CHAPTER 17

Wapato: Fact, Fantasy and Fiction

T.C. SPURGEON

Introduction

Wapato (*Sagittaria latifolia* Willdenow), a tuberous starchy carbohydrate food-plant, is frequently mentioned in ethnographies and archaeological reports concerned with the Katzie First Nation (KFN). First mentioned in the "*Fort Langley Journals*" of 1827/30 (Maclachlan 1998) and subsequently in local ethnographies (Jenness 1955; Suttles 1955, 1987a) and archaeological reports (Crowe-Swords 1974; Patenaude 1985; Peacock 1981), wapato has not been addressed critically in terms of it's archaeological and historic context, nor has its archaeological preservation potential been assessed. While it has been studied in detail by botanists (Brayshaw 1985; Clark and Clay 1985; DeLesalle and Blum 1994; Fassett 1966; Kaul 1985; Lieu 79; Marburger 1993; Pojar and Mackinnon 1994; Wooten 1971) and to a lesser extent by archaeologists (Darby 1996; Hather 1991, 1993; Kubiak-Martens 1996; Neumann *et al.* 1989) wapato in Katzie territory is not well understood. This paper is essentially a summary of Spurgeon (2001), addressing many of the issues associated with understanding wapato to enhance future archaeological interpretations of its pre-contact use.

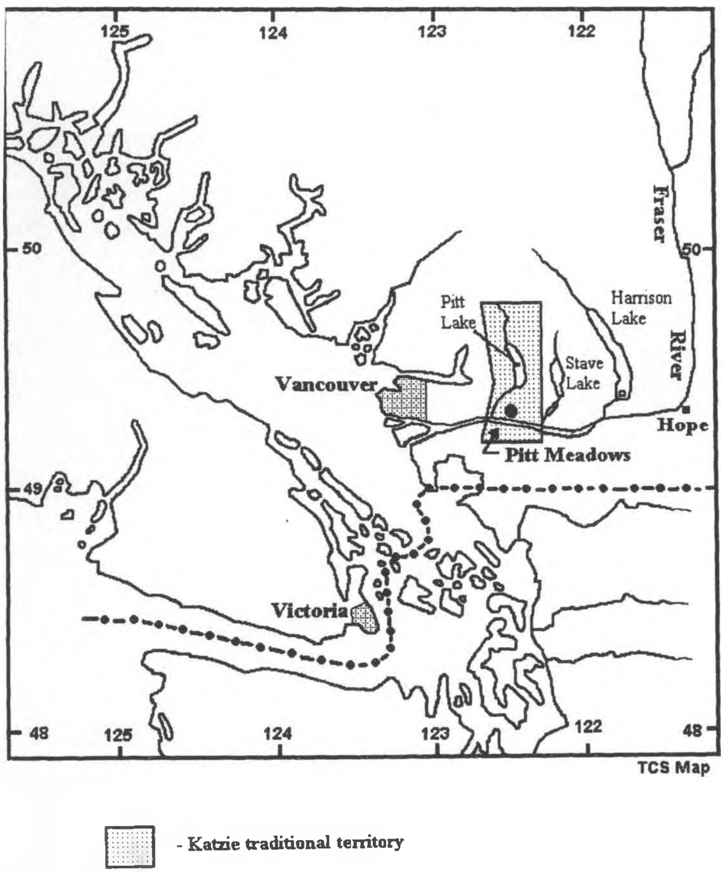


Figure 17:1. **Katzie Traditional Territory.**

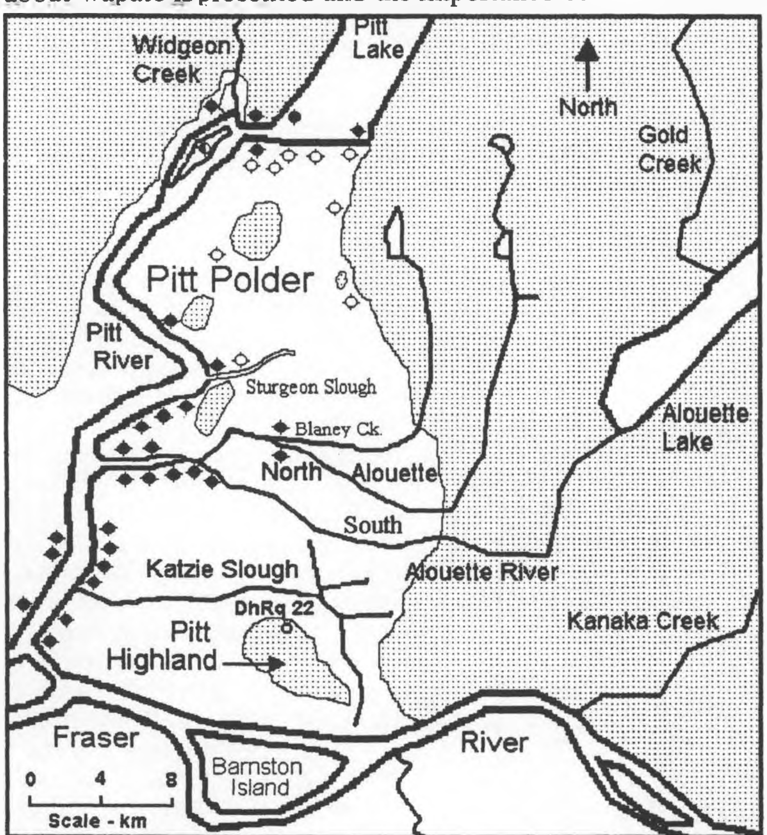
The need for research into wapato can be justified on several fronts. As a dietary source of starch wapato would have been a predictable and abundant complement to diets, which were high in protein. This fact accounts for its apparent popularity as a foodstuff and a trade item. Wapato species occur widely throughout the world and are abundant in the Pacific Northwest, especially along the lower reaches of both the Columbia and Fraser rivers. In wetland areas it could have been the object of cultural manipulation, including water management activities, to increase its abundance and production. There is a fleeting mention of such horticultural behaviour in one ethnographic account (Haeberlin and Gunther 1930:21). Much of what has been written in ethnographies and historical references is frequently taken out of context and a critical accounting of the sources is infrequent. The frequent inclusion of wapato in local archaeological reports is a case in point where much is made of wapato via ethnographic analogy and the direct historic approach, but ultimately no identification of wapato remains from archaeological contexts is provided. Hence, there is a need to assess its potential to survive in archaeological contexts and to predict where it might be found.

In view of the importance of wapato to the KFN, especially as regards traditional use studies in the environmentally sensitive Pitt Lowland area, a better understanding of what has happened to wapato since the time of first contact with Europeans is warranted. A critical and contextual review of the extant data on wapato helps fulfill this need while at the same time contributing to the creation of a predictive model for the archaeological occurrence of wapato. This review includes both a critical look at native language data relevant to wapato and the outcome of a wapato tuber charring experiment intended to provide an identification methodology. A host of important information about wapato is presented and the importance of critical, contextual and experimental analysis is established concurrently. The result reveals a need for researchers to break free from the common archaeological paradigms currently prevalent for the area in question.

Area of Study

This study focuses on the traditional territory of the Katzie First Nation (Figure 17:1). Katzie traditional territory, approximately 50 km up the Fraser River from the ocean, is located within the Georgia Depression and the Coast Mountain physiographic regions. The lowland areas of Katzie territory are just a few metres above sea level and prior to the advent of modern diking in 1892 (Collins 1975) were flooded annually by the Fraser River freshet. For linguistic purposes the area of study has been expanded outwards from the Fraser Valley to include adjacent Coast Salish speaking neighbours shown in Figure 17:2.

Today, low-lying areas are still subject to seasonal and daily water level fluctuations. On a daily basis there are tides which ebb and flow in the regionally dominant drainages of the Fraser and Pitt Rivers, affecting the lower reaches of the Alouette River and Widgeon Creek drainages, and Pitt Lake. During the middle-Holocene, as the Fraser delta migrated southwestwards, the Pitt Polder area was part of a large estuary. Tidal Pitt Lake is located in a former fiord, long cut off from the ocean by sea level change (Ashley 1977). The daily tidal reversal continues to build a delta front, which presently extends ca. 6 km into Pitt Lake (Ashley 1977). Mountains rising to elevations of 1,500 metres and more surround Alouette and Pitt Lakes. Rising vertically, from lowland to highland elevations in successive order, the area is contained within the Coastal Douglas Fir, Coastal Western Hemlock and Subalpine Mountain Hemlock Biogeoclimatic Zones. Driver (1998) provides a more detailed description of the geology, vegetation and wildlife. Figure 17:3 shows the lowland/highland distribution of terrain in Katzie traditional territory.



Wapato sites - ethnographic report ◇ - all inside dike system
observed 1998 ◆ - all outside dike system
both ◈ - outside dike system
▢ - Higher ground

Figure 17:2. **Halkomelem Dialects of Salish.**

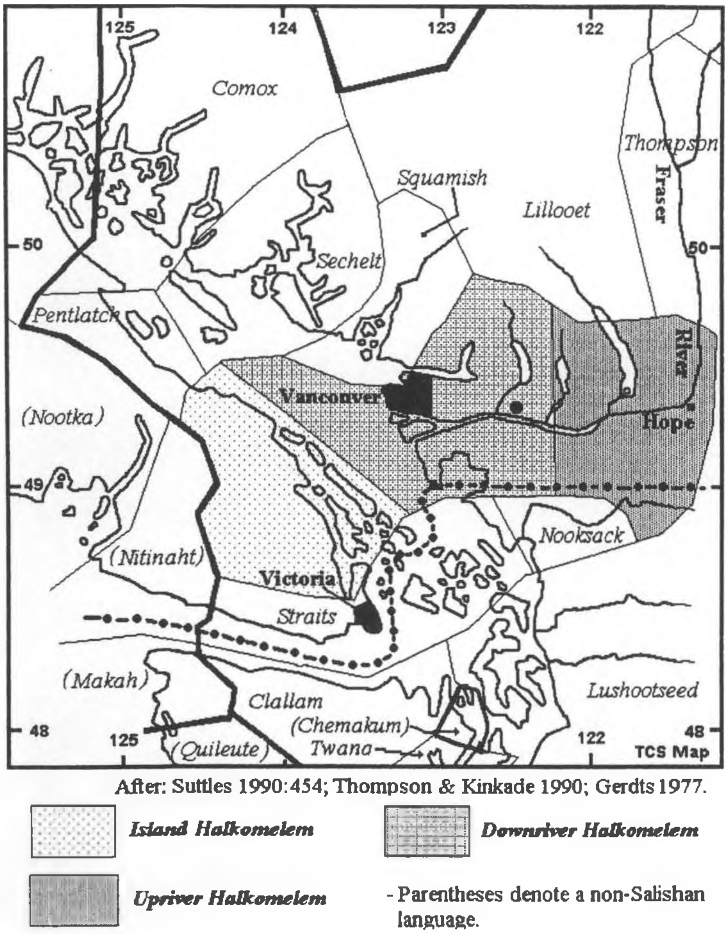


***Figure 17:3*. The lowland/highland Distribution of Terrain in Katzie traditional Territory in the Pitt Polder/Pitt Meadows Lowland.**

What Is Wapato and Where Is It?

