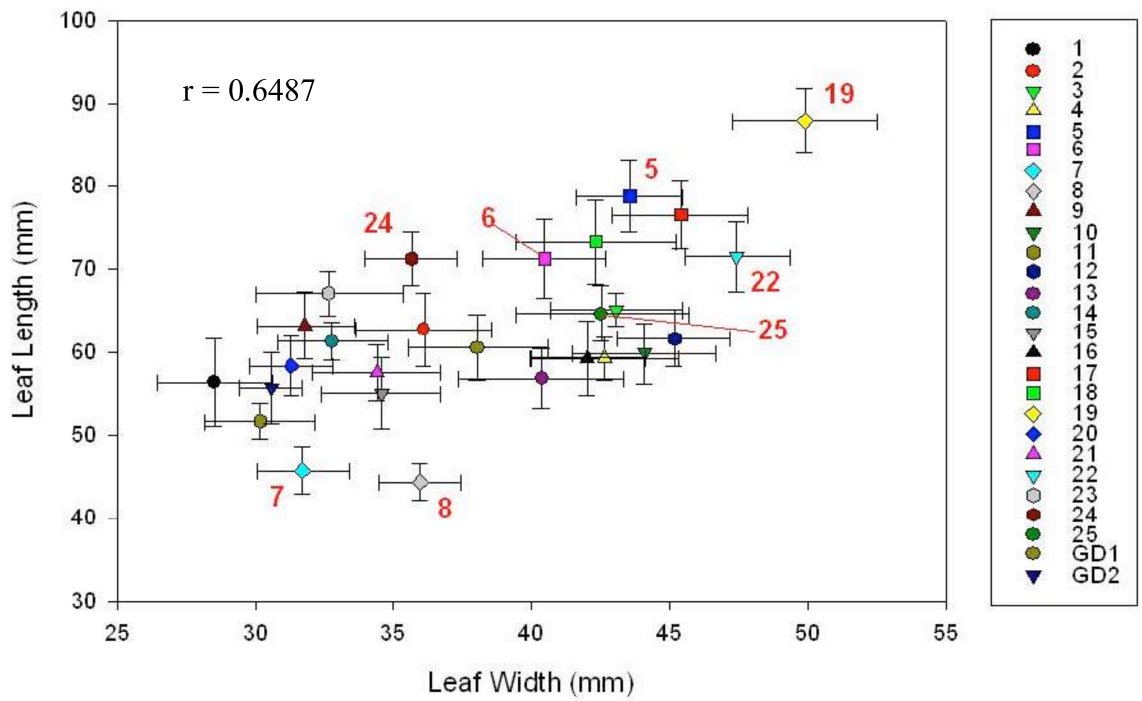


Figure 3.7. The relationship between leaf length and leaf width, plotted as individual tree averages with confidence intervals. Individual trees that are significantly different from others are numbered on the graph in red.

A series of one-way ANOVAs were carried out on individual leaf traits (length, width, and tooth number and tooth size on both left and right sides) to compare differences among trees for each trait. Significant differences among trees were found for all these traits. However, which trees in particular were significantly different was not able to be determined through this test (Tables 3.8, 3.9, 3.10, 3.11, 3.12, and 3.13)

Table 3.8. ANOVA for leaf length by tree.

Source	SS	DF	MS	F	P-value
Tree	24702.2	26	950.084	6.47	0.0000
Error	35664.4	243	146.767		
Total	60366.6	269			

Table 3.9. ANOVA for leaf width by tree.

Source	SS	DF	MS	F	P-value
Tree	9383.3	26	360.896	6.86	0.000
Error	12775.4	243	52.574		
Total	22158.7	269			

Table 3.10. ANOVA for number of teeth on left side of leaf by tree.

Source	SS	DF	MS	F	P-value
Tree	3377.3	26	129.895	3.99	0.0000
Error	7881.6	242	32.568		
Total	11258.8	268			

Table 3.11. ANOVA for number of teeth on right side of leaf by tree.

Source	SS	DF	MS	F	P-value
Tree	3130.79	26	120.415	4.62	0.0000
Error	6308.56	242	26.068		
Total	9439.35	268			

Table 3.12. ANOVA for size of teeth on left side of leaf by tree.

Source	SS	DF	MS	F	P-value
Tree	518.28	26	19.9338	4.10	0.0000
Error	1176.15	242	4.8601		
Total	1694.43	268			

Table 3.13. ANOVA for size of teeth on right side of leaf by tree.

Source	SS	DF	MS	F	P-value
Tree	512.79	26	19.7229	4.35	0.0000
Error	1097.44	242	4.5349		
Total	1610.23	268			

3.3.4 Comparison between fruit and leaf characteristics

Correlations between fruit and leaf traits were also examined. All results can be seen in Appendix 4, Table A4.3. In general, fruit and leaf characteristics showed little relationship. There was only significant correlation, fruit stem length and largest leaf tooth on the right side (Figure 3.8), with a medium, negative correlation ($r = -0.4473$, $p = 0.0193$). This indicates that trees with longer fruit stems tend to have smaller teeth.

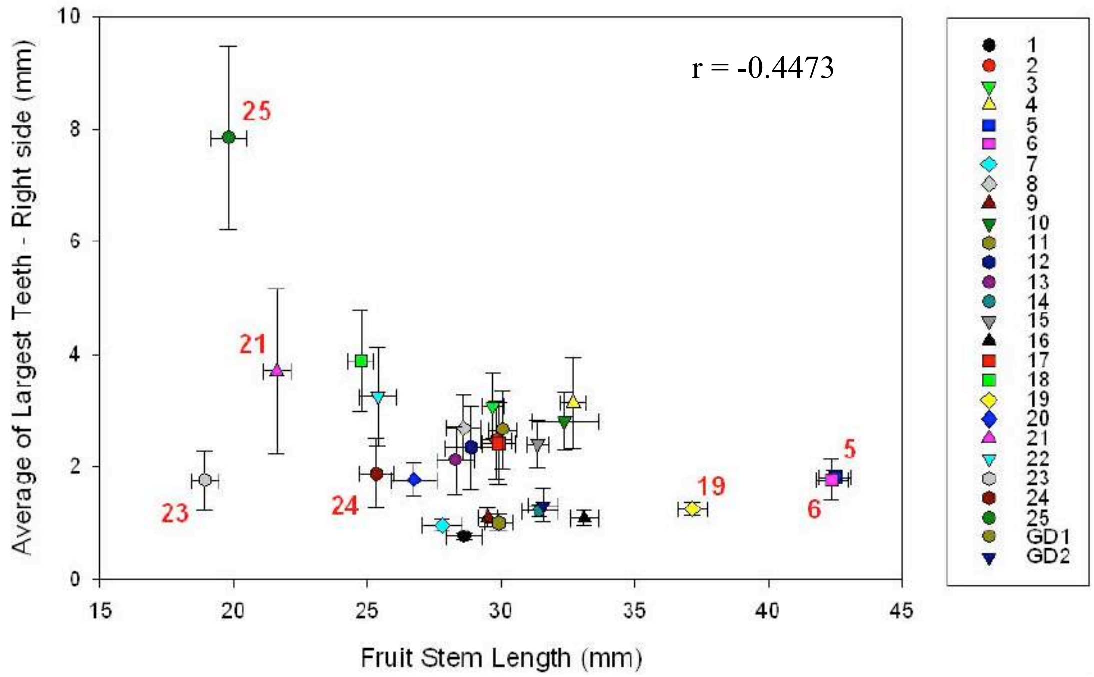


Figure 3.8. The relationship between fruit stem length and the size of the largest tooth on the right side, shown as tree averages with confidence intervals. Individual trees that are significantly different in the comparison between these two traits than others are numbered on the graph in red.

Using Principal Components Analysis, I determined which combined fruit and leaf traits accounted for the highest possible variation in the samples (Appendix 4, Table A4.4). For Principal Component 1, which accounted for 33.6% of the variability, the traits with the highest loading values for fruit length, fruit width, fruit weight, and number of teeth on both sides of the leaf. From this, I can conclude that these traits are the best traits to measure to indicate differences between samples. 82.8% of the variability was accounted for in the first 3 Principal Components.

3.3.5 Morphological comparison of cultural varieties

Fruit samples from each of the 27 trees were identified by one or more Gitga'at interviewees. Most tree identifications were not agreed upon by every interviewee as belonging to one variety, but often several interviewees agreed, or said they were varieties that were morphologically similar (Table 3.14). Once these samples were sorted into variety, the means and SD for each trait based on tree variety were calculated (Table 3.15). It can be seen from this table that when the sampled trees were grouped by variety and averaged, the averages of many traits were different from each other for different identified varieties, however, when standard deviation is considered, many of these values may overlap as well. Also, correlation and p-values between each trait for the averaged trait from each variety (Appendix 4, TableA4.5) were calculated. It was found that some different traits were statistically significantly correlated compared to when the trees were kept separated by sample. This was expected, and was likely because sample sizes were smaller, due to analyzing averages of each variety, instead of all the data from all samples.

Table 3.14. Identification of sampled trees (ordered by varietal designation) to recognized and named cultural variety by some of the Gitga'at elders interviewed. Key: 0 = no ID, 1 = *gasasii*, 2 = *bu'uxs*, 3 = grandma *dawł*'s *bu'uxs*, 4 = *moolks sigawgaaw*, 5 = *sm-moolks*. Any two or three letter combinations indicate uncertainty in which variety was correct, ranked in order of which they thought it was. Question marks after the ID indicate uncertainty, but no other variety was offered instead. In the final varietal designation, sampled trees assigned to the most mentioned variety.

Tree number	Interviewee A	Interviewee B	Interviewee C	Interviewee D	Interviewee E	Varietal designation	Variety name
D-5 (19)	2	5	3	2?	2	2	***Bu'uxs***
C-5 (GD1)	0	0	0	3	0	3	Grandma ***Dawł***'s ***bu'uxs***
C-6 (GD2)	0	0	0	3	0	3	
B-1 (4)	1?	5	4	4	0	4	***Moolks sigawgaaw***
B-3 (2)	54	5	4	1	0	4	
E-4 (14)	0	4	4	5	0	4	
A-3 (5)	41	4	1	4	0	41	***Moolks sigawgaaw/ Gasasii***
A-4 (6)	41	41	4	5	0	41	
A-5 (7)	2?	5	5	51	0	5	***Sm-moolks***
A-6 (8)	0	5	4	5	0	5	
B-2 (3)	0	5	4	5	0	5	
C-1 (9)	5	5	4	5	0	5	
C-2 (11)	5	5	4	5	0	5	
C-4 (13)	0	5	41	5	0	5	
D-1 (22)	5	5	5	5	0	5	
D-2 (23)	0	5	4	5	0	5	
D-3 (21)	0	5	4	5(2?)	0	5	
D-4 (20)	0	5	4	5	0	5	

D-6 (18)	0	5	5?	52	0	5	
E-1 (15)	0	5	4	5	0	5	
E-2 (17)	0	5	4	5	0	5	
E-3 (16)	5	5	5	5	0	5	
A-1 (24)	2	5	5	5	0	5	
B-5 (10)	0	5	4	54	0	54	***Sm-moolks/ Moolks sigawgaaw***
C-3 (12)	0	5	4	54	0	54	
A-2 (25)	0	5	4	3	0	Unknown	
B-4 (1)	0	5	4	1	0	Unknown	

Table 3.15. Means and Standard Deviation of all fruit and leaf traits for trees grouped by identified variety.

