CHAPTER 17

Pre-Contact Period Use of Sling Weaponry in Pitt Polder

Ryan Sagarbarria
Golder Associates Ltd.

Introduction and Background

In early 2005, Antiquus Archaeological Consultants Ltd. began a multi-year intensive and extensive subsurface testing program for a 10,000-acre agricultural parcel in Pitt Polder (Pitt Meadows) located west of the city of Maple Ridge (Figure 1). Surveys conducted over the next five years indicated these marshlands contain numerous pre-contact archaeological sites consisting of small briefly occupied field camps and larger long-term villages settlements of varying size, age and content (Antiquus 2001; Burk et al. 2009; Eng et al. 2008, 2009; Hammond and Kaltenrieder 2006; Knighton et al. 2009; Mitchell and Rousseau 2010).

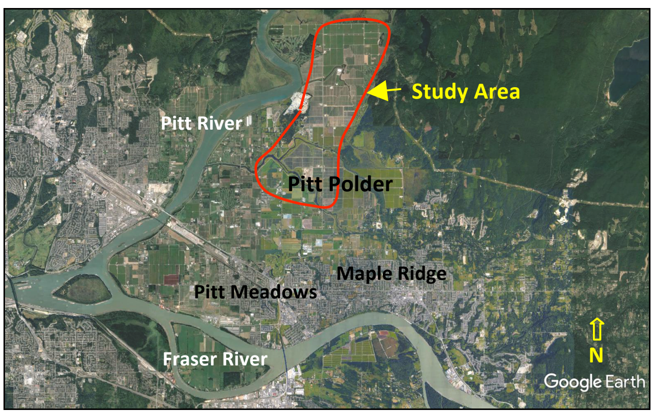

Figure 1. Location of Pitt Polder and the study area north of Pitt Meadows and Maple Ridge, B.C. Google Earth Image 2016.

During the first field season of the impact assessment, the crews noted a widespread presence of small (walnut to golf ball-size) ovoid and spherical pebbles contained within the uppermost Holocene-age, fine-grain, well-sorted, fluvial, clayey silt deposits formed in a low-energy marshy wetland floodplain environment on top of glacial clays (Figure 2). While these pebbles were observed to be clustered and densest within a 100 m radius of many archaeological sites, many were also randomly distributed in lower densities and isolated instances throughout the entire study area. In many exposures alongside drainage ditches, these stones were observed a varying depths within the uppermost clayey silts that are devoid of any cultural materials or features. A few specimens were noted in the very bottom of the upper Holocene fluvial clayey silts directly above glacial clay, attesting to mid-Holocene age deposition.

Since no plausible geological or zoological agencies can account for the ubiquitous presence of these pebbles in the fluvial silts, it logically remains that their presence and patterned distributions are anthropogenic in origin (Burk et al. 2009; Clague et al. 1991; Locher 2006). Upon collective consideration of the above, and after conducting some background research, it was concluded that these spherical and ovoid stones are very compelling hard evidence for intensive long-term use of sling weapon technology in the Pitt Polder locality over the last 5000 years. This chapter presents Salish ethnographic accounts and oral narratives pertaining to slings, and uses statistical shape analyses to provide a formal and behavioural baseline for pre-contact period use of sling stones and sling technology in the Pacific Northwest.

Pitt Polder Natural Setting

The geological formation of the Pitt Polder began around 9,000 years ago through a complex combination of sea level change and sedimentary deposition following deglaciation of the Fraser Valley (Hoffmann et al. 2016; Locher 2006). The narrow, steep-sided, u-shaped valley which now holds Pitt Lake was once a coastal fjord, and as the Fraser and Alouette Rivers met tidal waters flowing out of the fjord, these fine clayey-silt sediments were deposited. Eventually the fluvial floodplain built up this estuarine environment with clayey-silts and fine grain sands from 0.75 to 2.0 m thick (Locher 2006:96) (Figure 2).

The complex low-energy fluvial floodplain environment within Pitt Polder during the latter part of the Holocene was not conducive to natural transportation, deposition, or rounding of pebbles (Clague et al. 1991; Water 1992). This argues strongly for an anthropomorphic origin and distribution of these pebbles.

After the stabilization of marine shorelines around 5000 BP, Pitt Polder was a large, shallow, marshy tidal wetland that was most dynamic and deepest during Spring runoff. During lower water levels and drier conditions in the summer, numerous low sandy knolls and dunes were eventually formed adjacent to exposed sandy gravelly creek and river drainage channels by aeolian processes, providing ideal loci for human use and settlement.

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Figure 2. View of a fresh-cut ditch showing typical stratigraphy and flat terrain in Pitt Polder, looking north toward Pitt Lake. Note the infilled extinct drainage channel feature in center-right. Sling stones are present in the displaced lower Holocene silts at all depths, but in greater numbers in the overlying organic silts.