Wapato, also known as arrowhead, arrow leaf, Indian potato, swamp potato and duck-potato, produces starchy tubers, which were an ethnographically known food source for native groups throughout much of North America. Indeed, its "Old World" cousin *Sagittaria sagittifolia* is equally as common in Asia and Europe where it was widely consumed by people. *S. latifolia* is widespread in Southwestern British Columbia (Brayshaw 1985; Pojar and MacKinnon 1994; Turner 1995) and especially prevalent in the low wetland areas of the Fraser Valley. Two maps in Brayshaw (1985:136-137) show *S. latifolia* less widespread elsewhere in British Columbia than the related *S. cuneata* that is widespread outside the lower mainland area (Brayshaw 1985:45). Suttles (1955:16 Map II) provides a place name map for Katzie traditional territory that includes at least nine wapato locations. More will be said later about the relevance of ethnographic reports for wapato in the Pitt Meadows lowland area.

S. latifolia (Figure 17:4) is variously described as a marsh, semi-aquatic or aquatic herbaceous perennial with its above water foliage having leaves of a characteristic arrowhead shape (Borman *et al.* 1997; Brayshaw 1985; Pojar and MacKinnon 1994). There is consensus that wapato is most often found in the margins of water bodies at depths less than 1 metre, most commonly in depths of less than half a metre and pH readings of 5.9 - 8.8 (Marburger 1993:251). It is a member of the Alismataceae or Water Plantain family. Its characteristic arrowhead shaped leaves, and white three petalled flowers easily identifies Wapato. The plant produces tubers 1 to 3 cm in diameter in the substrate of shallow waters (Figure 17:5). The starchy tubers are storage organs produced from the plants' horizontally creeping underground stems or rhizomes. *S. latifolia* reproduces vegetatively from the tubers and sexually from seeds. The fruits are flattened beaked achenes (Figure 17:6). The production of tubers and achenes varies considerably with growing conditions (Marburger 1993). Widely used today for wetland enhancement, restoration and creation, this C_3 species tolerates and assimilates high levels of nutrients and heavy metals, and is eaten by insects, waterfowl, mammals and fish (Brayshaw 1985:45; Marburger 1993; Piper 1906).

S. latifolia is found in both monoecious (bisexual) and dioecious (unisexual) forms (Brayshaw 1985:45; Marburger 1993:249-50; Wooten 1971). Monoecious plants bear both male (staminate) and female (pistillate) flowers on an individual plant whereas dioecious plants have their male and female sex organs on separate individuals (Capon 1990:173). Marburger (1993:250) notes that "dioecious forms are more limited in their ability to reproduce sexually, since out-crossing is obligatory."

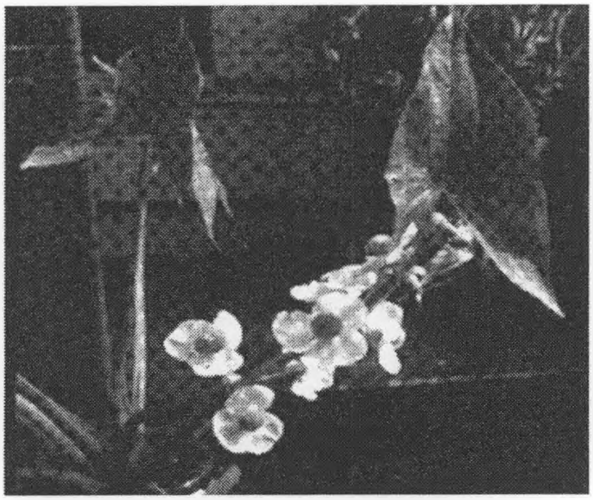


Figure 17:4. **Wapato Leaves and Flowers.**

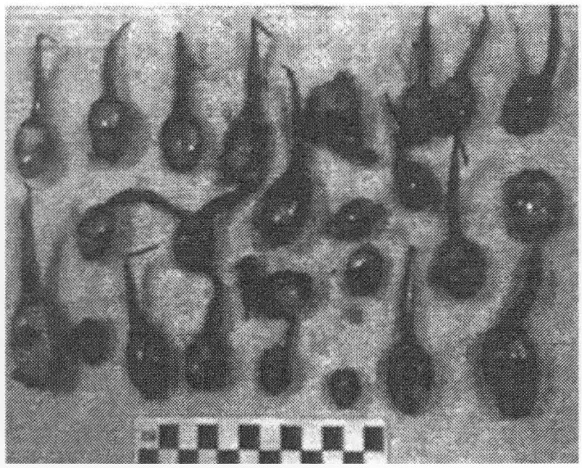


Figure 17:5. **Wapato Tubers.**

The Katzie and Wapato

The Katzie, who are Halkomelem language speakers, are included in the lower Fraser River Stalo sub-group and are one of the Central Coast group of Coast Salish peoples (Suttles 1990:453). Katzie territory encompasses the easternmost portions of the municipalities of Port Coquitlam and Coquitlam west of the Pitt River, portions of Surrey and Langley south of and adjacent to the Fraser River, and includes Fort Langley. The Katzie feature prominently in the "*Fort Langley Journals*" of 1827/30 (see Maclachlan 1998). For detailed accounts of Coast Salish and Katzie ethnography consult Barnett (1955) and Suttles (1987a, 1990).

In the past the Katzie utilized the abundant natural resources of the region in an annual round of fishing, hunting and gathering. Because their traditional territory encompasses such a variety of natural settings the Katzie had ready access to fresh and saltwater fish, a wide variety of mammals and birds, and a plentiful supply of plants. The Fraser River supported resident sturgeon and seasonally plentiful salmon, as well as other saltwater species such as eulachon and seals. The Katzie used all these species (Driver and Spurgeon 1998; Suttles 1955; Woodcock 1996).

The Katzie seasonal round had approximately 12 months divided into 10 counted and two supernumerary months, the first of which coincided approximately with the calendar month of June (Jenness 1955:7). A variety of hunting, fishing and gathering activities occurred throughout the year culminating in pot

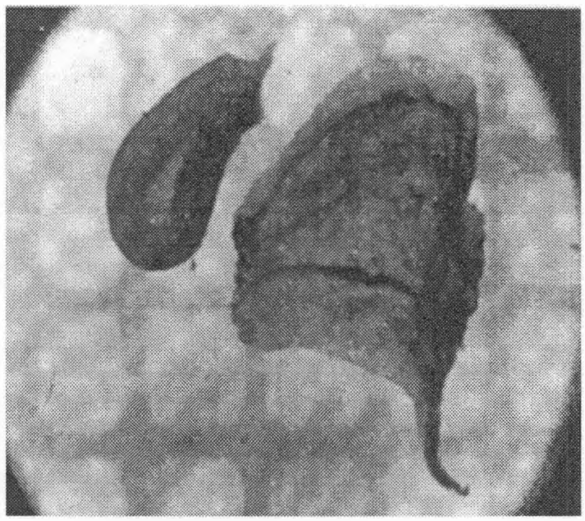


Figure 17:6. Sagittaria latifolia **(Wapato) Achene and Embryo. 1 mm background grid.**

latch and dance ceremonies at main villages during January and February. During the rainy, cold winter period the people stayed close to the main village, engaging in local food procurement activities not requiring extensive travel. In October the wapato harvest began and continued through November (Suttles 1955:27). I have harvested wapato into the month of April. Wapato patches, either owned by families or the tribe, were located on the west bank of the Pitt River around Siwash Island, on the flats north of Sturgeon slough,, and a shared patch near the head of Sturgeon Slough (Suttles 1955:27).

Some reports describe wapato harvesters wading in water and dislodging the tubers with their toes, or using canoes and pulling the plants free from the substrate (Pojar and MacKinnon 1994:337; Suttles 1955:27; Kuhnlein and Turner 1991:71; Turner 1995:37). It is not too great a leap to speculate that specialized tools similar to camas (*Camas quamash)* digging sticks (Haeberlin and Gunther 1930:20; Kuhnlein and Turner 1991:86) were used to augment the foregoing methods, although such perishable tools are not likely to be preserved archaeologically. The cultivation of introduced potatoes (*Solanum tuberosum*) eliminated the necessary requirement of entering water during the cooler months of the year to harvest wapato.

There are many cross-cultural examples of the use of digging sticks. One example is associated with the cultivation of taro (*Colocasia esculenta)* in Oceania (Sillitoe 1983; Oliver 1989). Golson and Steensberg (1985:347-384) discuss a wide variety of such digging stick implements used for several millennia in all phases of taro cultivation in the New Guinea Highlands.

Wapato Cooking and Nutrition

Mainly a starchy tuber of high water content, wapato provides a ready source of dietary carbohydrate. Wansnider (1997:2) states three reasons for cooking foodstuffs: 1.) to "advance the digestion process, so that more energy and nutrients can be obtained from any one mouthful of food" 2.) to "reduce the chance of illness by killing food-borne bacteria and parasites and by eliminating toxins that occur or develop in some tissues" 3.) so "spoilage bacteria are eliminated and water, needed by bacteria to grow, is reduced, so that the storage life of food may be extended." Cooking is an important factor in wapato nutrition as starch is not readily digested in the human gut without such processing (Englyst and Hudson 1997:9; Galliard 1987:3). Galliard (1987:3) notes that "because uncooked starch is poorly digested in the human alimentary tract, the main function of the various methods of cooking starchy materials is to convert starch granules to a form that can be attacked readily by the amylolytic enzymes of the digestive system."