	Bu'uxs	Grandma ***Dawł***'s ***bu'uxs***	***Moolks sigawgaaw***	***Moolks sigawgaaw /Gasasii***	***Sm-moolks***	***Sm-moolks/ Moolks sigawgaaw***	Unidentified
sample size	1	2	3	2	15	2	2
fruit length (mm) mean ± SD	13.53 ± 1.71	11.05 ± 1.13	11.94 ± 1.56	8.10 ± 0.91	12.39 ± 1.74	11.17 ± 1.28	10.40 ± 1.96
fruit width (mm) mean ± SD	11.68 ± 1.07	9.07 ± 0.95	8.84 ± 0.99	8.14 ± 1.01	10.10 ± 1.29	9.64 ± 1.27	8.30 ± 1.16
fruit volume (mm^3) mean ± SD	77.24 ± 7.67	61.12 ± 5.99	62.02 ± 6.87	51.08 ± 5.91	68.27 ± 8.45	63.76 ± 7.45	56.52 ± 7.19
fruit stem (mm) length mean ± SD	37.14 ± 4.64	30.74 ± 4.42	31.21 ± 3.89	42.41 ± 3.24	27.57 ± 5.33	30.09 ± 5.86	24.34 ± 5.92
fruit weight (g) mean ± SD	1.13 ± 0.30	0.57 ± 0.16	0.58 ± 0.18	0.37 ± 0.12	0.77 ± 0.27	0.62 ± 0.22	0.45 ± 0.16
leaf length (mm) mean ± SD	87.92 ± 12.76	58.09 ± 13.27	61.07 ± 10.25	75.01 ± 14.79	61.11 ± 14.54	60.74 ± 11.21	60.48 ± 14.56
leaf width (mm) mean ± SD	49.89 ± 8.43	34.32 ± 7.24	37.19 ± 8.53	42.01 ± 6.69	37.26 ± 8.65	44.63 ± 7.34	35.54 ± 10.98
leaf area (mm^2) mean ± SD	3180.63 ± 880.20	1479.25 ± 550.66	1688.97 ± 556.73	2296.33 ± 725.27	1703.72 ± 690.83	2065.62 ± 639.83	1578.36 ± 784.66
leaf number of teeth - left, mean ± SD	31.40 ± 5.60	26.30 ± 5.29	24.33 ± 5.18	28.40 ± 4.77	26.16 ± 7.21	29.45 ± 6.14	25.60 ± 6.53
leaf number of teeth - right, mean ± SD	29.90 ± 6.01	23.55 ± 5.08	24.77 ± 5.72	28.60 ± 4.21	25.79 ± 6.64	27.85 ± 4.18	26.10 ± 5.53
leaf, largest tooth - left, mean ± SD	1.36 ± 0.43	1.52 ± 0.93	2.54 ± 1.55	1.87 ± 0.46	2.20 ± 2.27	2.70 ± 2.10	4.41 ± 5.80
leaf largest tooth - right, mean ± SD	1.25 ± 0.39	1.98 ± 1.81	2.28 ± 2.10	1.79 ± 0.83	2.19 ± 2.21	2.58 ± 2.04	4.31 ± 5.13

Almost all *M. fusca* trees were clustered together in all significant trait comparisons (see XY scatter plots for fruits, leaves, and both together, all above), except for the following trees, which have been identified based on their cultural variety. Tree 19 (D-5, variety 2, ***bu'uxs***) was distinct in every trait comparison represented by the graphs above (both fruit and leaf separately, and combined). Of the trees identified as variety 5 (***sm-moolks***) two trees (21/D-3 and 23/D-2), were distinct in every graph, one tree (7/A-5) was isolated for only fruit and leaf traits separately, but not when they were combined, another tree (8/A-6) was distinct for three traits (fruit length x fruit width; stem length x fruit volume; and leaf length x leaf width), and an additional three trees of this designated variety (16/E-3, 22/D-1 and 24/A-1) were distinguished only for fruit traits, except for tree 24, which was also isolated for the stem length and leaf area comparison. Tree 25 (A-2, variety unknown) was distinct in every instance except when only comparing leaf traits (leaf length and leaf width). Trees 5 (A-3) and 6 (A-4) were identified as being variety 41, which means they were either ***moolks sigawgaaw*** or ***gasasii***, and they were clustered on together, but separate from all other trees for all trait comparisons.

When interviewees were asked to identify the sampled crabapple trees in terms of cultural variety, there was not complete agreement from everyone. Partly this was due to the samples being out of a spatial context for them, partly to the poor quality of the sampled fruit I was able to collect and show them, and partly to the 2012 sampling season occurring when the crabapples were not quite ripe. During interviews people mentioned that the crabapples have been smaller than normal, and of generally poor quality in recent times, due to lack of management and reduced harvesting. Perhaps this may be influencing peoples' lack of complete agreement on their identification of the cultural varieties (However, I was able to assign samples to a cultural variety when two or more people agreed on an identification). Because Gitga'at elders used colour, shape and size of fruit (including length of stem), and location to help them determine each cultural variety (see Chapter 2), identification confusion might have arisen in this study because the fruits were seen out of context (despite interviewees being provided with approximate collecting locations), and may not have been ripe enough for the elders to be confident in their identification. In addition, since the elders were missing the locational context of where each sample was taken, even through fruits are commonly harvested before they are fully ripe, perhaps these samples were at an even earlier ripeness stage. While the sampling season occurred during the time of the year when crabapples are normally harvested, it was at the beginning of this time period. There are several reasons as to why the fruits may not have been as ripe at the time as they might have been. As mentioned throughout this thesis, the unreliable and inclement weather has been heavily influencing ripening times of fruits and berries in the area during the last few years. This has potentially pushed back the ripening times of crabapples to later in the year, but the sampling time was constrained because of the risk of encountering poorer weather later in the year, the reason the first field season assessments were not able to be completed.

All trees, except one sample (D-1, ***sm-moolks***), were not unanimously assigned to a specific culturally recognized variety, so the variety that the majority of the interviewees agreed upon is the one I assigned to the sample. Several samples (A-3, A-4, B-5, C-3) were designated about equally, between two varieties. These differences could partly be explained because of personal differences between the traits different elders use to tell the folk varieties apart. As well, one interviewee commented that maybe the crabapples were hard to tell apart because they are “marrying each other”. This could indicate that through inter-pollination, and with reduced management, differences between folk varieties are being blurred.

For several other trees there was no interviewee agreement, and these were assigned to an ‘unknown’ variety (A-2, B-4). Using the Principal Components Analysis with the combined fruit and leaf traits (except fruit volume and leaf area) discussed above in Section 3.3.4 (and in Appendix 4), I displayed the PC1 and PC2 values for each tree with a scatter plot (Figure 3.9), upon which I have circled the identified cultural varieties, based on interviewee agreement. From this graph, it can be seen that most samples were not separated by variety based on the comparison of all fruit and leaf traits. One exception is between trees A-3 and A-4, which were identified as being either ***gasasii*** or ***moolks sigawgaaw***. As well, D-5, identified as ***bu’uxs***, and C-3 and B-5, identified as either ***sm-moolks*** or ***moolks sigawgaaw***, could have separated out if the ***sm-moolks*** samples hadn’t had such a large spread.

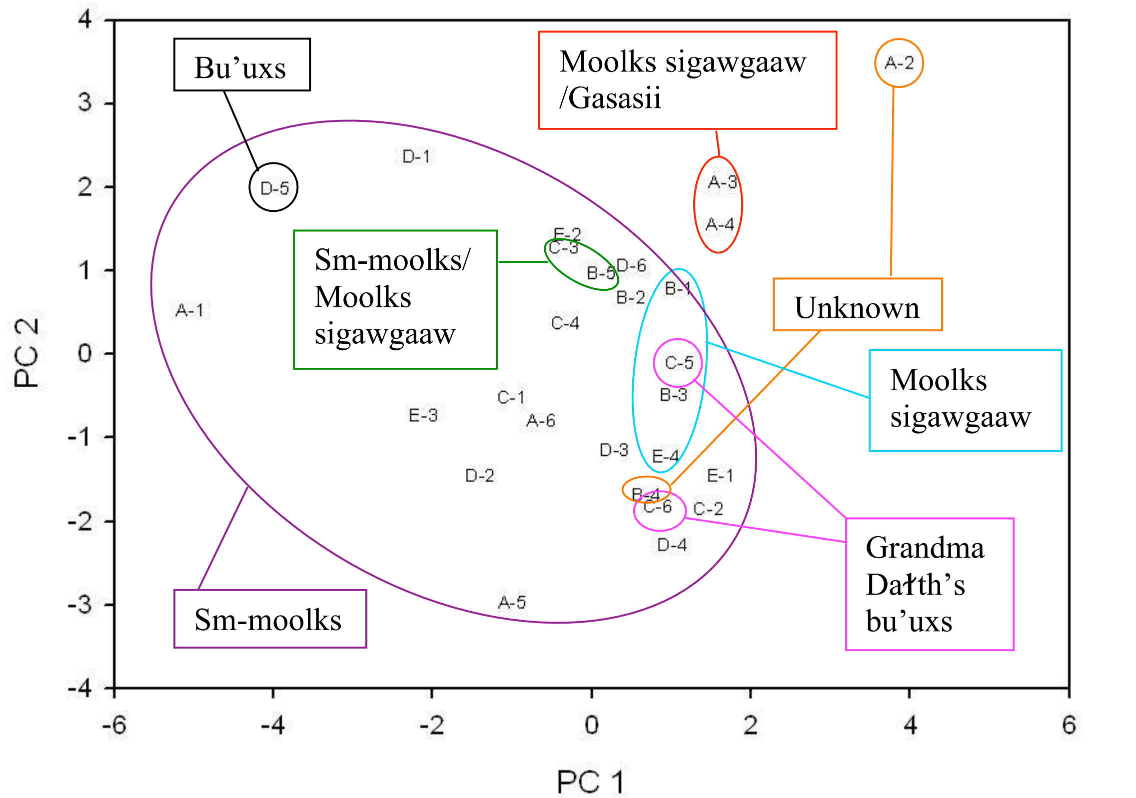


Figure 3.9. Principal components analysis (PCA) based on all fruit and leaf trait data (except fruit volume and leaf area) for *M. fusca*, showing similarity between sampled trees for characteristics, identified by geographic number.

3.3.6 Site comparison to Bamfield, B.C.

I was able to compare the data collected from this research with a similar study from Bamfield, British Columbia, Canada (Wyllie de Echeverria, 2008), which was an interesting avenue to explore. This comparison allowed me to examine the differences between two *M. fusca* populations. However, while Hartley Bay had a known history of relatively recent human management of crabapples (within the last 15-25 years), and Bamfield crabapple populations are probably unmanaged, or at least not managed in recent times, management may not be the most crucial difference between these two locations, as they also differ geographically and ecologically. In the Bamfield study, trees from three different habitat types were sampled: edges of land exposed to marine influences, bogs and estuaries (geographic information in Appendix 5). Potentially less managed crabapple sites in the vicinity to Hartley Bay could be sampled in the future to provide another comparison, to examine more closely the effects of just management.

The means of all traits from all trees in each location (Hartley Bay vicinity and Bamfield vicinity) were tested using a t-test to determine if they were significantly different. With $\alpha = 0.05$, it was found that most variables differed between these localities, with fruit traits differing slightly more than leaf traits (Table 3.16).

Table 3.16. Table showing differences between Hartley Bay and Bamfield for each of the fruit and leaf variables. * indicates a significant P-value ($\leq$ 0.05).