Pitt Polder is situated within the sub-maritime region of the Coastal Western Hemlock (CWH) biogeoclimatic zone. The CWH covers low- to mid-elevations and is considered one of the most productive environs in terms of overall biomass in B.C. (Jones and Annas 1978). On average, the CWH is also one of the rainiest zones, with cool Summers and mild Winters. Mathewes (1973) considers modern climatic conditions and vegetation to have been stable stretching as far back as 6600 BP, thus it seems reasonable to assume that modern environment and climate are somewhat similar to conditions experienced by human populations since then.

A number of plant species traditionally known and used by local First Nations are found in the CWH zone, including the very culturally significant 'wapato' plant (*Sagittaria lattifolia*) also known as Indian potato, duck-potato or arrowleaf (Hoffmann et al. 2016; Spurgeon 2001) (Chapters 16 and 28). Wapato is a starchy tuber that thrives in marshy wetland conditions. They are harvested by dislodging the root system and collecting the bulbs from October to February. Generally they were transported to a processing location where they were steamed using heated rocks, and consumed as a source of carbohydrates (Spurgeon 2001).

A variety of fauna inhabited this expansive marshy wetland, but most significant to this study are the many species of waterfowl that visited this locality in the tens of thousands to exploit plant foods (e.g., wapato) available to them during annual migration. I contend that there is a strong and direct relationship between these birds and the observed sling stones. Salmon were another important food resource that were harvested during low water levels in the late Summer and Fall when Alouette River and its tributary stream channels were exposed and active. Many recorded archaeological sites in Pitt Polder, notably the larger ones, are remains of re-occupied seasonal field camps situated in prime salmon fishery locations.

Archaeological References for Pre-Contact Period Use of Sling Technology in the Lower Fraser River Region

A search of the database maintained by the Archaeology Branch (Ministry of Forest, Lands, and Natural Resource Operations) provided only a small number of references pertaining to similar unmodified pebbles observed or collected from sites in the Lower Fraser River region. The dominate explanation is that similarly-shaped stones found in excavated sites functioned as 'boiling stones' (Antiquus 2008; Katzie 2010a; Mason 1994; Sto:lo 2004). This conclusion seems to be based on clusters or caches of similar pebbles within or near pit features, functional analogy with ethnographic accounts of boing stone use, and a bit of best-guess speculation. The vast majority of the Pitt Polder pebbles differ from these examples in that they do not have any direct correlation with charcoal, fire-staining, or processing pit features that are commonly linked with boiling stone use.

A few regional archaeological reports mention sling hunting technology and sling stones as projectiles, but never in any depth (Antiquus 2008; Knighton et al. 2009; Golder 2006, Sagarbarria et al. 2007; Katzie 2010b; Morley 1978, 1979; Rozen 1979; Sto:lo Nation 2004). The review makes it clear that pre-contact period use of slings has been largely overlooked or ignored archaeologically, and they are regarded and relegated as being a minor and relatively unimportant component of hunting weaponry used by local groups, and elsewhere in the Pacific Northwest.

Ethnographic and Oral Narratives Pertaining to Slings

A few Northwest Coast ethnographic accounts, narratives and catalogs list slings as being used for warfare, contests, as toys, or for hunting birds (Barnet 1937, 1939, 1955; Drucker 1950). Korfmann (1973:42) also illustrates the distribution of sling use throughout history on a world map that includes B.C. Miles (1963:37) also suggest sling and sling stones have been reported almost everywhere in North America. Of local interest is an account of villagers transporting canoe loads of ordinary orange sized rocks from the foothills of the Pitt Mountains and placing them in piles along the river for defense (Webber 1899:313).

A number of oral narratives mention sling weaponry. Boas' Tsimshian translations contain reference to slings and sling stones frequently, "…Tsauda's father gave to his son a magic sling and four sling-stones like pebbles out of a brook" (Boas 1912:298). Specific reference to slings and Pitt Polder is mentioned in Suttles (1955), where he recounts a story of an unfaithful mother and the dispatching of her lover.

> "...her son followed her and discovered her with a stranger. Silently he returned to his house and wept all through the night, pondering what to do. When morning broke he made a sling, and cast from it four large white stones... Sure now of his power, the youth seized his mother's lover and cast him from the sling far into the interior of the land... the women began to weep; but her son made her sit in the sling, and cast her far to the south ward." (Suttles1955:10).

Another narrative from Suttles (1955) linked to the Pitt Polder involves transformer *Swan-e-set* who is described as being created on Sheridan Hill.

> "Then he dispersed the people, and went to a place called s'cƏ'lq'Əs (sling) at the head of Sturgeon Slough, where he gathered some large round boulders, for he had determined to shatter Sheridan Hill that no one else might ascend to the sky from its summit. With the first boulder that he cast from his sling he knocked off the top of the mountain, hurling it into Pitt River..." (Suttles 1955:12).

Mathews (1954) recording conversations with August Jack Khahtsahlano from 1932 to 1952, provides another narrative linking local regional geographic locations and sling use.

> "When the gods were fixing the geography of the earth they threw this stone at the top of Mount Garibaldi that is chy-kai. Chy-kai is the mountain. Che-kai is the creek. The stone missed the mountain and landed at Chulks, and is there yet for you to see.
>
> One of the gods put the boulder in a sling and then swung the sling around and around his head to work up speed and force. Somehow the sling, as it flew around, touched something. Some say a raven's wing, others that a slave got in the way of the thrower — touched his arm, spoiled his aim—and the big stone missed the mountain, and now you see it in the crevasse, a big stone five or six feet in diameter in the crevasse facing due south at Chulks. That shows you what power the Squamish Indians had in those days; that's power." (Mathews 1954:25).