Once harvested wapato tubers could be stored fresh, raw and unwashed, for several months according to Kuhnlein and Turner (1991:71). Wapato is reported as being eaten raw (Turner 1981:2341), cooked in hearths or hot ashes and in pits (Fladmark 1986:106; Haeberlin and Gunther 1930:23). Barnett (1955:60) indicates direct heating, steaming and boiling as the main cooking methods used by the Coast Salish but does not specifically mention wapato. Haeberlin and Gunther (1930:23) state that for the Puget Sound Indians "the principal methods of cooking were boiling with stones, steaming in a pit and roasting by an open fire." They refer to various kinds of roots and tubers, but do not specifically indicate a cooking method for wapato, instead noting that potatoes were pit cooked covered with sand. Boiling is the cooking method for wapato according to Anderson (1925:134). Turner (1995:3) and Batdorf (1990:67) report wapato tubers being cooked in hot ashes. Annie York, informant of Nancy Turner *et al.* (1990:113), describes the pit cooking of large quantities of wapato tubers. Kuhnlein and Turner (1991:71) state that wapato tubers were "prepared for eating by boiling, or baking in hot ashes, or in underground pits, after which they could be eaten immediately or dried for long-term storage or trading." Darby (1996:69) indicates roasting in ashes or boiling as the most frequently mentioned cooking methods for wapato. The Katzie cooked wapato tubers as needed by baking them in hot ashes according to Suttles (1955:27). Fladmark (1986:106) attributes the use of clay lined roasting pits for processing wapato to influences reaching the coast from the Plateau. An AD 1749 report indicates that *S. latifolia* roots were either boiled or roasted in hot ashes by the Indians of the Missouri River region (Gilmore 1991:13). Porterfield (1940:46) reports that in China the tubers were boiled much as they cooked taro, *Colocasia*. Also in China, Simoons (1991:111) reports wapato tubers being baked, boiled or steamed. It is likely that boiling, steaming and baking were the cooking methods variously used by native peoples of the Northwest Coast to prepare wapato for consumption.

While important nutritionally as a foodstuff, it should be noted that *S. latifolia* and its Asian relative were also used medicinally. Arnason *et al.* (1981:2243) report *S. latifolia* being used by the Iroquois to treat night crying in babies, and by the Ojibwa to treat indigestion, the former as an infusion and the latter as roots steeped with coneflower. Porterfield (1940:47 and 1951:18) notes a number of therapeutic uses for arrowhead: "Bruised leaves are applied to infected sores, snake and insect bites, and as a powder to itching diseases. The eating of raw tubers is said to be dangerous, producing fluxes and hemorrhoids and inducing premature birth." Woodcock (1996) makes no mention of Katzie use of *S. latifolia* for medicinal purposes.

Table 17:1. Nutrient Composition of *Sagittaria latifolia* (Wapato).

Reference	Species	Kjoules x10^3	Calories	Protein (g)	Carbohydrate (g)	Ash (g)	Lipid (g)	Calcium (mg)
H.H. Norton	*S. latifolia*	15.06	3.60	0.16	0.80	0.06	0.00.	0.35
et al. 1984	*S. tuberosum*	15.73	3.76	0.10	0.85	0.04	0.00	0.35

- per gram dry weight

- cont'd.

Iron(mg)	Magnesium (mg)	Zinc (mg)
0.41	0.63	0.03
0.03	1.09	0.02

Reference	Species	Food energy (kcal)	Water (g)	Protein (g)	Fat (g)	Carbohydrate (g)	Crude fiber (g)	Ash (g)
Kuhnlein &Turner 1991	*S. latifolia*	103	68	4.7	0.2	20.0	0.8	1.5

- per 100 g fresh weight

- cont'd.

Thiamine (mg)	Riboflavin (mg)	Niacin (mg)	Vitamin C (mg)	Calcium (mg)	Phosphorus (mg)	Sodium (mg)	Potassium (mg)	Magnesium (mg)	Zinc (mg)	Iron (mg)
1.60	0.25	1.4	5.0	12	165	22	922	51.0	0.7	6.6

- per 100 g fresh weight

Reference	Species	Water	Protein (g)	Food Energy	Fat (g)	Ash (mg)	Ca (mg)	P (mg)	Fe (mg)	Na (mg)	K (mg)	Riboflavin (mg)
Horton (1987)	*S. tuberosum*	80 %	2.1	76 (kcal)	0.1	0.9	7.0	53.0	0.6	3.0	407.0	0.04

- per 100 gram edible portion

Speth and Spielman (1983) point out the importance of carbohydrates in hunter-gatherer diets particularly during lean periods when meat lacks sufficient fat content. This lack leads to several nutritional problems, among them elevated metabolic rates with correspondingly higher caloric needs and deficiencies in essential fatty acids. They indicate that carbohydrates are seen as an excellent substitute for the missing fats, with hunter-gatherer groups resorting to trade and limited cultivation activities to acquire needed carbohydrates. Wapato is potentially one such source of carbohydrate and was traded and sought after by groups not having local supplies of the tuber. Wapato may have provided a predictable carbohydrate balance to a largely protein diet based on salmon. A brief summary of nutritional values for wapato is shown in Table 17:1. For a detailed listing of nutritional values from a variety of researchers see Spurgeon (2001, Table 1).

Wapato Trade

Wapato has been associated particularly with the Katzie whose traditional territory includes the Pitt Meadows and Pitt Polder lowland areas where it once grew in abundance. The Katzie and their neighbors maintained relationships based on the growing and trade of wapato. Whether the movement of wapato in the Fraser River region was restricted to trade or also involved free access to wapato for some outsiders is unclear. Wapato acquisition by coastal and interior peoples from the Fraser Valley peoples, was common (Suttles 1955:26; Turner *et al.* 1990:113). The Straits and Halkomelem Salish people on Vancouver Island acquired wapato from the Katzie as did the Squamish (Kuhnlein and Turner 1991:70). Turner (1997:160) mentions the Lower Nlaka'pamux of the Spuzzum area acquiring wapato from the Halkomelem people of the Fraser Valley. Katzie territory is reported to have patches that were shared with annual fall visitors. In one instance a large number of people congregated for the harvest at the confluence of the Pitt and Fraser Rivers (Maclachlan 1998:40).

The existence of prehistoric trade routes in British Columbia is well established (Ames and Maschner 1999:170-76; R. Carlson 1994:307-50). Primarily based on lithic evidence, especially obsidian, there is no reason to suspect that perishables such as wapato were not involved prehistorically given the ethnographic evidence for trade in numerous other perishable items not normally found in the archaeological record. The *Fort Langley Journal: 1827-30* (Maclachlan 1998:40) records the passage up-river on 21 December 1828 of Cowichan canoes laden with camas from Vancouver Island to be cached with salmon from the fall to use as food over the winter. Camas was rare in Katzie territory according to Suttles (1955:27) so it is possible that camas was one item used in trade for wapato. That such trade took place could be demonstrated archaeologically by finding charred wapato archaeologically on the Island and charred camas in sites of the Fraser Valley.

Comparison of wapato distribution, language, and its potential for trade on the Columbia and Fraser Rivers is illuminating. This comparison is also relevant given the linguistic origins for the Chinook Trade Jargon term *wapato,* and the word's subsequent spread throughout the Northwest Coast. The major river drainages have long been regarded as significant corridors for prehistoric human interaction between Interior and Coastal peoples. They support significant migrations of anadromous salmon (Schalk 1981) and serve as major transportation corridors. The Wappatoo Valley (Portland Basin) of the Columbia River and the Fraser Valley section of the Fraser River systems both supported extensive areas of wapato. On the Columbia River wapato was involved in trade both up and downriver (Boyd 1996:149; Ray 1938:120; Ruby and Brown 1976:99). Darby's (1996) wapato research is centered on this region. A similar upriver/downriver movement of wapato is reported for the Fraser River, especially focused on the wapato patches in Katzie territory.

Potential Problems Evident in Studying Wapato

To fully understand wapato it is necessary to recognize several potential problems that must be considered in addition to the aforementioned issues of critical ethnography, historical context and lack of archaeological evidence. These problems include: 1. the paucity of comparative paleobotanical materials, 2. the potential presence of research, informant and gender bias in ethnographies, 3. the considerable passage of time from first contact to the recording of ethnographic data, 4. the relative lack of archaeological survey and excavation for the area of concern, 5. the potential for bias and misunderstanding of historical information pertaining to First Nations people, and 6.) the early diffusion of the potato (*Solanum tuberosum*) into the area (Brown 1868; Suttles 1987a) and the consequent potential for confusion. These issues will be addressed briefly in the following discussion, which critically reviews pertinent ethnographic information and contextualizes historical data.

Language

Halkomelem is a Central Salish sub-family language existing as a "long continuum of intergrading dialects showing considerable diversity, but with mutual intelligibility throughout" (Thompson and Kinkade 1990:37). There are three dialects, referred to as Chilliwack, Musqueam and Cowichan by Thompson and Kinkade (1990:35), and frequently as Upriver, Downriver and Island dialects (Gerdts 1977:17; Suttles 1990:453-454). The three dialect divisions are more or less in consonance with cultural and ethnographic divisions presented by a variety of researchers (see Duff 1952; Mitchell 1971 and 1990; Suttles 1990). Suttles (1998) discusses the difficulties the different Halkomelem dialects presented the English speaking recorders of *The Fort Langley Journals* when they recorded native group names. Prominent among these is the substitution of the sound *l* in the upriver dialect for the sound *n* in the Downriver and Island dialects (Thompson and Kinkade 1990:37). Figure 17:2 shows the Salishan languages of the regions adjacent to the Fraser Valley study area, plus the three-part dialect division of the Halkomelem language.

Table 17:2 contains a short-listing of Coast Salish and adjacent neighbouring language words for *S. latifolia* and *Solanum tuberosum* in various Northwest Coast native languages. The list of words provides a preliminary glimpse at the potential value that linguistics study has to further archaeological research focused on wapato. For more details regarding the words see Spurgeon (2001). In the following commentary the number(s) enclosed in square brackets [#] corresponds to the number given each word listed in Table 17:2.

Wapato [1] is the Chinook Jargon trade language word for potato. This Pidgin language was used along the coast from the California/Oregon border to the Alaskan Panhandle at least since the time of contact with Europeans. Chinook Jargon, which has vocabulary accretions from indigenous native languages of the area, as well as French and English, should not be confused with Native American Chinookan languages (Thompson and Kinkade 1990:41). Wapato as a jargon word for potato has a similarity with the Spanish words "batata" or sweepotato and "patata" or potato. It is not always clear from the literature whether wapato refers specifically to *S. latifolia* or *S. tuberosum* – the domesticated Irish or white potato. Today, it is generally conceded to refer to both, the latter having more or less replaced the former after its early introduction to the region (Suttles 1987a). Brown (1868:379), referring to *wappattoo (S. sagittifolia*), states " Since the introduction of the potato the use of the roots of the *Sagittaria* has much declined, and the name is now trans-

Table 17:2. Wapato Glosses.