Statistic	Hartley Bay Mean ± CI	Bamfield Mean ± CI	P-value
Fruit length (mm)	11.87 ± 0.12	10.21 ± 0.12	**0.0000***
Fruit width (mm)	9.72 ± 0.08	7.86 ± 0.11	**0.0000***
Fruit volume (mm^3)	65.56 ± 0.56	37.83 ± 0.44	**0.0000***
Stem length (mm)	29.48 ± 0.37	21.66 ± 0.45	**0.0000***
Fruit weight (mm)	0.71 ± 0.02	0.44 ± 0.02	**0.0000***
Leaf length (mm)	62.83 ± 0.87	55.89 ± 1.14	**0.0000***
Leaf width (mm)	38.28 ± 0.53	29.54 ± 0.61	**0.0000***
Leaf area (mm^2)	1801.57 ± 43.86	1200.44 ± 42.39	**0.0000***
Tooth # - L	26.63 ± 0.39	26.74 ± 0.58	0.8771
Tooth # - R	26.15 ± 0.36	26.37 ± 0.63	0.7617
Tooth size - L	2.34 ± 0.15	1.57 ± 0.15	**0.0004***
Tooth size - R	2.31 ± 0.14	1.66 ± 0.17	**0.0049***

A comparison of fruit length to fruit width in samples from the two localities (Figure 3.10), shows that the two sets of samples overlap in their distribution. However, fruits from the Bamfield samples were on average smaller than those from the vicinity of Hartley Bay.

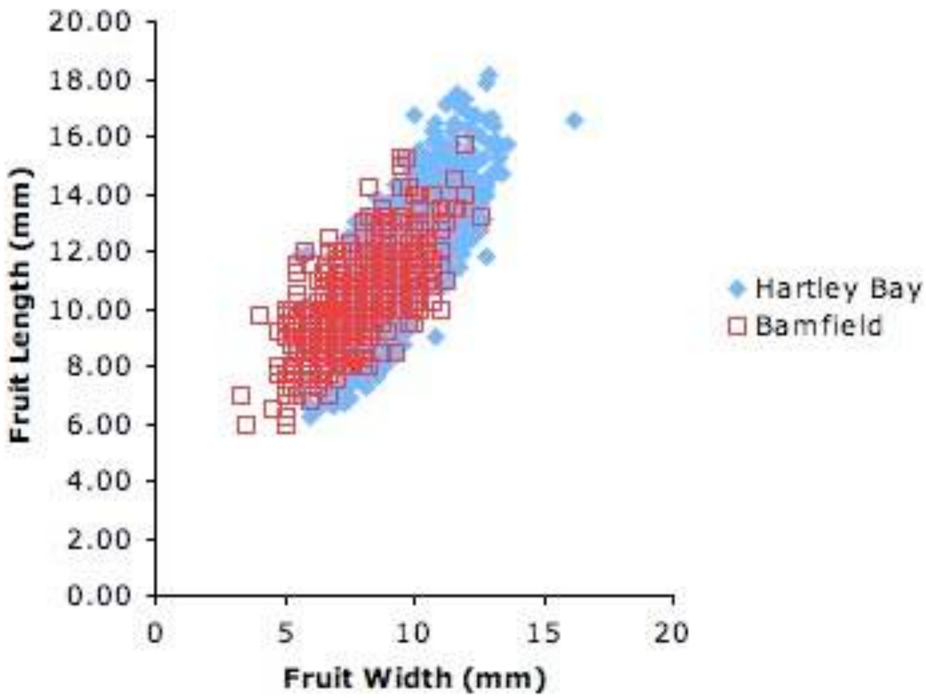


Figure 3.10. Length and widths of *M. fusca* fruits from Bamfield, BC, and from Hartley Bay, BC.

3.4 Discussion and Conclusion

As mentioned in the introduction, much of the previous work classifying *Malus* species based on morphological traits has been done using *M.* x *domestica* and *M. sylvestris*. In these studies, many tree, leaf and fruit characteristics were measured, and it was found that most of the variability could be described using only two to three morphological traits, but which traits these were differed depending on the study (De Silva *et al*., 2000; Jacques *et al*., 2009; Reim *et al*., 2012; Rohrer *et al*., 1991). It was found that it was possible to tell these species, and hybrids of them, apart from these morphological studies; however these species are most likely more genetically separated than the cultural varieties of *M. fusca* seen in this study.

Overall, in *M. fusca* six comparisons between fruit traits were significant and 14 comparisons were significant for leaf traits, but I found that fruit traits were more strongly correlated, in general, then leaf traits. Almost all correlations were positive, so the variables increased together. Several of these relationships were expected, such as longer and wider fruits being correlated to each other, and with heavier fruits, and the numbers of teeth being correlated on each side of the leaf. An unexpected correlation seen was the negative, low, but still significant, correlation between stem length and fruit length, weight and volume. In this case, longer stems are associated with smaller fruit. Also, when the means for each tree were plotted for comparing statistically significant traits in XY scatter plots, the confidence intervals were much smaller for fruit traits than leaf traits, indicating less variability between trees for fruit traits. From previous studies, fruit length, width and weight were all found to be traits with measurable differences (De Silva *et al*., 2000; Jacques *et al*., 2009; Reim *et al*., 2012; Rohrer *et al*., 1991), traits I also noticed were significantly correlated in this study.

I also compared fruit traits to leaf traits, and only found one trait between the two sets to be significantly correlated. The length of the stem on the fruit was significantly negatively correlated to the largest tooth on the right hand side of the leaf at $\alpha = 0.05$. This indicates that as the length of the stem increased, the tooth size decreased. From the ANOVA test run on each trait by tree, it could be seen that there is enough variability to differentiate between some of the trees for each trait, but not all of the trees for all of the traits. I chose not to analyze this data further although there are methods for doing so.

Through these trait comparisons, as represented on the XY scatter plots in the results above, it can be concluded that some *M. fusca* trees are quite different from others in relation to some traits, and also that the variation within a single tree is lower than the variation between trees, in most cases (particularly for fruit traits). As described in Chapter 2 (and earlier in this chapter), the Gitga'at interviewees recognize and name five cultural varieties, and differentiate between these varieties based on fruit shape, colour and taste, length of stems, and spatial location. For fruit traits, the most interesting comparisons I found to be significant were stem length with both fruit length, weight and volume. Since the stem length was negatively correlated with both these traits, it indicates that longer stems are associated with smaller fruits. Longer stems were also associated with smaller teeth, when fruit and leaf traits were compared. This is notable because stem length is a fruit trait that was mentioned in interviews as being a distinguishing characteristic between some of the cultural varieties. For example, the ***gasasii*** variety was said to have longer stems and smaller fruits than the other kinds.

However, many leaf traits were not strongly correlated, which indicates that even if it is possible to differentiate different varieties based on leaf traits, fruit traits will likely be more reliable identifiers. When comparing fruit and leaf traits to each other, it was found that a weak, significant correlation existed between stem length and the largest tooth on the right side of the leaf. Most fruit and leaf traits were not significantly correlated, so leaf traits cannot be used instead of fruit traits. While the data suggests there could be a possible relationship between these variables, I can't say so definitively.

While correlations between the measured morphological traits were found to be significant, when these significant traits were plotted against each other in XY scatter plots of trait mean and CI, it was found that most of the values of each tree for the individual traits were clustered together, which might indicate that there was not a significant enough difference between or among trees to group them into the culturally recognized varieties based solely on measuring morphological characteristics, and without knowing the exact location of a varietal population.

The varieties that were identified from these sampled trees were: varieties 2 (***bu'uxs***), 3 (grandma ***dawɫ***'s ***bu'uxs***), 4 (***moolks sigawgaaw***), 5 (***sm-moolks***), 4/1 (***moolks sigawgaaw*** or ***gasasii***) and 5/4 (***sm-moolks*** or ***moolks sigawgaaw***). Many of these trees were identified as ***sm-moolks*** because this category is also considered a catch-all or residual category for the crabapples, and it is also the most prevalent variety. Both of the mixed categories (4/1 and 5/4), are different varieties that have some similarity, such as fruit size in the case of 4/1 (see Chapter 2 for complete variety descriptions), and colour and taste in 5/4. As was seen in Table 3.14, there was not complete agreement on identification.

In addition to averaging and analyzing the data by individual sampled tree, since the Gitga'at elders identified the samples to variety, I then divided the sampled trees to group them into cultural varieties, and re-averaged and analyzed the data. This was done to determine if there were differences between samples organized by variety instead of individual tree, but it can be seen from the results that while some of the same traits were still correlated significantly, some traits were no longer correlated significantly. Also, all significant correlations were now in the positive direction, so compared traits increased or decreased together. For example, fruit stem length was no longer significantly correlated with any other fruit traits, and the numbers of teeth on both sides of the leaves were significantly correlated.

Fewer significantly correlated results were likely seen when samples were grouped by varietal category due to several factors. First, most trees were not unanimously identified as belonging to the variety by the Gitga'at elders, so there was uncertainty in the identification. Secondly, several of the varieties identified, only contained one or two representatives for a sample size, which makes it less likely that a correlation will be statistically significant.

One trait which I did not measure, but was mentioned as a diagnostic feature both in previous research (Jacques *et al.*, 2009; Miranda *et al.*, 2007; Reim *et al.*, 2012; Rohrer *et al.*, 1991) and as an important characteristic in identifying culturally recognized *M. fusca* varieties by my Gitga'at interviewees, was fruit colour. I chose not to record colour in my study, because the Gitga'at interviewees who identified the samples collected in 2012 noted that the fruits I collected for my samples were not fully ripe. However, based on the importance of colour in other studies and to the Gitga'at participants, this would have been an important characteristic to record if the fruits as sampled had been fully ripe. If they were fully ripe, sugars could also be tested, as taste was another important characteristic.

Another aspect which was not visited as much in this study was vegetative reproduction or regeneration. It has been shown that domesticated apples can regenerate from cuttings in a laboratory situation and the resulting seedlings transplanted (Caboni and Tonelli, 1999; Kaina *et al.*, 2011), and they can send up suckers from cut trunks or pruning (Fumey *et al.*, 2011). I mentioned in Chapter 2 that a few interviewees reported that some trees had been cut down at the fall harvesting camp, but since I did not have the exact location, I was not able to determine if they had resprouted. This should be checked at some point, and if they have regrown, determine if they are producing fruit. It would be particularly interesting to see if the fruit was the original variety, or if it had altered taste or appearance in any way. If these varieties are not consistent when the trees regrow, perhaps grafting may have to be looked at as a way to maintain these varieties.

Despite significant correlation between some fruit and leaf traits, and isolation of some of the trees for certain variables, based on morphological characteristics alone, most of the trees did not separate into distinct varieties in the graph of principal components 1 and 2. As I stated in the results, the samples identified as potentially being ***gasasii*** did separate out from the rest of the samples, but there was also uncertainty as to whether these samples were in fact ***gasasii***, or if they were ***moolks sigawgaaw***. The sample identified as ***bu'uxs*** would have been slightly separated from other samples if the ***sm-moolks*** variety did not spread so widely, but this is also slightly misleading, as it was a single sample. Looking at the table of means and standard deviations of samples separated by variety, it can be seen that means did differ between varieties. While standard deviations were not huge, they were large enough to see that there was overlap between means for many traits. Also, trees up river and downriver did not seem to live in different habitat types, based on a principal components analysis of associated species data, which did not show differing environmental characteristics between sampled trees, despite each variety being strongly associated with a small region of the estuary and river by Gitga'at interviewees. Therefore I conclude from this study that some differences can be found through measuring morphological traits, but due to variability within and among *M. fusca* trees, the morphological and ecological data I collected is not sufficient to distinguish and characterize the varieties beyond a rudimentary sorting, and scientific research should still be used in conjunction with Indigenous knowledge in order to fully describe slight varietal differences in a localized environment. Perhaps there are other parameters, not examined in this study, such as soil type, or the chemistry of the fruit, or more finely detailed morphological features, which might enable natural sciences to distinguish the different cultural varieties of Pacific crabapple, or ***moolks***, that are named and delineated by the Gitga'at experts.

Chapter 4: Bringing it all together: Using multiple stories to examine varietal diversity in *moolks* or Pacific crabapple.