1. wapato - Chinook Trade Jargon; also known as *S. latifolia*, Indian potato, arrow leaf, duck potato, swamp potato, wapatoo; also reported as wap'to (Le Jeune 1924).
2. x^{w}aq'^{w}o_l_s - a distinct word for *Sagittaria latifolia* used by Katzie (Suttles 1955:27).
3. sq__w_ - what visiting tribes to Katzie area called wapato (Suttles 1955:27).
4. scous or skous - Halkomelem for wapatoes or *Sagittaria latifolia* (Duff 1952:73).
5. skă_us - northern Straits, Halkomelem, Nooksack, word for tuber (Suttles 1987a:142).
6. sqéws - Lummi (Suttles 1987a:144).
7. sqáwc - Samish, Klallam and Northern Puget Sound (Lushootseed) (Suttles 1987a:144).
8. ska_us or ska_wec - Southern Straits, Klallam and Samish (Suttles 1987a:143).
9. s-qawc or sqaúc - Squamish for potato (Kuipers 1970:65).
10. s-qawc - Mainland Comox for spud, potato (Davis 1968:84).
11. skawi_s_l'_ - derivative word for the whole *Sagittaria* plant (Suttles 1987a:143).
12. s.píq^{w}uc or s.páyq^{w}uc - Puget Salish for potato; arrowhead plant, wapato (Hess 1976:340).
13. sp_q__ c - Twana for arrowhead or wa_p_tu (Elmendorf 1960).
14. q'^{w}aß/q'^{w}úl's or q'^{w}_ß/q'^{w}úl's - Nlaka'pamux Interior Salish for *S. latifolia* (Turner *et al.* 1990).
15. s-qawc - Lillooet (van Eijk 1997:246).
19. sqig^{w}c - Coeur d'Alene from qig^{w} "dig roots" reconstructed as s-qawc (Kuipers 1970:65).
20. qa.wac - Nootka for potatoes (Sapir and Swadesh 1939:292).
21. ska_w_s - Nootka word for potato (Suttles 1987a:143 from Dr. Morris Swadesh) - in error.
22. skow-sh_ t - Haida word for potato (Dawson 1880:113B in Suttles 1987a:143).
23. _wa - Klamath for root (wild potato or *S. latifolia*) and potato (Barker 1963:80, 524-5).
24. ma'mptu - Tualatin branch of Kalapuyan word for *S. latifolia* (Zenk 1976:85 in Darby 1996:63).
25. ma_mpDu - Tualatin or Wappato Lake dialect of Kalapuya for wild potato (Jacobs 1945).
26. páapa - Lake Miwok (Penutian) for potato (Callaghan 1965).
27. wáala - Lake Miwok (Penutian) for Indian Potato (*Sagittaria latifolia*) (Callaghan 1965).
28. wakxa't - Wishram word for wapato (Spier and Sapir 1930:183 in Darby 1996:66).
29. tuk-hát or tuk´-hut - Chinook for wappatoo root (Gibbs 1863).
30. káßwats - Quileute for potatoes (from Chinook Jargon), (Powell and Woodruff 1976).
31. _síßxa_ - Quileute for root (edible), (Powell and Woodruff 1976)

ferred to the potato." Suttles 1987b:138-9) suggests several possible early sources for *S. tuberosum* on the Northwest Coast, all attributable to the presence of Russian, English and Spanish maritime explorers prior the close of the 18th century and to fur-traders early in the 19th century. There are no reported accounts, which discuss the possible influx of potatoes to the Coast Salish area through native trade prior to these early white contacts. This is in contrast with *S. latifolia*, which was widely traded by native peoples living along the Fraser and Columbia Rivers.

The existence of distinctively separate words, x^{w}aq'^{w}o_l_s and q'^{w}aß/q'^{w}úl's or q'^{w}_ß/q'^{w}úl's [2 & 14] for wapato in the Thompson and Katzie areas may be significant as indicators of where *S. latifolia* grew and as words that existed before the more common *scous* or *skous* [4] variants and *wapato* [1] terminologies arrived.

There are numerous words, which appear similar to sq__w_ [3] and include all of [4, 5, 6, 7, 8, 9, 10, 15, 19, 20 & 21]. These encompass an area, which includes Howe Sound, the Fraser Valley, Vancouver Island, Puget Sound and the Gulf Islands, Lillooet and Northern Idaho. Kuipers (1970:65) notes an etymological similarity for [9 & 19] which involves Squamish and Coeur D'Alene, both Salish languages separated by some distance. Hess (1979) has reported the wavelike nature of the distribution of native words for *deer* in much of the same territory in which *wapato* words based on sq__w_ [3] variants indicate similar patterning. He suggests that Halkomelem, as a centrally located Central Coast Salish language, served as the originator for the spread of the different words for *deer* (Hess 1979:10). The role of Halkomelem speakers of the lower Fraser in river trade has already been noted, and this is consistent with the middlemen role speculated upon by Hess (1979:16) when he suggests that Halkomelem may have been "quite widely known - perhaps as an incipient pidgin, parallel to the case of Chinook along the lower Columbia River." A similar development for *wapato* words should not be surprising for the Halkomelem dialects and those other languages in the Gulf of Georgia and Puget Sound areas immediately adjacent to the Halkomelem speakers.

The use of the word *wapato* is related to trade and was generally applied to both *Sagittaria latifolia* and *Solanum tuberosum*, particularly in more recent times. Given the nature of Chinook Trade Language trade would have facilitated cross-language communication and the associated passage of native language variants between adjacent dialects and close language neighbours. The movement of wapato throughout the Halkomelem area down the Fraser River and across the Gulf of Georgia, up the Fraser River to Lillooet and Thompson country, and into Howe Sound to Squamish is evident in the word morphology similarities. There is no similarity in word morphology between the Fraser River associated languages and those of the Columbia River groups [24 & 25], the other well known *S. latifolia* growing and trade area. For more distant language groups there is little word morphology similarity in evidence which may be a function of Chinook Trade Jargon usage and limited contact due to distance from the Fraser Valley. The lack of similarity suggests differing native language origins for *wapato* words for these distinct areas, a problem made more difficult to resolve with the advent of the Chinook Trade Jargon and the rapid spread and common use of the term "wapato."

Quileute [30] and Nootka [20 & 21] words for potato appear similar. Suttles (1987a) indicates the Nootka word [21] is in error, but the similarity of the Nootka word [20] to the Lushootseed word [7], the Southern Straits [8], Squamish [9] and Mainland Comox [10] words is apparent. All of these languages are immediately adjacent to Halkomelem, and in the case of Nootka perhaps provided the language link to Quileute via the Olympic Peninsula and the Makah, or alternatively the adjacency of Lushootseed and Straits may have influenced the Quileute usage.

While not strictly a language problem, botanists, ethnographers and historians variously refer to wapato as *Sagittaria sagittifolia* or *Sagittaria latifolia* depending on the date of the record. Early records compiled by European researchers likely refer to wapato as *Sagittaria sagittifolia*, nomenclature with which they were familiar in the Old World. Later recorders eventually adopted the plant classification *Sagittaria latifolia* to conform to the more modern convention for the New World form of the plant. Coupled with the variable native language words and meanings when referring to wapato and potatoes, the issue is further complicated.

There are several other tuber species in the Pacific Northwest that are frequently referred to as Indian and swamp potato. Ethnographies and botanical guides frequently contain references to Spring Beauty (*Claytonia lanceolata*) as "Indian potato" (Turner *et al.* 1980:113), Mariposa Lily (*Calochortus macrocarpus*) as "Wild potato" (Turner 1997:64), Broad-Leaved Starflower (*Trientalis latifolia*) as "Indian potato" (Pojar and MacKinnon 1994:322), and the Yellow Avalanche Lily (*Erythronium grandiflorum*) as "Indian potato" (Turner *et al.* 1990:121). The potential for confusion is obvious where proper botanical nomenclature is not used in conjunction with common names. It is likely that linguists and ethnographers frequently confused these species with wapato. Table 17:3 lists these species with the native language word for each. Fortunately, it appears that the native language words for these species are distinct from those related to wapato. It can only be hoped that ethnographers and other historic recorders accurately documented native language words so as to preclude this kind of confusion.

Bias

Recognition of bias is an important consideration in critically reviewing available information. Hammersley and Gomm (1997:1.1) conclude that accusations of bias are a recurrent event in the social sciences. They make the point that in response to such accusations there is often a counter-charge that it is not the original research that is at fault, it is the evaluation of the research that is biased. Bias exists in three main forms in their view: the first is "the adoption of a particular perspective from which some things become salient and others merge into the background"; and secondly in reference to systematic error, or "deviation from a true score as a valid measurement of some phenomenon or to accurate estimation of some population parameter"; and lastly in a more specific form denoting a particular form of systematic error:

> that deriving from an unconscious or conscious tendency on the part of the researcher to produce data, and/or to interpret them, in a way that inclines towards erroneous conclusions in line with his or her commitments (Hammersley and Gomm 1997:1.1).

Communication in the form of verbal accounts, written records and observed behaviour is the basis upon which the historic and ethnographic information researchers use was recorded. Communication implies something in the way

Table 17:3. Native Language Names for Selected Species of Food Plants.

Common Name	Botanical Name	Native Language Word	Source
Spring Beauty	*Claytonia lanceolata*	skwe_kwí_em (Okanagan-Colville)	Turner *et al.* 1980:113
Mariposa Lily	*Calochortus macrocarpus*	/m_q_=ú[_]pe_ (Thompson)	Turner *et al.* 1990:119
Broad-Leaved Starflower	*Trientalis latifolia*	/ciq^{w}=ó[q^{w}]pe_ (Thompson)	Turner *et al.* 1990:245
Yellow Avalanche Lily	*Erythronium grandiflorum*	s/k-ém-ec (Thompson)	Turner *et al.* 1990:121

of information being transmitted from the source and the reception of this information by the recorder. For the former the expectations of the enquirer may not always be fully understood and for the latter understanding of the information being transmitted may not always be clear. Subsequently, users of the recorded information also bring their biases and potential for misunderstanding into the process, often at great distances in time and space. Obviously the process is fraught with potential problems that must be addressed to ensure the veracity of the final record and subsequent interpretations. Assuming the process at least includes an informant and a recorder, (leaving out the ultimate user for the moment), some of the problems are:

- recorder qualifications - writing ability, language understanding
- recorder and informant comprehension - what is really meant?
- informant knowledge and biases - gender, width of view (family, community) and validity
- informant distance in time from the activity being recorded
- distance in time the recording takes place from the activity being recorded
- translation problems - is a potato a potato?
- do informants intentionally mislead or are they misinformed?
- do recorders inject their biases and is the research itself biased?

Glavin (2000) puts the need to consider these numerous ramifications quite succinctly when he states "Sorting out the history of the North Pacific involves the business of considering questions not only about the observed but also about the observer and the observer's own culture and ideology." Such questions pertaining to Katzie traditional territory are examined elsewhere (Driver and Spurgeon 1998).