4.1 Thesis summary

This masters' research was designed to incorporate specific methodologies in both social sciences and natural sciences to examine the question of the taxonomy and cultural significance of ***moolks***, or Pacific crabapples. Using techniques from social sciences, I interviewed Gitga'at knowledge holders of Hartley Bay, BC, to elucidate the ethnobotanical and ethnoecological significance of ***moolks*** to their people and, in particular, to delineate different named cultural varieties that are part of the Gitga'at classification of this important fruit. Through interviews and conversations with nine Gitga'at experts, I recorded the subtle nuances around characterization of fruits, leaves and location that leads to the recognition of these unique cultural varieties. Using methodologies from natural sciences, I selected 27 trees from the traditional fall harvesting camp of the Gitga'at, where stands or patches of the different cultural varieties of ***moolks*** exist, to sample and measure fruit, leaf and environmental traits, in order to delineate the variability existing between and among this crabapple population using botanical parameters.

In chapter 1, I presented the background on my project, including my research questions, botanical details of Pacific crabapple and information about the Gitga'at people and their home community of Hartley Bay, where I undertook my work. I also presented a literature review of crabapple biogeography and ethnobotany, together with details concerning its food, technological and medicinal uses; harvest timing and protocols; role in Indigenous narratives; ownership, management, translocation and trade patterns; and recognition of crabapple "orchards."

In chapter 2, I presented the results of my interviews with Gitga'at elders about ***moolks*** use, the different varieties they recognize and how these are distinguished and characterized through their classification scheme. Five unique cultural varieties of this species, as described by the elders, are featured, differentiated via fruit shape and size, colour, taste and tree location. I also reported how crabapples trees were managed and transplanted, and how the fruits were harvested, prepared, eaten and traded, based on the Gitga'at elders' descriptions. Despite the lessening in its prevalence in the contemporary diet of the Gitga'at, these fruits were traditionally a very important resource. Their high significance was expressed through the quantities used, the unique words and techniques associated with them, their use in feasting, and the recognition of different varieties.

In chapter 3, I presented data from investigations of Pacific crabapple variation in Gitga'at territory and beyond through techniques from natural science, quantifying the variation within and among randomly sampled trees by measuring fruit, leaf and ecological characteristics. Through this data collection, I found that various traits were significantly correlated to each other. Significant correlations were found more often in fruit traits than in leaf traits, and also more often in both sets of traits separately than when they were compared to each other. All significant correlations were positive, except for the following negative correlations: stem length compared to fruit length, fruit weight and fruit volume (indicating that smaller fruit had longer stems); and stem length compared to largest tooth on the right side of the leaf. Even for statistically significant trait comparisons, averaged trait comparisons (with confidence intervals) from the majority of sampled trees clustered together on XY graphs. This meant that despite the traits being significantly correlated in general, most trees were not significantly different from other trees.

At the end of chapter 3, I link both components of this study. During the field season, the elders identified the varieties of the sampled trees. In the data analysis, I then reanalyzed the correlation data, grouping by variety instead of individual sample. It was found that correlations between some fruit and leaf traits were significantly correlated, but not as many traits as when this data was analyzed by individual sample, instead of grouped and averaged by variety. Using a Principal Components Analysis to analyze all measured traits, I found that most of the individual trees did not cluster together into variety based on morphological traits measured. The only variety that definitely did was that of the samples identified as being either ***moolks sigawgaaw*** or ***gasasii***. By identifying these samples to Gitga'at variety, I was investigating whether morphological traits could be used to differentiate between culturally designated varieties. I concluded that while some trends were seen, overall the results were not conclusive, probably due to a small sample size, and uncertainty with variety identification.

In chapter 4, I discuss the implications and future of working within the two knowledge systems of traditional ecological knowledge and western scientific knowledge, and explore how these systems complement and support each other in helping to describe and understand the cultural, botanical and ecological traits of Pacific crabapple, ***moolks***, as well as the broader picture. I also suggest at where this research could lead to in the future and how it might be used by both the Gitga'at community and the scientific community.

4.2 The broad picture

It is important to state here that I am not attempting to validate Indigenous knowledge with western scientific knowledge in this research. Both knowledge systems are valid in their own right and have important roles to play in our understanding of ecosystems, but they also express different aspects documenting the processes of a changing landscape and its species. In western science there is a goal of classifying organisms and processes within a universal scheme, and hence scientific knowledge is objective and often quite broad and general. Indigenous knowledge, on the other hand, is integrated and imbedded in specific environmental and cultural contexts, and organisms are regarded and classified through a local lens, often reflecting a longstanding, personal and interactive association with humans. Through its very nature, Indigenous knowledge is place-based and culturally specific.

As we saw from the way Pacific crabapples are embedded in the cultural framework of Gitga'at knowledge, they have many more facets than could be described in this study. A study comprising purely western scientific methods may be able to account for some of these complex links between crabapples and their environments, and would contribute important insights, but would lose the rich cultural elements of crabapple diversity. When you lose context, you lose so much more than just another way to describe a species. In the past, Indigenous People have not always been consulted in western scientific studies, and their knowledge, particularly relevant in local contexts, has often been ignored and overlooked (Turner and Clifton, 2006). Lately, however, Indigenous, or traditional ecological knowledge (TEK) has been increasingly recognized, particularly for its ability to provide detailed localized insights and observations about species and ecological processes (Berkes, 2012; Hunn, 1999; Hunn *et al.*, 2003; Parlee and Berkes, 2006). With so many rapid changes happening in the environment currently, it will be increasingly important to consult all possible sources of knowledge as we struggle to understand and adapt to these changes.

The purpose of this thesis was not only to record the Indigenous Gitga'at knowledge regarding ***moolks***, to assist in its preservation and transmission, and to use natural science to describe the morphological variability of this important resource, but also investigate how both sets of knowledge can inform the process of human adaptation to the environment. Berkes (2012) argues that in the past, many studies recording Indigenous knowledge have focused on the longstanding interactions these people have with a localized environment, and how that has informed their practices. Local knowledge, reflecting small-scale, focused observation embedded in a multigenerational time frame, is very important to include with western scientific studies, which tend to measure data within a relatively small time frame but at a larger geographic scale. Today, with the earth currently in a state of great fluctuation, both socially and environmentally (Turner *et al*., 2012), not only are many resources being over-harvested and invasive plants and animals becoming more prevalent, but with a changing climate, both people's lifestyles and the earth's ecosystems are changing at a rapid rate (Turner and Clifton, 2006; Turner *et al*., 2012). Traditionally, Indigenous People built resiliency in the face of a changing world through the structure of feasts, trading, flexibility in resources harvested, and sharing stories and food (Turner and Clifton, 2006; Turner *et al*., 2012). Now we are telling a different kind of story, as the changes we are currently seeing are happening too rapidly and on too large of a scale to compensate for as we have in the past. Because the changes being seen in the landscape are unprecedented, even

Indigenous knowledge, which is deeply connected to the landscape through generations of interactions, may be losing its adaptive resiliency to respond to these changes because they are happening so rapidly. Berkes (2012) argues that, even though changes are taking a form and scale Indigenous People have not experienced before, if we start to view Indigenous 'knowledge as process', rather than as a static 'traditional' historical knowledge, it can contribute to decision-making processes at many levels. In a general sense research that combines different approaches to environmental understanding by focusing on different knowledge systems can help in this endeavour, and will lead to learning how to build resiliency within genomes, knowledge and ecosystems functions.

4.3 Importance to the Gitga'at community

There are several ways in which this study is useful to the Gitga'at community at Hartley Bay. Firstly, I talked to several elders about their interest in creating a ***moolks*** garden in Hartley Bay, with each of the varieties represented. We know that in the past ***gasasii*** trees have been transplanted to Hartley Bay, and the quality and taste of its fruits stayed relatively consistent, up until the last tree was cut down in the summer of 2012, so perhaps there might be locations in Hartley Bay that would be conducive to creating a ***moolks*** orchard. One potential problem is that there was concern the ***bu'uxs*** trees (and potentially ***gasasii*** as well) might have disappeared from the area around the fall harvesting camp. However, this would have to be investigated more closely, as some of the trees I sampled were identified as belonging to the ***bu'uxs*** (and some potentially to ***gasasii***) variety. Creating a crabapple garden would allow representative sample trees of each variety to be preserved from some of the environmental fluctuations experienced in their original location (especially sea level rise, and river flooding), and would also create an opportunity for the Hartley Bay School to get involved and for younger Gitga'at to become more familiar with these cultural varieties. Another possible problem if the trees are planted in close proximity in a community garden might be pollen transfer between varieties, as this species needs to outcross to other individuals to produce fruit. This could lead to fruit and new trees expressing a mix of characteristics from both parent varieties, if they are crossed. However, since these varieties already grow in relatively close proximity in their natural habitat, and pollen crossing has not appeared to be a problem in identifying varieties in the past, perhaps this would not be an issue, although it should be examined in the future.

There are many ways in which the Gitga'at community could continue to record TEK and, particularly through programs in the Hartley Bay School, help the young people in the community remember their history on the land and the details of the species that are an important part of their heritage. Some possibilities include the school being involved in the creation of the ***moolks*** garden already mentioned. Elders' knowledge about ***moolks***, and many other fall resources can be incorporated into the school curriculum. The school could facilitate student trips to the fall harvesting camp where the crabapple varieties and other particular resources are found, similar to how the students already visit the spring harvesting camp. Trips to the fall camp could be short day outings, or overnight trips, to teach the students about fishing, hunting and berry picking practices, in addition to tending and managing these areas. If it is not possible for elders to go up to the fall camp with the students, the students could still learn from the ***moolks*** garden, and in the classroom, with their elders. Several years ago, the school held a workshop to teach the students how to whip grease, and prepare ***moolks*** (and other berries) to eat with grease (Hartley Bay School, 1997). This event could easily be repeated and incorporated into the curriculum every few years – not only for ***moolks*** but for other fall foods as well. I believe there are plans currently in the school to provide students with voice recorders and maps so that they can visit their elders and family members to record stories, place names, and TEK.

For this study on ***moolks***, my next steps in the community are to refine the map upon which I recorded ***moolks*** and other berry locations from the fall harvesting camp, and return this to the community. I am also going to facilitate creating more large poster maps of other regions in Gitga'at territory for the school mapping project mentioned above. I hope this will be a helpful addition. I would also like to assist in the making of the garden, if the community decides they would like to go in this direction.

4.4 Future scientific work

Several of the traits that I quantitatively measured in this research – fruit size (length and width, and shape) and stem length – were attributes also identified as diagnostic features by the Gitga'at interviewees their culturally recognized varieties. However, sampled trees could not be differentiated clearly into distinct cultural varieties in the natural sciences analysis of these traits. This was likely seen because the overall sample size was small (n = 27) and since these trees were selected randomly, I did not collect a large enough sample of each variety to adequately describe it. Several of the varieties were only represented in this study with one or two sampled trees. Thus I did not sufficiently account for the existing range of variability in these traits in each of the ***moolks*** varieties. Some trends in the morphological traits of different sample trees were evident, but these were not consistent enough to completely categorize this species in a western scientific botanical classification scheme to the same extent and level of detail as exhibited in the Indigenous classification scheme.

We saw from this research that the cultural varieties of Pacific crabapple recognized by Gitga'at knowledge holders cannot be completely described by the morphological traits measured in this study. While measurements of these traits might serve as a proxy for describing species variability, additional morphological features beyond those identified and measured in this study undoubtedly need to be examined, which I would suggest for future work. As well, perhaps characteristics about the soil composition and structure might prove important, as sandy soil was a feature that was noted as being characteristic of where the ***gasasii*** variety grew, as well as the region having rich soil from rotting salmon carcasses and other nutrient inputs, and fruits could be examined for chemical signatures, such as sugar content and phenolic compounds, as taste was an important feature in differentiating between cultural varieties. Using genetic analysis as a way to tell varieties apart is another option for future research. As mentioned in Chapter 2, Routson (2012) examined the genetic variability in Pacific crabapple along its entire geographic range, but did not feel that he would be able to tell cultural varieties apart based on the markers he chose. However, genetic analysis is a powerful tool, and additional markers should be looked at for their ability to differentiate between cultural varieties.