On the Northwest Coast bias at a high level is quite evident in several forms. There is a bias in archaeological artifact preservation, where lithics dominate and faunal and floral remains are less successful in surviving the vagaries of taphonomic processes. The bias in artifact recovery results in the dominance of lithics analysis in reports, while faunal and floral analysis are less evident. Faunal analysis is more prevalent than botanical analysis that is only emerging in the last decade as a major focus in research design, recovery and interpretation (Lepofsky 2002).

The traditional categorizing of hunter-gatherer bands and sedentary agricultural societies into separate entities is somewhat problematic on the west coast as sedentary collectors have more in common demographically, socially and politically with agriculturalists than they do with most hunter-gatherers (Trigger 1989:399). Archaeology can lead to re-interpretation of misleading or erroneous information in historic and ethnological information, as is evident in the emergence of paleoethnobotany on the Northwest coast (Lepofsky 2002; Lepofsky *et al.* nd; Loewen 1998; Lyons 2000).

Ethnography and History

The potential entry of myriad biases into the historic and ethnographic record regarding wapato must be accounted for. There are a host of identifiable entry points for misleading information or bias to come into play when studying wapato in Katzie territory. It is useful to address the numerous historic changes since contact that have influenced our present knowledge of wapato use and our confidence in using the direct historical approach and ethnographic analogy as methods to infer prehistoric practices. Table 17:4 presents post-contact influences, which have regionally affected our modern understanding of this plant resource.

Table 17:4 presents the major influences in more or less chronological order from the present to early contact times and includes brief comments on each of the impacts listed. Accompanying these influences, especially since diking commenced, is a continuous disturbance

Table 17:4. Factors affecting Wapato use in Katzie traditional Territory.

Major Influence	Associated Impact(s)
Urbanization and development	Since 1860 - ever-increasing access restrictions to traditional use areas.
Hydroelectric development	Since dam construction in 1925 - reduced water flow in Alouette River, changes to Alouette Lake(s).
Forestry	Since late 19th century, ending by 1930. Mainly second growth left, large forest fires burned remainder, ending logging.
Agriculture	Mainly since dyking - reduced access, increased biotic disruptions.
Dyking	Started in 1892 - diversions, ditches, dredging, continuing maintenance, major biotic disruptions.
Botanical nomenclature	Old world/New world plant naming conventions.
Land alienation/Indian Reserves	Since 1860 - reduced or prohibited access to traditional use areas, ghetto like treatment of native population; land surveying started.
Colony status granted	1858 - new government, spurs settlement, irrevocably sustains new economy.
Language change	Constant erosion/change to native languages.
Fur Trade/Fort Langley	1827 - a new economy introduced - furs, money, jobs, trade goods, demand for consumer items such as food products.
Simon Fraser	Spring 1808 - Fraser river in freshet, notes expanses of water in Fraser Valley area, natives with firearms at mouth.
Potato (*Solanum tuberosum*) introduced	May signal end of large-scale wapato harvest.
First contacts/ Disease	Pre- AD 1800 - native population reduction begins, trade goods introduced

to or loss of archaeological sites. Represented in the table is an almost continuous series of impacts with both one-time and cumulative affects such that any speculation about wapato must be tempered with at least one or more of these factors. For many traditional uses the local native population was precluded from accessing significant portions of the landscape by land alienation, which, while distributing land first to speculators (Collins 1975) and later to settlers,, excluded native land ownership.

The continuous depredations of disease, estimated to have reduced pre-contact native population levels by up to ninety percent, would have limited traditional uses. This factor coupledwith the relatively late or, depending on viewpoint, recent gathering of ethnographic data (Jenness 1955; Suttles 1955) raises questions about the accuracy of male dominated information about female activities and the nature of what was being reported and its closeness to precontact practices. Suttles (1987a:16 footnote 2) notes that personal recollections of the oldest informants did not date back earlier than the 1870s and 80s, a situation that raises questions about the potential archaeological significance of some ethnographic reconstructions. It has been pointed out to me by Katzie band members that the knowledge of one family group about wapato as reported in Suttles (1955) might not necessarily reflect that of another family group.

An exception to closeness in time would be *The Fort Langley Journals: 1827-30* (Maclachlan 1998) which record activities during the AD 1827-30 period but have their own problems relating to the recorder's old world colonial and cultural biases and their difficulties in understanding and writing native languages (Suttles 1998). The accompanying new economic climate where paid jobs, trade goods and changed markets dominated, would have affected wapato use through the introduction of potato (*S. tuberosum)* growing by natives for their own consumption and to serve local white markets. Suttles (1987b:145) suggests that in addition to meeting their own food needs the natives also grew them because they had cash value at nearby trading posts. In contrast, the Fort Langley Journal (Maclachlan 1998:112) notes potatoes (*S. tuberosum*) from the Fort being used as payment to native labourers in May 1829. Brown (1868:380) notes that native grown potatoes (*S. tuberosum*) commanded higher prices, even from white men, than any other potatoes. More discussion of the impacts can be found in Spurgeon (1998a).

A factor further complicating our knowledge of wapato is the aforementioned rapid influx of the common potato (*Solanum tuberosum)* following first contact with Europeans as documented by Suttles (1987a). The rapid influx may in part have contributed to the decline in wapato consumption (Brown 1868:379; Rivera 1949:21). A comparison of the nutrient composition of *S. tuberosum* and *S. latifolia* as reported by Norton *et al.* (1984) and Horton (1987:94) shows them to be quite similar. The major difference between the two species is in their growing and harvesting conditions. Wapato is grown and harvested in water whereas *S. tuberosum* is grown and harvested on dry land.

Analysis of the following quotation illustrates the potential problems attendant upon uncritically accepting information at face value from quotations taken from a variety of historic and ethnographic sources. Taken as a whole such sources offer something of value when studying wapato, but nearly all can be misleading. There are potential problems with subject, intent, context, recorder and informant bias and many other issues. An excellent example is how the original George Barnston quote from "The Fort Langley Journals 1827-30" (Maclachlan 1998:40) appears in different sources. The handwritten transcription by MacIntosh (1963:26) of the original archival copy reads:

> We hear that a mass of Indians are now collected there, but that most of them intend soon to clear out entirely for their lands, not to return again until next summer. It appears that they procure, where they are at present, a great number of Wappatoes a root found under water in pools and marshes, and held by them in great estimation as an article of food. The name they give it here is Scous or rather Skous. On the Columbia it is known by the one first mentioned.

The most recent version of the quote from Maclachlan (1998:40) appears as follows:

> We hear that a mass of Indians are now collected there, and that their women are busied in gathering Wappatoes (wapatos) a root of which they are particularly fond, and which is found under the water in Pools and Marshes. The Indians here call it Skous, tho' I have given it the name by which it is known on the Columbia.

The MacIntosh (1963) version does not attribute the entry to Barnston, implying that it is a journal entry by James MacMillan. Duff (1952:73) has essentially the same information, although he names the location as the "Forks" (of Pitt and Fraser Rivers) whereas the MacIntosh transcription of Barnston refers to the location as "the forks below." It is the recent work of MacLachlan (1998:40) that attributes the entry to George Barnston and introduces the notion that women did the digging, although there is no mention of women doing the digging in the other versions. Several references to this passage refer to 5,000 Indians assembled at the confluence to dig skous on return from salmon fishing up-river (Suttles 1987b:142 footnote 12; McKelvie 1947:33, 1991:39) although no such figure exists in the original journal. It appears this number originates from an 1829 estimate in a separate report by a Hudson's Bay Chief Factor (Duff 1952:26; Murphy 1929:19). Overall, there is evidence here of bias, error and interpretation, all added at later dates well removed from the original to enhance the quotation, notwithstanding that events may well have transpired each year as indicated.

The following quote best sums up the present situation regarding typical Northwest Coast ethnography:

> When field notes were worked up into books, an academic datum plane was created: traditional Northwest Coast culture. If ethnographers asked their questions at the end of the nineteenth or early in the twentieth century, as many of them did, their informants remembered and described early- to mid-nineteenth-century societies. This was the slice of time that ethnography transformed into timeless traditional culture. (Harris 1997:28)

Paleoethnobotany

It is widely reported in archaeobotanical literature that charred tuber remains are difficult to identify in archaeological contexts (Hather 1991), and that tubers as food may "leave little waste and are rarely burned" (Ford 1979:300). In part, Hather (1991) attributes this situation to the lack of a developed identification methodology. Pearsall (1989:165) notes that in spite of their prehistoric subsistence importance, macroremains of underground storage organs are sparse. She attributes this to problems of preservation and identification difficulties.

In his study of Near Eastern grass seeds, Nesbitt (1997:181) notes three reasons for the importance of charring studies in archeobotany. First, he indicates that some seed characters (for example: color, appendages, relief) may no longer be visible on charred remains. Second, he states that some seed characters may remain visible but become distorted. Finally, some seeds are less likely to survive and will thus be underrepresented in the archaeological record. Pearsall (1989:440) attributes difficulties identifying charred remains to the species level to charring often destroying delicate structures and distorting specimen size and shape. Nevertheless, she (Pearsall 1989:173) states that "by studying the overall form of root or tuber material, external characteristics, anatomical structure, or a combination of these , it is often possible to identify archaeological material."

A survey of the more recent charring experiment literature reveals that charring experiments have not focused upon wapato or other tuberous plants but on seeds/fruits. Hather (1993) provides an example of wapato tuber charring aimed at the identification of parenchymous tissues, although he used *S. sagittifolia* not *S. latifolia*. The study is specifically intended as a guide to identifying a variety of charred parenchymous tissues.

Archaeology

The traditional territory of the KFN contains several excavated archaeological sites: Carruthers (DhRp 11 - Crowe-Swords 1974); Pitt River (DhRq 21 - Patenaude 1985); Telep (DhRq 35 - Peacock 1981); Port Hammond (DhRp 17 - Smith 1903) and Park Farm (DhRq 22 - Spurgeon 1984, 1994, 1996, 1998b). Paleobotanical remains were specifically looked for in the last four excavations listed but none were found there or in the other excavations.

Elsewhere, several reported instances for the archaeological presence of *S. latifolia* or *S. sagittifolia* are noted. In Poland, Kubiak-Martens (1996) reports the presence of the latter species at the Calowanie site. Neuman *et al.* (1989) report the possible presence of Sagittaria species in coprolites from the Dryden Cave site in Colorado. At the Duwamish Number 1 site in Washington state Stenholm (1987) reports the occurrence of what she calls PET (possible edible tissue) which may well turn out to be wapato. Melissa Darby (pers. comm.) has indicated that wapato is present archaeologically in the Columbia River area. Essentially, there has been very little archaeological work addressing wapato, this in part attributed to the lack of an identification methodology (Pearsall 1989) and the still uncommon inclusion of paleobotanical methods in research designs (Lepofsky 2002).

Environment

Wapato was generally harvested between October and March. Periods of colder temperatures may have had energy gain and loss implications related to harvesting activity and success. This is particularly so where tuber recovery required harvesters to enter the water as noted in ethnographies. In order to better understand the present day climate of the Pitt Polder area, especially for the colder months, a regular weekly set of qualitative and quantitative measurements was recorded at six locations for the 69-week period between December 11, 1997 and April 04, 1999. Climate records for the Polder have not been kept in the past making comparisons difficult, but the weather during the monitoring period did not appear to be appreciably different than that experienced in the last decade.

The information recorded included: date, time (local), water temperature, air temperature, general sky condition, precipitation, wind, water level fluctuations (to record seasonal, tidal or dyking/pumping influences) and for flowing water locations *i.e.*, Blaney Creek, the current direction. The recording sites are all located in the Pitt Polder, north of the North Alouette River. The sites were selected judgmentally after a lengthy period of familiarization and observation based upon access, maximizing coverage of the Polder area and providing a mix of inside/outside the dike system sites. The distance from the more southerly - Blaney Creek, to the northernmost - Grant Narrows is only 8.9 kilometres. The other sites are more or less evenly spaced between the two. Despite the relative proximity of the recording sites there were noticeable minor climate variations amongst them as can be seen in Tables 17:5 and 17:6.The further north the site, the cooler the air temperatures. The Grant Narrows air temperatures are frequently cooler. The Grant Narrows water temperatures do not follow the general pattern, a situation I attribute to Pitt Lake acting as a huge heat sink, which reduces the magnitude of water temperature fluctuations.

Of major relevance are the water and air temperatures, especially for the cooler winter months from October to March. There were a total of 42 observations taken during this period over parts of three years, the resulting water and air temperature ranges being shown in Table 17:5. During the 42 observations moderate to strong winds were experienced just over a third of the time, with strong outflow winds present on several occasions. The net result was water and

Table 17:5. Selected Water/Air Temperature Ranges October through March - Degrees C.

Month	Blaney Creek		Sturgeon		Dike		Gate		Grant Narrows	
	Water	Air	Water	Air	Water	Air	Water	Air	Water	Air
October - Low	10.0	9.5	11.0	9.0	10.5	9.0	10.0	9.0	12.0	9.5
High	12.0	13.0	15.0	13.0	12.0	13.0	12.0	13.0	14.0	13.0
November - Low	7.0	6.0	7.5	6.0	6.0	6.0	6.0	6.0	7.5	6.0
High	10.0	11.5	10.5	11.0	10.0	11.0	9.5	10.5	11.0	10.5
December – Low	-0.5	-5.5	0.5	-6.5	-0.5	-8.0	-1.0	-7.0	2.5	-7.0
High	6.0	5.5	7.0	5.5	5.5	5.0	5.5	5.5	7.0	5.5
January - Low	0.0	-1.0	1.0	-1.0	0.0	-2.0	1.0	-1.0	4.0	0.0
High	5.0	7.0	6.0	7.0	5.5	6.0	5.0	6.5	5.5	5.0
February - Low	4.0	3.5	4.0	3.0	4.0	3.0	4.0	3.0	4.5	3.0
High	6.5	9.0	6.0	10.0	7.0	9.5	5.5	9.0	5.0	6.0
March - Low	5.0	5.0	5.0	5.0	5.0	5.0	4.5	4.5	4.5	6.0
High	9.0	12.0	10.5	12.0	10.0	12.0	9.5	11.0	6.0	7.5

air temperatures that I felt did not encourage wading in the water. Several instances of ice-covered water were also noted.

The general pattern of warm summers and cooler winters is evident in Figure 17:7. Precipitation in the form of rain or snow for the winter period (October to March) was approximately six times more frequent than for the summer (April to September) period. This pattern is consistent with the expected wetter winter period. The cooler temperatures of the wapato harvest period from October to March lend credence to the use of digging sticks for wapato recovery in place of wading which is widely reported as the tuber recovery method. It may be a modern bias but on those occasions when I harvested tubers using a shovel or trowel during the cold period, my hands rapidly stiffened and tolerable exposure times were very short.

Finding Wapato

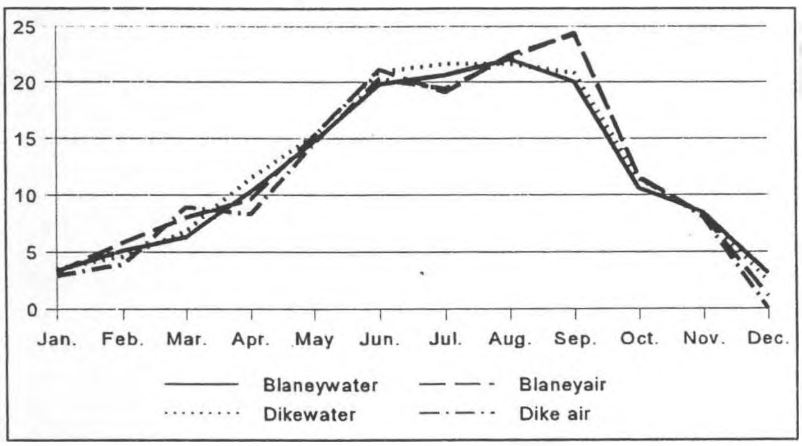
During 1998 I recorded wapato patches on the banks of the Fraser and Pitt Rivers, the lower reaches of Blaney Creek, the North and South Alouette and the Alouette River main channel below the forks. Wapato is also present on the Pitt River fronting IR4, in Widgeon Creek and slough and on Siwash Island. Field reconnaissance was split approximately evenly between inside and outside dike locales. The search involved walking along dikes observing water on both sides and included canoeing in the Pitt River, Pitt Lake, Widgeon Creek and Slough, and the Pitt Marsh where foot access is impossible. An estimated total in excess of 50 km was surveyed by foot and canoe. Ongoing reconnaissance continues to reveal new patches. In all instances to-date the patches have been located in water bodies where there is daily flow, albeit subject to short term water fluctuations (*i.e.*, tides, flood stages), and with bottom sediments comprised of silty/clayey muds. As yet, no wapato has been observed growing in non-flowing waters or those subject to long term fluctuations in water level or where the bottom sediments are largely peat with mixed silt/clay, conditions typical of those behind dikes. Marburger (1993:250) indicates wapato grows in inland and coastal freshwater marshes, around the margins of lakes andponds, and along rivers and streams. Turner (1995:36) notes the habitat for wapato as wholly or partly submerged in the water at the edges of lakes, ponds and streams, or in wet mud. Brayshaw (1985:45) has wapato growing in marshes and sheltered shallow water. Marburger (1993:250-52) discusses a variety of conditions affecting the sexual and asexual reproduction and growth of wapato, among them achene production being higher in water bodies with stable levels versus fluctuating levels, low water and dry conditions resulting in reduced flower and achene production, and plants growing in soft organic silts producing 14-15 times as many achenes as those growing in hard-packed clays. She further notes that above and below ground plant biomass is higher in sandy loam sites than in silty clay sites along the Mississippi River.

The initial association of wapato with flowing, muddy-bottomed waters subject to short term level fluctuations, in contrast to its apparent absence in non-flowing waters with peaty clay/silt bottoms and longer term water level fluctua-

Table 17:6. Monthly Average Water/Air Temperatures - %C. Observation period from 1 Apr. 98 to 31 Mar. 99 - 52 weeks.

		Blaney Creek		Dike Site		Grant Narrows	
Month	n=	Water temp.	Air temp.	Water temp.	Air temp.	Water temp.	Air temp.
January	5	3.3	3.2	3.5	2.9	4.8	3.1
February	4	5.1	5.8	4.6	3.9	4.8	4.4
March	4	6.3	8.0	6.8	8.9	5.4	7.1
April	4	10.3	9.6	11.5	8.3	-	-
May	5	14.7	15.2	15.2	14.5	-	-
June	4	19.8	21.1	20.9	20.3	-	-
July	4	20.6	19.1	21.6	19.4	-	-
August	4	22.0	22.4	21.6	22.1	-	-
September	5	20.0	24.3	20.8	24.4	17.5	22.0
October	4	10.6	11.6	11.4	11.5	12.9	11.6
November	5	8.4	8.2	8.2	8.0	9.3	8.0
December	4	3.1	1.1	2.4	0.0	4.8	0.75

Figure 17:7. **Average Monthly Water/Air Temperatures Degrees C.**



ions leads to the conclusion that modern diking, which has interrupted the water flow in the extensively channeled pre-diked lowland, has resulted in conditions where wapato no longer thrives. Also contributing to the negative impact of diking on wapato and archaeological site preservation is the regular maintenance of the dike system and the frequent dredging of channels, ditches and slough systems in the dike-enclosed areas. Figure 17:8 shows reported wapato sites from Suttles (1955: Table 1, Map II) and those wapato patches observed by Spurgeon during summer 1998. In all instances the observed modern wapato was located outside the dike system, whereas many of the named ethnographic sites were at locations now inside the dike system where there is no longer any wapato. Notwithstanding the frequent mentions of wapato in Suttles (1955), it should be noted that in his later compilation of plants for Chapter 3in Woodcock (1996), Suttles notes that during his peregrination with Simon Pierre in August 1955 *Sagittaria latifolia* was not gathered for subsequent identification at UBC (Suttles 1996; also see footnote pp. 27 in Suttles 1955).

Based on my observations the notion that wapato remains hidden below ground if not extensively cultivated, is not correct. This false view is likely the result of several factors that once understood render wapato easy to find. These include diking impacts, water level fluctuations, wildlife predation and a narrow growing season. The distinctive arrowhead shaped foliage is best sought in the months of July and August. It is also seen in June and September depending upon annual growing conditions at.

other times of the year the roots and tubers remain hidden below ground level making it important to have knowledge of the patch locations to effect the fall/winter tuber harvest, when foliage is no longer visible. Daily tidal fluctuations may also obscure the emergent foliage early in the growing season making searching during low tides a good practice. High tides seem to protect young plants from predation but during a protracted period of low tides - common in the summer - plants are exposed to predation. While in the field I observed numerous instances of Canada geese feeding on the foliage whereby a large patch visible one day would be undetectable the next. Anderson (1925:134) mentions seeing flocks of swans "heads under the water, and tails in the air" feeding on wapato in the Columbia River. On the Columbia River predation by introduced European carp is blamed on the near extermination of this once abundant plant (Piper 1906: 101). I observed that patches in the vicinity of frequent human activity *i.e.*, boat launching ramps and hiking paths, were less impacted by animal predation and seemingly ignored by people.