Context, both spatially and ecologically, is very important. There were some disagreements on identification of sampled trees by interviewees, which could be due to several reasons, such as the poor quality of the fruit, the samples being removed from the context of the fall harvesting camp, or of the fruit not being ripe enough to distinguish varieties due to a cold, delayed season during the sampling period. An aspect I couldn't completely elucidate in this thesis was where the different ***moolks*** grow, as these harvesting sites are being kept confidential. However, as I stated in Chapter 2, different ***moolks*** varieties were affiliated with different locations in the estuary. Even though the associated vegetation did not show a difference between sampled trees, potentially, there are other factors, such as soil type or salinity levels that create a unique microhabitat around the varieties, which could contribute to differences between these varieties.

Another comment that came up repeatedly in interviews with Gitga'at elders was the issue of increased amounts of water in the crabapple sites, both from an increased intensity of rain flooding the rivers and from sea level rising in this area (Abeysirigunawardena and Walker, 2008; Chief Albert Clifton, pers comm.), as well as from weather becoming more inclement and unpredictable. It can be seen that the changing climate is a concern for the Gitga'at, as for many other Indigenous communities, particularly those located along the coast. This issue is of pressing concern because the estuaries and rivers that line the coast have been an extremely rich zone for resource extraction by Indigenous Peoples for centuries, and the ongoing and predicted changes in estuarine water levels, salinity, and bank erosions, described more fully in Chapter 2, would greatly impact both people and the environment, and would be an important issue to study in the future.

4.5 Final conclusions

In conclusion, the important contributions of this study have been to document specific folk varieties of ***moolks***, Pacific crabapple (*Malus fusca*) known to members of the Gitga'at First Nation on the north coast of British Columbia, the way these varieties are used and recognized, and the broader significance of this Indigenous food resource through descriptions of management, ownership, harvesting rules, transplanting and trade. As well, a preliminary morphological and ecological investigation was done with a set of *Malus fusca* trees sampled from the traditional harvesting site to explore how the differentiation between these varieties can be identified through a western science lens. As seen throughout this thesis, knowledge relating to both western scientific methods and Indigenous methods has its individual strengths, and it is important to keep exploring the connections between them to keep bringing both bodies of knowledge together.

Throughout this work, a key theme that emerged was that of change, and change at a rapid rate, both culturally and environmentally. This was particularly seen through the interviews, as the morphological data was collected at too short timescale to exhibit this change. The change was expressed in particular through accounts of changing weather, harvesting patterns, loss of cultural knowledge and evident disappearance of crabapple trees and varieties. For many generations there has been an ongoing and enduring relationship between the Gitga'at and their environment, including with ***moolks***, a major crux of which includes the interactions of humans and ***moolks*** through tending and management. The management of ***moolks*** has been mentioned several times in this thesis, but this bears repeating, as it has emerged as a keystone concept. In this case, I am not simply referring to management techniques such as clearing and pruning around trees, but also the worldview encompassed by the interactions between humans and ***moolks*** that was woven in throughout the interviews. Since many elders did not specifically view many of their practices as management *per se*, I believe this indicates that the connections between ***moolks*** and the Gitga'at go back multiple generations, to render these thoughts so engrained, that it would just be assumed that you would take care of the plants, animals and environment that were providing you with resources to survive. As well, expressions of management were seen on the landscape, in the growth pattern of ***moolks*** trees and orchards, and in the fact that since management has mostly ceased, the area of formerly-cared trees appears to have become overgrown and unkempt, as seen from the pictures earlier. People described that through the process of picking the fruits in cluster, together with a few leaves, the trees would produce more the next year, and, now, when they are no longer picking the fruit, the trees aren't growing or producing as well. All of the above comments reinforce the strong connections between people and their environments, that both rely on each other, and showed that humans also actively engaged with the management, movement, harvesting and eating of ***moolks***.

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Appendix 1: Participant Consent Form and Information Letter

Participant Consent Form

***Moolks* (Pacific crabapple, *Malus fusca* Raf.): Knowledge and Meaning in Gitga'at culture**

You are being invited to participate in a study entitled ***Moolks* (Pacific crabapple, *Malus fusca* Raf.): Knowledge and Meaning in Gitga'at culture** that is being conducted by Victoria Wyllie de Echeverria.

Victoria Wyllie de Echeverria is a graduate student in the School of Environmental Studies at the University of Victoria and you may contact her if you have further questions by phone [redacted] (work) or [redacted] (cell) or emailing [redacted].

As a graduate student, I am required to conduct research as part of the requirements for a degree in Environmental Studies. This research is being conducted under the supervision of Dr. Nancy Turner (School of Environmental Studies). You may contact my supervisor at [redacted] This research is being funded by a Social Sciences and Humanities Research Council grant to Nancy Turner, and I personally received research support from the Jacobs Grant.

Purpose and Objectives

The purpose of this study is to learn about the classification systems and ethnobotanical uses of ***moolks*** or Pacific crabapple (*Malus fusca* Raf.) by the Gitga'at people of Hartley Bay, British Columbia. I have learned from previous work that the people in Hartley Bay recognize between five and six unique ***moolks*** varieties based on fruit and tree morphology, taste, and other variables, as distinguished by key knowledge holders. Through interviews and botanical field investigations, I will identify the locations, habitats and main features of each of these varieties. The study will also encompass understanding the cultural significance of each of these varieties to the people of Hartley Bay, including recording knowledge about use, management, ownership and trade. With this research I plan to explore how Indigenous Peoples, specifically the Gitga'at, categorized the species that were important to them culturally and how these varietal differentiations of the fruit showed their close association to certain species.

Importance of this Research

This research is important because it will help to elucidate the close relationships that some indigenous cultures held with certain cultural keystone species. One of the outcomes of these relationships is that people were cognizant of very subtle changes in a species' morphological and phenotypical characteristics. By learning from elders and other adults in the community the knowledge they hold in this respect, it will lead to greater understanding about cultural links to natural systems and thus, of biocultural diversity.

Participants Selection
You are being asked to participate in this study because either you are considered to be a plant specialist in your community, you were referred to me by somebody else, or you have approached me yourself about participating in this study.

What is involved
If you agree to voluntarily participate in this research, your participation will include between one to several interviews of one to two hours in length, in your home or another location where you are comfortable in the community of Hartley Bay. The interviews will be one-to-one, unless you would like a family member or close friend in attendance, or if a group interview is held. I would also like to conduct interviews in the field, and observe crabapple harvesting at the sites where they were traditionally harvested in Old Town. However, I know that the site may be difficult to get to for some participants, so material may be brought to you in Hartley Bay to examine when I interview you about subjects such as harvesting techniques and recognizing known varieties. If you are interested in coming out to the field site, I would welcome your knowledge, but participation in the field component is not mandatory.

I would like your permission to record audio (tape-record) during the interviews. Written notes and observations will also be recorded. A transcription will be made of any recorded tapes for you to approve before they are included in this study.

I would also like your permission to take photos during the interviews of you, especially when we are out in the field or you are demonstrating a technique visually, and possibly video record interview sessions.

Inconvenience
Participation in this study may cause some inconvenience to you, including the amount of time required for the interviews, but I will attempt to lessen these effects by making interviews pleasant and enjoyable, and I will monitor your energy levels. If you decide to travel to crabapple sites, you may experience tiredness, but again I will attempt to minimize that, and it is likely that traveling for this project would require no greater amount of time or energy than you would normally expend in your day-to-day life.

Risks
There are some potential risks to you by participating in this research and they include you becoming tired while participating in activities such as interviews and field trips. It is also possible that you might experience emotional stress and sadness when talking about the loss of traditional food and culture, loved ones previously involved in cultural activities who have passed away, and environmental degradation. To prevent or to deal with these risks I will carefully observe you while I am working with you to monitor your energy levels and state of mind, and I may also ask relatives or friends to assist if you anticipate that a particular interview or trip might cause higher than normal risks. If you wish to share an emotional story, I will listen with compassion and understanding. If

either you or an assisting friend or relative implies that you should stop the activity at any time, I will do so, and make sure that you get to rest as soon as possible. If you agree and feel better, I will resume interviewing on another day. If we are not in your home (i.e., if we are traveling or out in the field), I will make sure to have chairs, blankets, food, drinks and other amenities to make you comfortable. If you become emotionally troubled by a topic, I will let you take the conversation where you would wish, such as changing the topic or providing support and comfort while you share an experience.

Benefits

The potential benefits of your participation in this research include most likely gaining benefits because you will be recognized for your knowledge, both within and outside your home community. You will also be provided with compensation for your time. This research is important to society because by recording this knowledge we will be documenting the status of an important food tradition, which allows people to understand the cultural significance of this food system and surrounding knowledge to revive and continue these traditions for future generations. This research will also contribute to the state of knowledge because it will help elucidate links between the social and physical sciences with regards to key food plant species and help document an important aspect of bio-cultural diversity.

Compensation

As a way to compensate you for any inconvenience related to your participation, you will be given appropriate compensation depending on the protocols in place in the community of Hartley Bay, but will mostly likely consist of an honorarium of approximately $25/hour or a gift of equivalent value to individual participants. If you agree to participate in this study, this form of compensation to you must not be coercive. It is unethical to provide undue compensation or inducements to research participants. If you would not participate if the compensation were not offered, then you should decline.

Voluntary Participation

Your participation in this research must be completely voluntary. If you do decide to participate, you may withdraw at any time without any consequences or any explanation. If you do withdraw from the study your data will be used in the analysis only if you agree to this, with any stipulations you choose to make on the material. Material may be removed outright or portions can be kept in, depending on your wishes, including your name being removed from the material, but some of the information staying in. If the data has already been collected, full compensation will be given to you, but if you have not been interviewed yet, compensation will not be provided. If you have been interviewed in a group interview, your data is linked to group data, so it will be used in a summarized form with no identifying information.

On-going Consent

Since I anticipate that this research will require several interviews over the course of a few months, I would like to request your permission for on-going consent. After the initial interview, I would like to come back for follow-up interviews close to when the initial interview occurred, and also come back at longer intervals over the next couple years. At each subsequent interview, I will ensure that your consent continues and remind you that you can withdraw at any time from these interviews. You will be given an additional letter of consent if the time period between the interviews is more than a year, to indicate your continued participation.

Anonymity
Anonymity will not be protected when gathering the data or disseminating the results of this study. This means that you will be associated with the information that I learn from you. If you have a problem with this, I will attempt to preserve your anonymity. If you are not comfortable with the levels of anonymity that I will be able to provide, then your information will be left out of the research.

Confidentiality
Your confidentiality and the confidentiality of the data is not going be protected in this study, which means that you will be associated with your data during this study. If you have a problem with this, I will attempt to preserve your confidentiality. If you are not comfortable with the levels of confidentiality that I will be able to provide, then your information will be left out of the research. One of the reasons that your information will not be protected is due to the nature of participating in group activities, such as group interviews, or field trips to the harvesting sites. You will be provided copies of all photos, video and audio materials and transcripts from your interviews to check that your information has been accurately recorded and that you approve of this information being shared in a wider company. Copies of transcripts, audio and video recordings, written notes and photographs will be kept secure in my files at the University of Victoria, in Hartley Bay with your community and some portion of them at a museum archive that provided grant monies. If you would like copies of any of your data, that can also be arranged. Also, all of the information about the whereabouts of your personal crabapple harvesting sites and individual trees will be protected and remain confidential. This information will only be cited generally in any publications and other presentations. I will only set up sampling plots in these areas by permission, and will not return to these areas if not given permission to do so.