While these are only preliminary conclusions based on several seasons of fieldwork it is not unreasonable to speculate a bit on the Katzie traditional use of this once important plant. The notion of the seasonal round that included some summer intervention to tend patches, ultimately leading to a tuber harvest, oversimplifies the realities of the activities associated with wapato. Considerable effort would have been required to initially locate patches, eradicate competing plants, ensure a continuous supply of fresh water, and protect immature foliage from predation. Familiarity with the location of patches is necessary to facilitate fall/winter tuber harvesting, a time when the distinctive foliage would no longer be in evidence. Planning around high and low tides is another complication that required attention as the lowest tides are not always conveniently present in daylight hours or during the season of interest. To not properly plan these activities would potentially lead to a poor energy return for the time invested, a particularly serious matter given that air temperatures in the area during the harvest period (October to March) generally fall between minus 8 to plus 13 degrees centigrade and water temperatures fall between minus 1.0 to plus 15.0 degrees centigrade (see Figure 17:6), a rather cool mix for wading. While diking appears to have had a negative impact on wapato growing inside dike enclosed areas, wapato remains in abundance outside the dike system. One could speculate that perhaps the many conditions and impacts attendant upon successful cultivation and harvest of wapato rendered the popularity of the introduced common potato (*Solanum tuberosum*), inevitable.

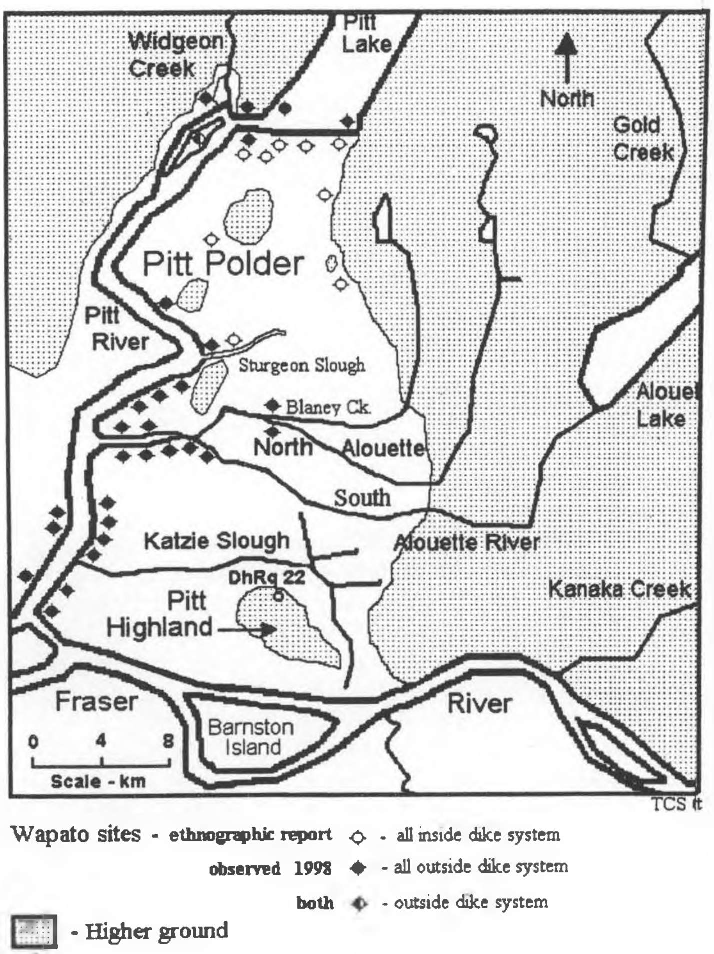


Figure 17:8. **Wapato Locations.**

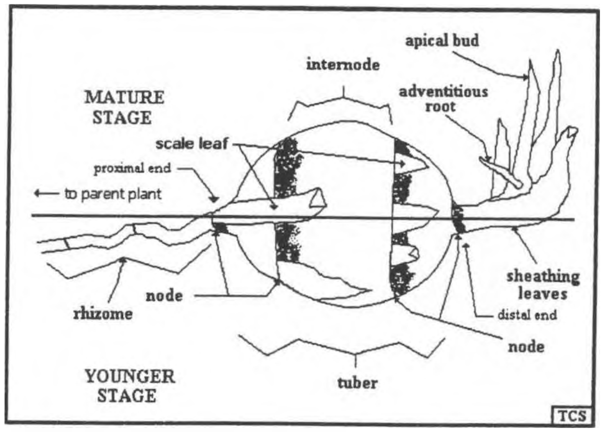
A final word on harvesting methods is in order. In the compacted silt/clay substrates in which the modern tubers grow it is almost impossible to dislodge tubers with toes pushed into the mud. The natural detritus contained in the substrate further complicates this difficulty. It simply may be that the substrates in pre-diking times were less compacted and were not so fouled with modern detritus easing the effort required to dig with toes. Furthermore, several attempts have been made to pull tubers from the substrate using the above ground foliage for gripping. In all instances the foliage has been torn away with no movement of the buried tubers evident. Again the nature of the modern substrate may preclude success with this method. It is possible that some form of digging stick suitably shaped at the end for dislodging tubers and breaking up the substrate and root mat was used for harvest. Darby (1996:68-9) notes several accounts of digging for wapato tubers but digging sticks are not mentioned. Unfortunately, while such root digging tools are widely reported ethnographically associated with other root species (Brown 1868:379; Duff 1952:73; Haeberlin and Gunther 1930:20; Suttles 1987b:137 in reference to *S. tuberosum*; Turner 1979:33), there is little likelihood of such tools surviving in archaeological contexts unless waterlogged conditions exist.

Identifying Charred Wapato

Based on much of the foregoing plus the noted lack of an identification methodology it seems prudent to establish a preliminary model for finding and identifying wapato remains. The experiment reported here was concerned with charring wapato tubers in a variety of heat and temporal regimes to ascertain if any remains might be expected archaeologically and the form such remains might take. Reference should be made to Spurgeon (2001) for all the details of the experiment that cannot be presented here due to space demands.

Archaeological macro-remains of roots and tubers can be identified based on external characteristics, anatomical structure or a combination of both (Pearsall 1989:173). If the shape of macroremains is not distorted by charring, and not all seeds and fruits are distorted badly, then differentiation based upon shape should still be possible (Pearsall 1989:440). Some features of gross morphology may be preserved to aid in identification. Features such as "nodes, scars left by the detachment of rhizomes, stolons, roots, scale leaves, buds, petioles and other aerial parts" may be of use for macroscopic identification (Hather 1993:5). Other identification criteria used by Hather (1993:4-8) for charred tissues include character of the parenchyma, charcoal colour, lustre and hardness, surface characteristics and cavity patterning. See Figure 17:9 for details of wapato tuber morphology.

The main variables associated with charring are time or duration of heating, the temperature achieved and whether the charring atmosphere



- younger stage shows tuber just after harvest.
- mature stage shows tuber breaking dormancy.

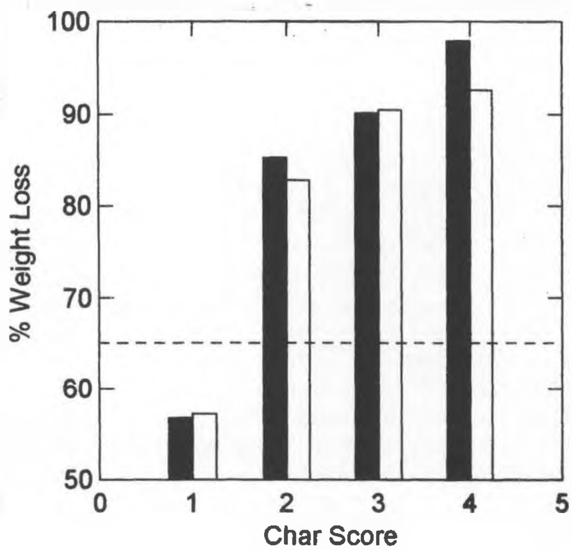
Figure 17:9. **Wapato Tuber Morphology (after Brayshaw 1985:47, Sculthorpe 1967:344, and Turner 1995:37).**

is oxygen rich or reduced. In addition to duration, final temperature and oxygen available, Smart and Hoffman (1988:172) indicate that for wood (they include a variety of plant tissues in the wood category) size, moisture content and tissue chemical composition are all factors in the outcome. Prolonged heating at higher temperatures produces only ash, while too short a period of heating will not result in charred remains that have the potential to be preserved in archaeological features. Temperatures ranging from 150^0 C to 250^0 C are reported as the region of onset for morphological changes in ancient and modern cereal grains based on comparative Electron Spin Resonance spectroscopy studies (Hillman *et al.* 1985:57). Smart and Hoffman (1988:172) indicate that charring can occur at temperatures below 200^0 C given enough time. In the range ca. 200-280^0 C they note "thermal decomposition produces primarily noncombustible gases and char." At temperatures above these thermal decomposition produces flammable gases, tars that burn when enough oxygen is present resulting in less char and more ash (Smart and Hoffman 1988:172). There is a linkage noted between temperature and charring period according to Hather (1993:viii). A possible confounding factor is whether the charring atmosphere is oxygen rich or reduced - a rich atmosphere produces complete burning of combustible plant remains, whereas oxygen reduced conditions at the base of a fire prevents complete combustion.

Wapato tuber charring was conducted under controlled laboratory conditions using a Thermolyne Type 30400 Furnace, rated at 5500 watts that employs a single temperature set point controller with a temperature range of 204^0 C -

982%C. In this instance randomly selected tuber pairs were subjected to temperature regimes of 200, 250, 300 and 350%C. The durations for each of the four temperature regimes were runs of 30, 60, 90 and 120 minutes. This experiment accounts for atmospheric variation by heating tubers in both ambient and reduced furnace conditions to determine the regime(s) likely to produce useful charred remains. To test reduced regimes several researchers have simply covered the subject crucible or placed the specimen in sand or wood-ash (Boardman and Jones 1990:3; Goette *et al.* 1994:12; Hather 1993:ix). Fine washed dry sand is used as the reducing agent in this experiment. Thus, there were sixteen runs involving 32 moist tubers with each run heating a sand covered and an uncovered tuber.

A variety of data was recorded before and after the tuber charring. After charring the resulting remains were assessed for charring extent. Charring extent was scored as 1 for incomplete (not completely turned to charcoal), 2 for complete (completely turned to charcoal), 3 for some tissue ashing or destruction (some charcoal turned to ash), and 4 for complete ashing (all ash, no charcoal, very fragile). Each crucible with its contents was weighed after cooling. This result subtracted from the pre-heating weight gives an indication of tissue and moisture loss. Remains permitting, details of their general morphology such as fragmentation or tissue loss were recorded for each tuber. Figure 17:10 shows Char Score plotted against Percent Weight Loss for all 32 of the tubers.