Dissemination of Results
Results from this study could be presented in several ways. It will definitely be included in my M.Sc. thesis, both a version for the university and a community version, and directly to the participants in this study (such as you). Other ways it could be disseminated are through publishing books, chapters or articles, presentations at scholarly meetings and on internet sites and other media. Funders of this research have asked that copies of some of the materials collected be archived in their museum in exchange for monetary help. However, any material I archive with them will be under appropriate access restrictions as per your instructions.

Commercial Use of Results
Although it is not my intention, this research may conceivably lead to a couple different commercial products or services that would be proprietary for the Gitga'at Nation. One possible nature of this commercial use is that this information could be used in the future

in providing source stock for domesticated apples or in providing propagules for growing some of the varieties documented in this research. However, protocols and agreements would have to be carefully worked out between the community of Hartley Bay and any intended enterprise. A Code of Ethics has been implemented by the International Society of Ethnobiology and other organizations to help guide and protect indigenous rights in this kind of situation. The Gitga'at community of Hartley Bay might also wish to use this information in commercial projects of their own, such as using crabapples as a focus species in ecotourism ventures.

Disposal of Data

Data from this study will be destroyed only if you request it. I will personally keep all the data until the completion of the project and then I will store it in accredited archives (perhaps the University of Victoria Special Collections, but this location is yet to be determined), dependent on your personal wishes and the wishes of the community. The community of Hartley Bay will also receive copies of all data for the community archives, and if you would like a copy, that can be arranged as well. If you would like your data destroyed, this will be done through shredding papers, secured disposing of cds and recorded files and permanently erasing digital files from computers and memory sticks.

Contacts

Individuals that may be contacted regarding this study include Victoria Wyllie de Echeverria, the main researcher, and Dr. Nancy Turner, her supervisor, at the phone numbers and emails listed above. In addition, you may verify the ethical approval of this study, or raise any concerns you might have, by contacting the Human Research Ethics Office at the University of Victoria [redacted].

Your signature below indicates that you understand the above conditions of participation in this study and that you have had the opportunity to have your questions answered by the researcher.

Visually Recorded Images/Data Participant to provide initials:

Photos may be taken of me for: Analysis _______ Dissemination* _________
Videos may be taken of me for: Analysis _______ Dissemination* _________
*Even if no names are used, you may be recognizable if visual images are shown in the results.

After this consent form is signed, you will receive one copy, along with a copy of the Information Sheet, and the researcher will retain the other copy.

I, __________________________________ on this ____ of _________________:
(participant's full name) (day) (month and year)

PLEASE SELECT STATEMENT:

❑ have read and understood the **information sheet** provided by Victoria Wyllie de Echeverria on her research entitled: ***Moolks* (Pacific crabapple, *Malus fusca* Raf.): Knowledge and Meaning in Gitga'at culture.** (*please check box if you agree)*

❑ am aware that my participation in one or more interviews or focus group discussions with Victoria Wyllie de Echeverria is completely voluntary, and that I can withdraw participation at any time without consequences. (*please check box if you agree)*

❑ am aware that the information that I provide in these interviews or focus group discussions with Victoria Wyllie de Echeverria 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 provided in the interviews or focus group discussions. (*please check box if you agree)*

I ❑ do ❑ do not consent (*please check one box*) that these interviews or focus group discussions with Victoria Wyllie de Echeverria be recorded on audio cassette. I am aware that the interviews or focus group discussions can proceed without being recorded on audio cassette. Even if I do consent to have this interview or focus group discussion audio-recorded, I am aware that I am free to request that the audio recording be turned off at any point during the interviews or discussions.

I ❑ do ❑ do not consent (*please check one box*) that these interviews or focus group discussions with Victoria Wyllie de Echeverria be recorded on video cassette. I am aware that the interviews or focus group discussions can proceed without being recorded on video cassette. Even if I do consent to have this interview or focus group discussion video-recorded, I am aware that I am free to request that the video recording be turned off at any point during the interviews or discussions.

I ❑ do ❑ do not consent (*please check one box)* that these interviews or focus group discussions with Victoria Wyllie de Echeverria be photographed and that photographs from this interview or taken at other times, with my consent, may be used in publications and presentations pertaining to the specific information that I provide in the interview or focus group discussion or during related events. Even if I do consent to have this interview or focus group discussion photographed, I am aware that I am free to request that photographs not be taken at any point during interviews or discussions, or during other related events.

I ❑ do ❑ 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 Victoria Wyllie de Echeverria, and be credited in the results of this study.

I ❑ do ❑ do not consent (*please check one box)* to having my responses attributed to me by name in the results of this study by Victoria Wyllie de Echeverria.

I ❑ do ❑ do not consent (*please check one box)* that my information from this project may be used for future projects conducted by Victoria Wyllie de Echeverria that are related to traditional preparation, harvest, and management of food plants and other culturally important resources.

I ❑ do ❑ do not consent (*please check one box)* that my information from this project related to traditional preparation, harvest, and management of food plants and other culturally important resources may be placed in an archives at the University of Victoria by Victoria Wyllie de Echeverria.

I ❑ do ❑ do not consent (*please check one box)* that my information from this project related to traditional preparation, harvest, and management of food plants and other culturally important resources may be placed in an archives or cultural resource library or centre in your community by Victoria Wyllie de Echeverria.

I ❑ do ❑ do not consent (*please check one box)* that the researcher, Victoria Wyllie de Echeverria, can retain my information from this project for her own records, to be kept in a secure location by her.

_______________ (Participant to provide initials)

_______________________________ _______________________________ ________________

Name of Participant *Signature* *Date*

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

DETAILED DESCRIPTION OF PROJECT: The ethnobotany, knowledge and cultural meaning of ***Moolks*** (Pacific crabapple) to the Gitga'at people

Victoria Wyllie de Echeverria
Masters' student, University of Victoria
[redacted]

The primary objective of this study is interviewing people about how they use, or used, ***moolks***. I would like to interview people in two different groups: elders and other adults, and youth. I would like to interview the elders and other adults because they will not only know about the ethnobotany of ***moolks***, but also likely have had plenty of first-hand experience, and hold some knowledge of the different varieties and techniques of management, ownership, harvesting and processing. They would also most likely be interested in sharing this knowledge, not only to be preserved in the written records, but also in transmitting this knowledge the younger generations of Gitga'at community members. I am interested in interviewing people in the youth group because I am interested in seeing the engagement of younger people in the process of working with traditional foods and in looking at how knowledge is transmitted down through generations. I would also like to learn if younger people currently use ***moolks***, and if not, are they interested in reviving these practices.

In the first set of interviews, I hope to learn about the basic ethnobotanical information about ***moolks*** that is specific to the Gitga'at people and knowledge around ownership, management, trade and linguistic terms. I would like to ask about how people prepared for going out to collect ***moolks***. I would also like to map out the locations of the trees but this information will be kept very private with the interviewee. In the second set of interviews, I would like to spend some time up at Old Town with the participants I am interviewing, if possible. If it is not possible, I would like to bring samples of the ***moolks*** back for people to look at. From the elders and adults, I would like to learn how ***moolks*** were managed and tended while harvesting was occurring, harvesting techniques and protocols, and the timing of the harvest, including physical knowledge about how to tell if ***moolks*** are ripe. With the help of the youth, I am interested in reviving the practices of tending the ***moolks***, based on the elders' advice, such as clearing the area around the trees. While I am in Old Town, or back in Hartley Bay after collecting ***moolks***, I would also like to learn the processing techniques of ***moolks*** (including the tools that were used), how each different variety is used and the cultural significance and more specific linguistic terminology around each of these varieties. The focus of these interviews will be on all the knowledge about post harvesting processes, and really digging deeply into unpacking the cultural significance of each of the varieties that have been identified.

I am also going to have a science side to this study. In this part, I would like to measure various parts of the trees, such as the fruits and leaves, to record any differences in size, shape, colour and taste. I would also like to record the environmental conditions around the tree, such as amount of water and sunlight, and what direction the tree is facing to see how these characteristics influence the different varieties of ***moolks***. I don't wish to contrast and compare this biological information with the ethnobotanical information, or attempt to validate the anyones knowledge in any way. Previous studies with other groups have hinted at the vast knowledge that is held by Indigenous People about many plants, including ***moolks***, but few have investigated one plant extensively, and also linked the science to the traditional knowledge. This is important because the elders know that this knowledge is true, but scientists and other people on the outside world don't always appreciate the elders' knowledge and need science to help explain things to them. I hope that by both learning about the traditional knowledge and measuring the trees that I can show the rest of the people about the elders' deep knowledge. By recording this western scientific information, my study could also be used as another piece of evidence to present to the outside world how much the Gitga'at rely on the resources from the land around them, and how much care they took of it – particularly in cases like Enbridge, where they just don't realize how much their proposal could impact your way of life.

Appendix 2: Interview Questions

With these questions I am hoping to learn about *moolks*, crabapples, including how they are collected and prepared, and their importance in Gitga'at culture. I would also like to know whether, and how, people distinguish different varieties of these fruits, and if so, how these are named and classified. I am also interested in ownership practices and management or tending of crabapple trees, and the significance of this plant in a Gitga'at worldview.

I am planning to use a semi-structured interview format, and the questions I have outlined below will serve to guide the interview, and to make sure that I cover all the different areas of information about ***moolks***. I do not anticipate following the order of the questions explicitly, but all the topics will be covered as the interview progresses, in whatever order seems to fit at the time.

Interview Questions

Date:________________________________ Time:___________________

Location:____

Interviewer:__________________________
Interview number:_________

1) Basic personal information (if ok).
    a. Name
    b. Age
    c. Gender
    d. Place of Birth
    e. Parents and grandparents names
    f. How long have you lived in Hartley Bay?
    g. How many generations has your family been in Hartley Bay?

2) Do you know about ***moolks***?

3) Have you eaten ***moolks***?

4) Have you heard of more than one variety of ***moolks***?
    a. If so, how many?

5) Where do you [or your family members] harvest ***moolks*** from? [IF YOU WISH, THIS INFORMATION WILL REMAIN CONFIDENTIAL, EXCEPT FOR THE GENERAL REGION]
    a. If you know about more than one variety, where is each different variety found?
    b. Do you know the names of different varieties in Smal'gyax?

c. How do you tell the varieties apart?
d. Do you personally use more than one variety?
e. How far apart are the areas where each variety is found?
f. Do you know of crabapple trees or patches that are owned by clans or individuals?
g. Are all the areas owned by someone, or are some owned by everyone?

6) Were there certain practices about taking care of, and managing, the ***moolks*** trees?
   a. How were these pratices done?
   b. What time of year was it done?
   c. Who did it?
   d. Why were these pratices done?
   e. Where are the trees that were taken care of? If not all trees, why not?
   f. Have you personally done any of these practices?
   g. If not, how did you hear of/how do you know about them? (oral history?)

7) Have you heard of ***moolks*** being moved to a new area and planted by people?
   a. Who moved them?
   b. What time of year were they moved?
   c. How were they moved?
   d. Why were they moved?
   e. Which varieties were moved?
   f. Why were these specific varieties moved?
   g. Where were they moved from and where were they moved to?
   h. Have you personally moved any trees?
   i. What part of the tree was moved? (sapling, fruit, seed, etc…)
   j. Were fruits of a certain size (of one or all varieties) favoured?
8) Other than the fruit, are there other parts of the tree that you have or do use, or have heard of others using? (collect basic information on all parts used, but ask detailed questions about the fruit)

FRUIT

9) What time of year do you collect the fruit of ***moolks***?
   a. Is there any difference in collecting times for the different types?
   b. What environmental/phenological characteristics indicate that you should start harvesting ***moolks***?
   c. What other resources are harvested at the same time?
   d. What other resources are harvested just before? Just after?
   e. Are there rules about the first harvest of the year?
   f. What are the rules about harvesting from areas that other people have rights to? Other people harvesting in your area?
   g. If you didn't have an area, where could you harvest?

10) How do you collect the fruit?
   a. At what level of ripeness do you like to collect the fruit?

b. If more than one level, why do you collect at different levels (unripe vs. mushy, used for different things)?
c. If picked unripe, were fruits ripened after collection? How?
d. What tools or containers do you use?
e. What are the words for the different tools, ripeness levels, varieties etc.?
f. Can you describe how harvesting practices have changed from the past?

11) How do you prepare and store the fruit?
   a. In the past?
      i. For storing?
      ii. For eating right away?
      iii. What tools do you use?
      iv. How do you eat the fruit?
      v. When do you eat the fruit?
   b. Today?
      i. For storing?
      ii. For eating right away?
      iii. What tools do you use?
      iv. How do you eat the fruit?
      v. When do you eat the fruit?
   c. What are the words for the different tools, preparation techniques, etc.
   d. Do people eat as much of this fruit as they did in the past?

12) Can you tell me more about the cultural significance of this plant?
   a. Are there any legends/stories that refer to ***moolks***?

13) How has use of ***moolks*** changed over the time that you have been harvesting?

14) Is there anything else you would like to share with me about ***moolks*** or the tree?

Appendix 3: Gitga’at Seasonal Harvest Round

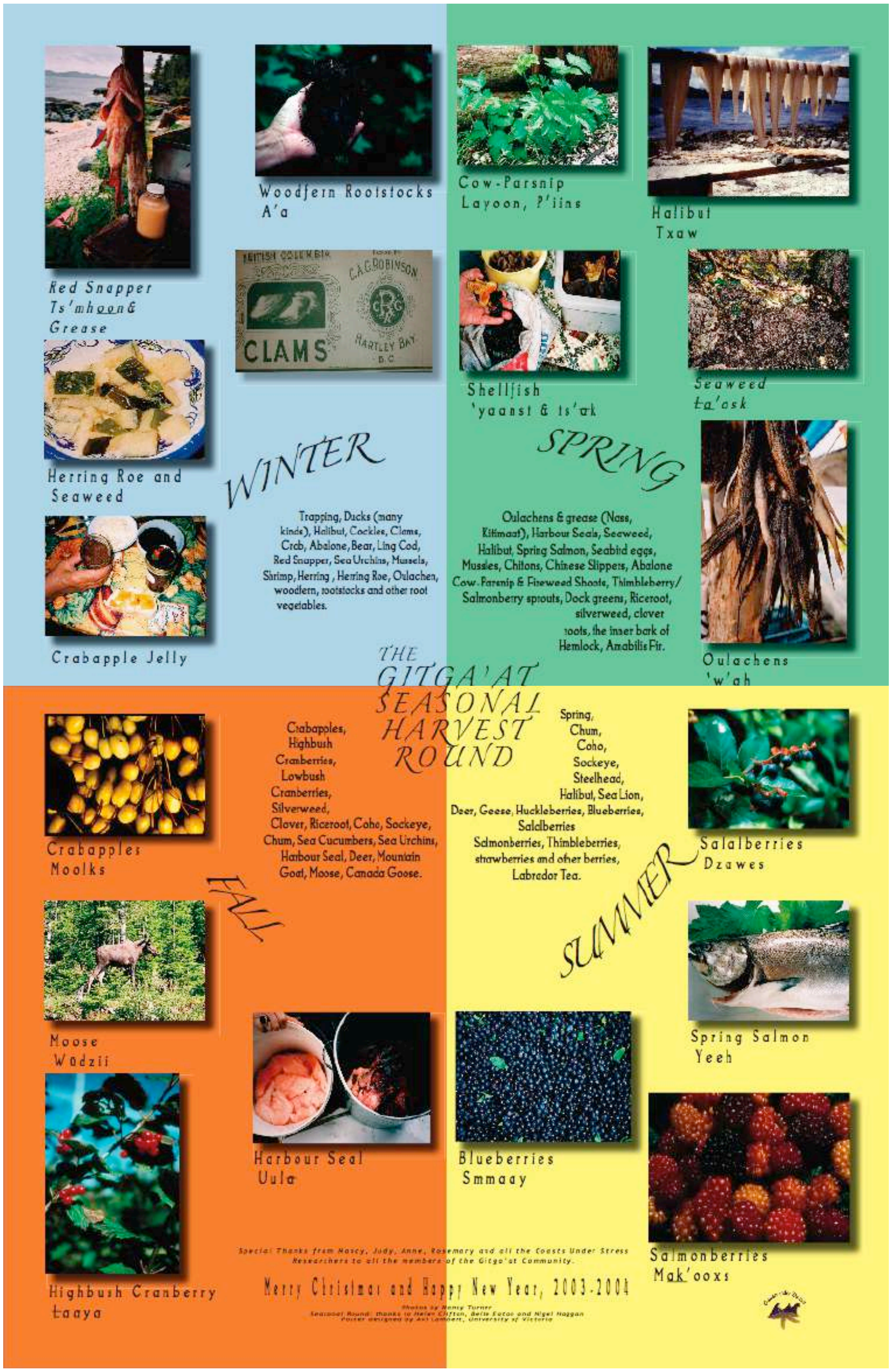

Figure A3.1. Gitga'at seasonal harvest round, compiled by N.J. Turner.

Appendix 4: Summary Statistics and Pearson's Correlation Coefficients

Table A4.1. Means and Standard Deviation (SD) values for fruit traits.

Tree number	Length (mm) mean ± SD	Width (mm) mean ± SD	Volume (mm^3) mean ± SD	Stem Length (mm) mean ± SD	Weight (g) mean ± SD
1	11.90 ± 1.37	8.11 ± 1.37	58.88 ± 7.83	28.62 ± 3.98	0.51 ± 0.18
2	12.30 ± 1.75	9.03 ± 0.93	63.58 ± 7.20	29.81 ± 3.89	0.61 ± 0.19
3	12.11 ± 1.28	9.49 ± 0.85	65.10 ± 5.96	29.68 ± 2.73	0.69 ± 0.17
4	11.19 ± 1.24	9.06 ± 0.92	61.36 ± 6.28	32.69 ± 2.78	0.58 ± 0.17
5	8.04 ± 0.94	8.20 ± 1.09	51.20 ± 6.34	42.48 ± 3.33	0.37 ± 0.13
6	8.16 ± 0.89	8.09 ± 0.95	50.96 ± 5.58	42.34 ± 3.21	0.36 ± 0.11
7	13.21 ± 1.20	11.15 ± 1.45	74.40 ± 7.97	27.78 ± 5.44	0.96 ± 0.31
8	12.76 ± 1.10	10.29 ± 1.04	69.83 ± 6.25	28.59 ± 4.67	0.79 ± 0.22
9	12.65 ± 1.28	8.96 ± 0.97	64.02 ± 6.45	29.48 ± 1.81	0.62 ± 0.19
10	11.51 ± 1.34	9.68 ± 1.15	64.66 ± 6.60	32.36 ± 5.58	0.65 ± 0.19
11	10.33 ± 1.19	8.66 ± 1.10	57.90 ± 6.84	29.90 ± 4.31	0.48 ± 0.15
12	10.99 ± 1.23	9.61 ± 1.34	63.28 ± 7.93	28.86 ± 5.72	0.60 ± 0.23
13	11.21 ± 1.36	10.10 ± 1.34	65.80 ± 7.99	28.29 ± 4.91	0.71 ± 0.24
14	12.20 ± 1.39	8.45 ± 1.00	60.93 ± 6.85	31.43 ± 4.24	0.55 ± 0.17
15	11.11 ± 0.84	9.45 ± 0.78	62.86 ± 4.78	31.35 ± 2.90	0.63 ± 0.13
16	13.75 ± 1.06	11.03 ± 0.74	75.02 ± 4.89	33.10 ± 3.53	0.98 ± 0.19
17	12.28 ± 1.21	9.82 ± 1.03	66.84 ± 6.60	29.90 ± 4.00	0.73 ± 0.21
18	11.31 ± 0.92	10.23 ± 0.82	66.55 ± 5.09	24.74 ± 3.92	0.69 ± 0.17
19	13.53 ± 1.71	11.68 ± 1.07	77.24 ± 7.67	37.14 ± 4.64	1.13 ± 0.30
20	12.30 ± 1.42	9.58 ± 1.04	65.90 ± 6.90	26.73 ± 5.89	0.71 ± 0.20
21	12.53 ± 1.24	10.64 ± 1.28	70.81 ± 7.69	21.61 ± 3.79	0.84 ± 0.25
22	13.57 ± 1.19	10.65 ± 0.88	73.04 ± 5.98	25.38 ± 4.45	0.92 ± 0.21
23	14.06 ± 1.15	10.31 ± 0.69	72.63 ± 5.02	18.91 ± 2.68	0.91 ± 0.18

24	16.01 ± 1.26	11.33 ± 1.32	81.02 ± 7.15	25.32 ± 3.64	1.18 ± 0.25
25	8.80 ± 0.98	8.49 ± 0.87	54.02 ± 5.52	19.80 ± 3.91	0.38 ± 0.11
GD1	10.59 ± 0.98	9.03 ± 1.04	60.00 ± 6.22	30.05 ± 4.42	0.53 ± 0.16
GD2	11.59 ± 1.05	9.11 ± 0.85	62.43 ± 5.46	31.55 ± 4.31	0.63 ± 0.15

Table A4.2. Means and Standard Deviations values for leaf traits.