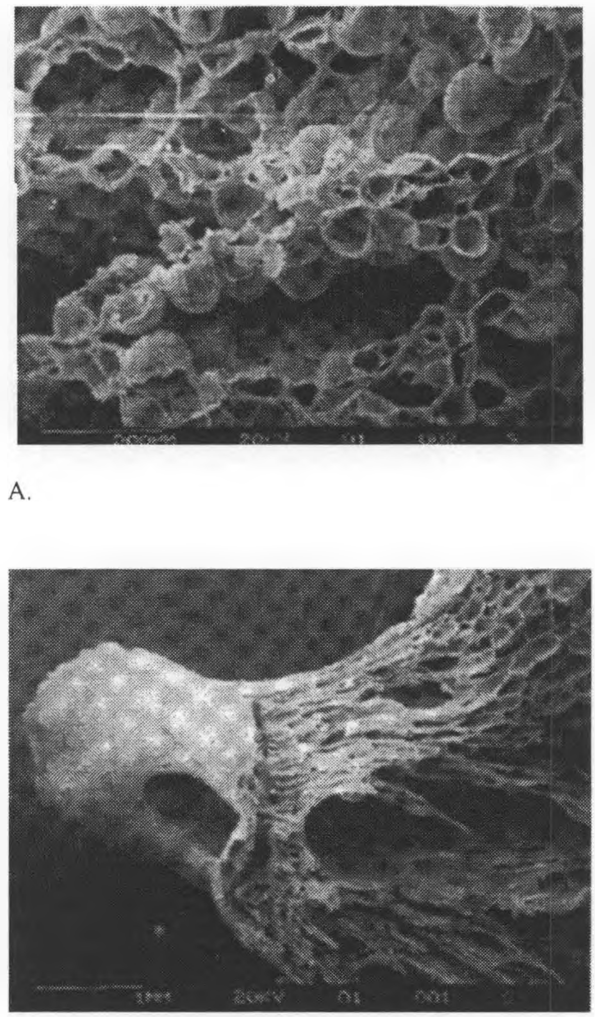


Charring Environment ■ Ambient □ Reduced

Char Score 1 incomplete charring
2 complete charring
3 some tissue ashing or destruction
4 nearly complete ashing

-----------------% water content of wapato tubers

Figure 17:10. **Wapato Tuber Charring showing the per cent of Weight Loss and Char Score.**



A.

B.

Figure 17:11. **SEM Photomicrograph of Charred Wapato Tuber.**

Perusal of the data reveals that the charring results using wapato tubers are generally consistent with the time/temperature/results as described by Smart and Hoffman (1988). Lower temperatures and times produced incomplete charring while the higher temperatures and longer times resulted in complete charring and

Figure 17:12. **Low Power Microscope Image of Charred Wapato Tuber (nodal line at 20X).**

at the higher extremes ashing or destruction. For specimens that were not completely ashed or consumed it was found that the tubers retained their general shape with some shrinkage.

At the shortest time/lowest temperature end of the scale tubers were caramelized but not charred and a characteristic caramel/molasses smell was noted. It is possible the caramelized or partially ashed remains would survive in archaeological deposits, although the more fragile ashed parts or the partly cooked inner tissues would probably not last for long periods. The heat hardened outer portions of some of the caramelized tubers would likely have the best survival potential. The tubers that were completely ashed were very fragile and deemed unlikely to leave any preserved macroscopic remains archaeologically. Due to their fragility it was difficult to record some parameters.

Of note, while preparing the charred remains for SEM and photomicrography it was found that the completely charred tubers were quite robust. To have an uncrushed or relatively undamaged surface to photograph it is necessary to snap the whole tubers in half. Cutting them would crush or otherwise damage the surface. In the event, whole tubers grasped in fingers and snapped were found to be not all that easy to break. This may give some small measure of the tubers potential to survive in the archaeological record. Attempts to snap whole tubers even a year after they were charred produced a similar result. Of course the partially or completely ashed tubers were much more fragile.

The charring experiment answers questions regarding the potential to find identifiable charred wapato tuber remains in archaeological contexts. Charring wapato tubers in a controlled environment where the remains are easily recovered makes it possible to observe the morphological characteristics of the resulting charred remains. At the same time the temperature/time conditions conducive to the experimental production of charred tuber remains can be evaluated. Using SEM, low power microscopy and naked eye observation it is apparent that charred wapato remains can be identified on the basis of generalized shape, charred tissue lustre, features of the tuber nodes, internal structure patterning and parenchyma tissue similarities with comparative specimen. Figure 17:11A, B show SEM images of internal parenchymous tissue and the apical bud emerging from a charred tuber. Figure 17:12 shows a low power microscope image of the nodal area of a charred wapato tuber. A similar nodal area in detail is shown in SEM imagery in Figure 17:13 A, B. Scale leaf remains are visible in 13A as are the scale leaf vein/stem entry perforations in 13B. The general shape of the charred tuber remains and presence of nodal characters can be used to eliminate other tuber, bulb and corm species in the study area that might be confused with wapato. Charred tuber remains can be compared to the published results of others to determine similarities in morphology where possible. The final results can be used along with ethnographic information to construct a model for the archaeological preservation of wapato remains and contexts that subsequently can be field-tested. The charring experiment results indicate that one can expect identifiable wapato tuber remains in archaeological contexts given the vagaries of taphonomic processes.

Archaeological Model of Wapato

The archaeological model for finding wapato in the area of the Pitt Polder and adjacent higher ground is constructed around the availability of relatively dry conditions underfoot for processing, the availability of firewood and rock, the likely plant tissues to be processed and the potential for providing shelter from the winter period elements. Integral to the model building is the critical and contextual analysis of pertinent ethnographic, historic and environmental information. Given that wapato was likely widespread in the lowland area prior to the advent of diking and the existence of numerous waterways providing ready access from camp and village sites, it seems reasonable to conclude that access was not a major challenge even during the winter period when the tubers were available.

The relative paucity of usable high ground that is not bedrock indicates that the highland areas rising similar to islands in the lowland were of major significance for food processing. Indeed, it is likely these areas were significant for many other purposes as well. Prehistorically, or at least pre-diking, dry conditions for earth-oven cooking and the potential to erect shelter would best be found on the elevated areas of the Pitt Polder. Food processing sites involving holes in the ground or plant materials harvested during the winter are probably located on higher ground.

Several of the higher elevation areas such as Sheridan/Menzies Mountain, Swaneset and Little Pine/Big Pine provide rock supplies for hearths and heating elements and were likely wooded making the gathering of firewood easier than in the wet lowland areas. While rock is less prevalent in the vicinity of the adjacent higher ground of Maple Ridge and Pitt Meadows it was not too Distant. It is probable that these locations had tree cover, a source of firewood.

It is likely that the only remains of *Sagittaria latifolia* to be preserved will be pieces of charred tubers. Other parts of the plant were less likely to have been preserved through charring. The achenes have some potential to enter the site (Minnis 1981) and be charred. Several tubers were allowed to air dry during my research, and a year later were still intact and extremely hard such that a pressure from a thumbnail barely dents them. Storage caches of dried wapato might be found in village sites.

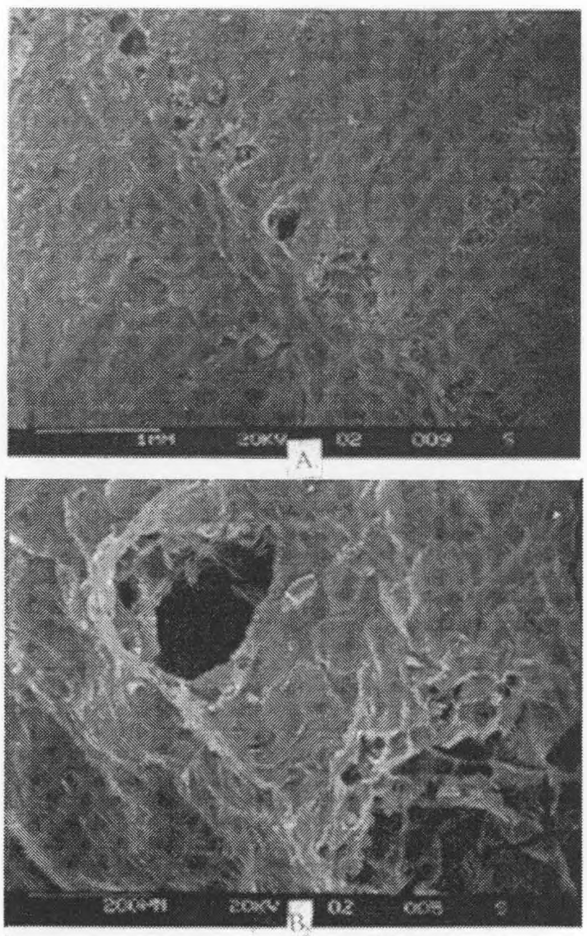


***Figure 17:13.* SEM Photomicrograph of charred Wapato Tuber.**

Although directed at Katzie territory, the model has elements applicable elsewhere. Identification parmeters for charred wapato were established by the charring experiment and can be applied in other locales. Perhaps not all elements of the model are applicable or available elsewhere, but certainly each has its appropriate place in archaeological research.

Summary

Hodder (1991:151) says we can only understand the human world through asking questions of it. Interpretation and understanding in his view emanate from an endless spiral of asking logical questions and seeking logical answers. Just as Hodder (1992) employed the notion of an hermeneutic spiral, I have experienced a journey of several years along a critical and contextual spiral to arrive at a better understanding of wapato. Movement along the spiral is bi-directional and in fact the spiral I have negotiated has two strands. One strand has lead to the clarification of many issues pertaining to wapato use and set the stage for future wapato research by developing an archaeological model for the prehistoric occurrence of wapato and establishing a methodology for the identification of charred wapato remains. The other spiral strand has simply reemphasized the value of conducting in-depth critical and contextual analysis of relevant ethnographic, historic and environmental information to achieve clearer and more accurate interpretations.

The double spiral has led to a number of conclusions pertaining to the original research and leaves us with additional questions warranting more journeys along the hermeneutic spiral Charred wapato remains from archaeological sites can be identified using the methodology developed. Notwithstanding, while wapato is often mentioned in local archaeological reports such remains are as yet to be identified. Wapato has been affected by diking in the Pitt Meadows Lowland/Pitt Polder area such that it is no longer found at ethnographically identified locations that are within the dike system. This could be the case elsewhere in the Fraser Valley. In terms of "Fact, Fantasy and Fiction" of the title, enough has been learned to put most information and ideas about wapato into the appropriate category.