Tree number	Length (mm) mean ± SD	Width mean (mm) ± SD	Area (mm^2) mean ± SD	Number of teeth (L) mean ± SD	Number of teeth (R) mean ± SD	Largest teeth size (L) mean ± SD	Largest teeth size (R) mean ± SD
1	56.33 ± 17.04	28.54 ± 6.67	1181.86 ± 608.01	27.50 ± 6.33	27.40 ± 5.08	1.04 ± 0.49	0.76 ± 0.18
2	62.71 ± 14.34	36.11 ± 7.89	1737.01 ± 713.95	22.80 ± 6.11	24.00 ± 7.23	2.73 ± 1.12	2.47 ± 2.25
3	65.13 ± 6.23	43.08 ± 7.72	1953.34 ± 365.48	25.00 ± 6.41	24.10 ± 4.75	3.23 ± 1.88	3.08 ± 1.86
4	59.23 ± 8.44	42.66 ± 8.60	1812.19 ± 475.46	25.90 ± 5.55	25.20 ± 4.44	3.26 ± 1.90	3.14 ± 2.62
5	78.74 ± 13.92	43.56 ± 6.15	2443.21 ± 736.93	27.60 ± 4.67	28.30 ± 3.86	1.94 ± 0.56	1.81 ± 0.38
6	71.28 ± 15.41	40.46 ± 7.16	2149.44 ± 720.75	29.20 ± 4.98	28.90 ± 4.72	1.80 ± 0.33	1.77 ± 1.14
7	45.73 ± 9.05	31.73 ± 5.38	1137.54 ± 350.19	23.30 ± 4.19	22.70 ± 2.95	0.98 ± 0.31	0.96 ± 0.36
8	44.38 ± 7.13	35.97 ± 4.88	1291.37 ± 318.86	27.50 ± 4.90	28.50 ± 5.56	2.50 ± 2.13	2.69 ± 1.90
9	63.19 ± 13.13	31.83 ± 5.67	1435.62 ± 522.34	31.80 ± 6.96	31.10 ± 6.61	1.02 ± 0.33	1.10 ± 0.51
10	59.83 ± 11.85	44.09 ± 8.34	2033.85 ± 735.93	28.70 ± 7.78	25.90 ± 3.90	3.04 ± 2.24	2.81 ± 1.66
11	51.63 ± 6.85	30.17 ± 6.40	1145.67 ± 388.33	26.10 ± 3.63	24.20 ± 3.05	1.00 ± 0.45	1.01 ± 0.48
12	61.65 ± 11.09	45.17 ± 6.60	2097.39 ± 566.05	30.20 ± 4.24	29.80 ± 3.65	2.36 ± 2.00	2.34 ± 2.42
13	56.77 ± 11.74	40.35 ± 9.58	1803.50 ± 739.51	27.70 ± 8.50	28.70 ± 7.57	2.91 ± 3.00	2.12 ± 1.96
14	61.25 ± 7.40	32.80 ± 6.51	1517.72 ± 459.27	24.30 ± 3.59	25.10 ± 5.70	1.62 ± 1.13	1.22 ± 0.36
15	55.01 ± 13.92	34.58 ± 6.95	1387.12 ± 583.19	20.78 ± 6.34	21.22 ± 5.47	1.96 ± 1.24	2.40 ± 1.37
16	59.25 ± 14.56	42.03 ± 6.68	1996.51 ± 716.66	27.50 ± 6.20	25.60 ± 4.67	1.27 ± 0.48	1.09 ± 0.42
17	76.56 ± 13.21	45.39 ± 7.93	2482.83 ± 750.45	25.60 ± 4.62	25.80 ± 4.02	3.43 ± 3.19	2.41 ± 2.35
18	73.32 ± 16.36	42.34 ± 9.34	2211.77 ± 766.10	23.90 ± 5.92	23.70 ± 5.62	3.31 ± 2.39	3.88 ± 2.95
19	87.92 ± 12.76	49.89 ± 8.43	3180.63 ± 880.20	31.40 ± 5.60	29.90 ± 6.01	1.36 ± 0.43	1.25 ± 0.39

20	58.31 ± 11.74	31.32 ± 4.91	1303.46 ± 376.41	20.00 ± 4.22	20.50 ± 3.95	1.50 ± 1.69	1.77 ± 0.94
21	57.51 ± 10.83	34.41 ± 7.49	1434.23 ± 477.02	21.90 ± 5.34	22.00 ± 4.08	2.66 ± 3.39	3.70 ± 4.72
22	71.54 ± 13.69	47.44 ± 6.18	2555.25 ± 622.97	31.10 ± 6.19	30.90 ± 4.95	4.31 ± 3.66	3.25 ± 2.85
23	67.09 ± 8.78	32.67 ± 8.58	1577.84 ± 578.28	26.20 ± 5.83	24.40 ± 5.40	1.51 ± 0.96	1.76 ± 1.74
24	71.31 ± 10.47	35.65 ± 5.44	1839.77 ± 394.28	36.10 ± 5.72	35.60 ± 5.08	1.67 ± 1.94	1.88 ± 2.00
25	64.62 ± 10.90	42.54 ± 10.07	1974.85 ± 762.08	23.70 ± 6.48	24.80 ± 5.92	7.77 ± 6.75	7.85 ± 5.26
GD1	60.52 ± 12.71	38.05 ± 8.13	1698.34 ± 623.71	27.10 ± 5.28	24.30 ± 5.19	1.73 ± 0.94	2.65 ± 2.25
GD2	55.66 ± 14.04	30.59 ± 3.71	1260.17 ± 380.09	25.50 ± 5.46	22.80 ± 5.14	1.32 ± 0.92	1.31 ± 0.94

Table A4.3. Pearson correlation coefficients for combinations of fruit and leaf traits, with p-value underneath. Data used was averages of all measurements from each tree, to have the same N size for fruits and leaves. P-value ≤ 0.05.

	Fruit length (mm)	Fruit width (mm)	Fruit volume (mm^3)	Fruit stem length (mm)	Fruit weight (g)
Leaf length (mm)	-0.0267 0.8947	0.1082 0.5910	0.0488 0.8091	0.2693 0.1743	0.1337 0.5062
Leaf width (mm)	-0.1463 0.4667	0.2546 0.2000	0.0739 0.7143	0.2731 0.1681	0.1165 0.5628
Leaf area (mm^2)	-0.0682 0.7352	0.2563 0.1968	0.1133 0.5738	0.3377 0.0850	0.1860 0.3529
Number of leaf teeth (L)	0.2706 0.1722	0.2277 0.2532	0.2637 0.1838	0.2206 0.2689	0.3110 0.1143
Number of leaf teeth (R)	0.2253 0.2585	0.1798 0.3695	0.2140 0.2839	0.1921 0.3372	0.2591 0.1920
Largest tooth (L)	-0.2902 0.1420	-0.0896 0.6567	-0.1942 0.3317	-0.3709 0.0568	-0.2166 0.2778
Largest tooth (R)	-0.3141 0.1106	-0.0782 0.6982	0.1994 0.3188	-0.4473 **0.0193***	0.2272 0.2545

Table A4.4. Component Loading from first five Principal Components Analysis for fruit and leaf traits combined.

Trait of tree	PC1	PC2	PC3	PC4	PC5
Fruit length (mm)	0.45	0.21	-0.23	0.05	-0.16
Fruit width (mm)	0.44	0.03	-0.30	-0.29	0.29
Stem length (mm)	-0.04	-0.11	0.56	-0.39	0.35
Fruit weight (mm)	0.49	0.09	-0.23	-0.19	0.06
Leaf length (mm)	0.16	-0.43	0.13	-0.32	-0.79
Leaf width (mm)	0.10	-0.53	-0.03	-0.38	0.32
Number of teeth, left side	0.36	-0.26	0.27	0.45	0.10
Number of teeth, right side	0.33	-0.30	0.24	0.50	0.07
Size of largest tooth, left side	-0.19	-0.42	-0.39	0.14	0.10
Size of largest tooth, right side	-0.22	-0.36	-0.44	0.13	0.06
Eigenvalues	3.36	2.61	2.31	0.95	0.45
Cumulative Percent of total	33.6%	59.8%	82.8%	92.3%	96.8%

Table A4.5. Correlations for combinations of fruit and leaf traits, with sampled trees divided by variety. Significant P-value ≤ 0.05. Sampled trees were grouped by variety and data averaged. Correlation and p-value was found for 7 samples (the trees separated by variety), with varying numbers of trees in the sample.

	Fruit Length (mm)	Fruit width (mm)	Fruit Volume (mm^3)	Fruit stem length (mm)	Fruit weight (g)	Leaf length (mm)	Leaf width (mm)	Leaf area (mm^2)	Number of leaf teeth (L)	Number of leaf teeth (R)	Largest tooth (L)
Fruit width (mm)	0.8385 **0.0184***										
Fruit Volume (mm^3)	--------	--------									
Fruit stem	-0.3173	0.0991	-0.0758								

length (mm)	0.4880	0.8327	0.8717								
Fruit weight (g)	0.8804 **0.0089***	0.9867 **0.0000***	0.9821 **0.0001***	0.0740 0.8747							
Leaf length (mm)	0.1707 0.7145	0.5620 0.1892	0.4172 0.3518	0.7369 0.0588	0.5745 0.1774						
Leaf width (mm)	0.2717 0.5556	0.6670 0.1017	0.5258 0.2265	0.5807 0.1716	0.6142 0.1422	0.8231 **0.0229***					
Leaf area (mm^2)	0.2720 0.5551	0.6741 0.0968	0.5293 0.2218	0.6719 0.0983	0.6566 0.1091	--------	--------				
Number of leaf teeth (L)	0.1585 0.7342	0.6376 0.1234	0.4582 0.3011	0.5604 0.1907	0.5568 0.1941	0.7698 **0.0429***	0.9261 **0.0027***	0.8864 **0.0078***			
Number of leaf teeth (R)	-0.0005 0.9992	0.4473 0.3143	0.2735 0.5529	0.5939 0.1598	0.3958 0.3794	0.8349 **0.0194***	0.9163 **0.0037***	0.9004 **0.0057***	0.8647 **0.0120***		
Largest tooth (L)	-0.2257 0.6266	-0.5006 0.2525	-0.4033 0.3697	-0.6725 0.0979	-0.4695 0.2878	-0.4854 0.2695	-0.3960 0.3792	-0.4752 0.2812	-0.4540 0.3062	-0.1834 0.6939	
Largest tooth (R)	-0.2610 0.5718	-0.5458 0.2051	-0.4461 0.3157	-0.7356 0.0595	-0.5188 0.2328	-0.5813 0.1710	-0.5196 0.2319	-0.5857 0.1671	-0.5037 0.2491	-0.3137 0.4932	0.9752 **0.0002***

Appendix 5: Geographical Information from Bamfield, British Columbia

Figure A5.1. Map of sampled trees in Bamfield, B.C. Circles represent island locations, squares represent bog locations and triangles represent estuary locations. Each colour represents a different set of sampled trees, referred to in the table below. Scale is 1 km (bottom left corner).

Table A5.1. Specific place names, habitats and GPS coordinates for all sampled *Malus fusca* trees, Bamfield, B.C.

Tree Number	Habitat	Place name	Latitude and Longitude
1	Island	Islet between Sandford Is. and Fleming Is., closer to Sandford	N 48° 52’ 18.3, W 125° 09’ 44.0
2	Island	Islet between Sandford Is. and Fleming Is., closer to Sandford	N 48° 52’ 19.0, W 125° 09’ 44.8
3	Island	Dixon Island, South	N 48° 51’ 02.9, W 125° 07’ 16.9
4	Island	Dixon Island, West	N 48° 51’ 04.9, W 125° 07’ 18.7
5	Island	Dixon Island, West	N 48° 51’ 08.2, W 125° 07’ 18.1
6	Island	Santa Maria Island, Southeast	N 48° 53’ 27.5, W 125° 01’ 45.1
7	Island	Santa Maria Island, Southeast	N 48° 53’ 31.7, W 125° 01’ 32.2
8	Island	Mainland, across from Santa Maria Is.	N 48° 53’ 31.1, W 125° 01’ 23.1
9	Bog	Skating Bog, off Lifesaving Trail (now West Coast Trail)	N 48° 48’ 54.5, W 125° 07’ 38.8
10	Bog	Skating Bog, off Lifesaving Trail (now West Coast Trail)	N 48° 48’ 54.0, W 125° 07’ 38.8
11	Bog	Skating Bog, off Lifesaving Trail (now West Coast Trail)	N 48° 48’ 53.6, W 125° 07’ 38.6
12	Bog	Skating Bog, off Lifesaving Trail (now West Coast Trail)	N 48° 48’ 53.2, W 125° 07’ 38.8
13	Bog	Path to Baby Bog, near Mother Bog	N 48° 48’ 45.0, W 125° 08’ 47.2
14	Estuary	Estuary near Anacla, Huu-ay-aht village	N 48° 48’ 10.8, W 125° 07’ 10.4
15	Estuary	Estuary at end of Bamfield Inlet, near trail to Cape Beale	N 48° 48’ 47.2, W 125° 09’ 22.9
16	Estuary	Estuary at end of Bamfield Inlet, near trail to Cape Beale	N 48° 48’ 46.7, W 125° 09’ 23.6
17	Estuary	Estuary at end of Bamfield Inlet, near trail to Cape Beale	N 48° 48’ 46.7, W 125° 09’ 23.9
18	Estuary	Estuary at end of Bamfield Inlet, near trail to Cape Beale	N 48° 48’ 45.1, W 125° 09’ 24.8