Additional evidence for use of slings and sling stones are inferred in local traditional First Nation place names such as *P'ena's*, which is a transformer hill known as the piece that Swaneset knocked off Sheridan Hill (Carlson 2001), and a boulder at Erwin Point that was thrown at Garibaldi Peak from Point Grey by the a transformer being *x̌ai̯ʔs or x̌é·l̓s* but slipped (Kuipers 1969; Rozen 1979:5). A name for Swartz Bay is *S,JELKES*, meaning hand sling (Elliot 1990), and *s-CHUL-kus* which refers to type of sling (Rozen 1979), and *S:awsê'nes* (currently known as Swaneset) which refers to good place for waterfowl at the mouth of Raven Creek (Carlson 2001). Collectively, these ethnographic accounts, oral narratives, and traditional place names stand as strong evidence that use of slings in the Pitt Polder locality was well-known and embedded in local oral tradition, but they do not specifically state why slings were being used.

Slings and Sling Stones

Some variations of sling weaponry styles are represented in the literature, but most describe simple construction with minimal required materials. Generally, a sling is comprised of two lengths (cordage, string, or animal skin), one of which remains attached while the other is released during operational use. In addition to the lengths of cordage, a pocket, pouch, or cradle made of woven material or animal skin is built into the center of the sling to hold the projectile (Barnet 1939; Heizer and Johnson 1952; Stov 2015). Duff (1952:60) describes a sling from the Northwest Coast as having an elongated diamond-shaped animal skin piece used to hold the stone. The cordage that is tied to the skin maintains a loop on one end for the slingers finger, and a knot on the opposing end that provides a simple mechanism for release (Duff 1952; Korfmen 1979; Richardson 1998; Stov 2015).

Although slings are simple in design and construction, considerable practice and skill are necessary to accurately sling a projectile and hit a target. However, once proficient, slingers can achieve remarkable and consistent success at long-distance shots, as demonstrated by modern South

American shepherds and in the military accounts of slinger divisions in Europe (Greep 1987; Mixter 2001). To minimize compensational factors that could detrimentally influence accuracy, the slinger would consistently select similar shaped and sized projectiles. This is reflected in ground (modified) sling stones, formed clay missiles, or mass produced lead sling ammunition. Selective collection of appropriately sized and shaped, unmodified, spherical, ovoid, and bi-conical (football-shaped) pebbles from river and lake shoreline gravel deposits also provide slingers with a ready-made arsenal that can be gathered in just a few minutes. Table 1 presents a summary of archaeological sling projectile types (stone, clay and lead) and some details regarding shape and size.

Figure 3: Study sample of sling stones surface collected from within and adjacent to archaeological sites in Pitt Polder. The lower right inset photo shows a ground sling stone from the Bishop Museum.

Recent experimental sling use suggests an upper range of casting limits between 105 to 170 m (Skov 2013) while Richardson's (1998) work achieved an average of 82 to 90 m. Horizontal dispersal patterning of sling stone projectiles has been used to recreate casting limits of slings and slingers. Archaeological sling stone horizontal distributions are expected to be clustered in a defined range originating from the launch location, such as hunting blind or defensive area (Mixter 2001; Richardson 1998; Schaepe 2006; Skov 2013).

Pitt Polder Sling Stone Study Sample and Comparative Attribute Analyses

The focus of this study is a sample of 148 sling stones randomly collected during several occasions from the uppermost clayey silt deposits lying peripheral to several archaeological sites in Pitt Polder (Figures 3 and 4). The exact provenience of these stones was not recorded nor deemed important for the purposes of this study. At a glance, it is clear there is an obvious selective preference reflected in the sample, as most examples are ovoid in form and are remarkably consistent in size and mass. There is no evidence that any of the sling stones in the sample were intentionally modified by pecking or grinding. Lithic (mineral and rock) material determinations, visual shape analysis, and basic metric attributes (mass, length, diameter) were recorded for all the sample specimens (Figures 6 to 8). The results of these observational and statistical comparisons are presented below.

Table 1: Comparative data on sling stones presented by other researchers.

Reference	Locality	Material	Mass (g)	Length (mm)	Dia. (mm)	Shape
Antiquus 2008	Yale, BC	Stone	49 to 142	47 to 70	27 to 38	Ovoid
Butler 1988 as described in Kubíková 2015	Rota Island	Stone	18 to 57	41 to 55	27 to 40	Oval and Bi-pointed
Craib 1988 as described in Kubíková 2015	Rota Island	Stone/ clay	51 to 89	52 to 69	28 to 41	Bi-conical
Foss 1974	Greece	Lead	26.8 to 42.8	27 to 38	13 to 19	
Greep 1987	United King-dom	Lead	28 to 78	30 to 35		Bi-conical
Hunter and Anderson 1994 as described in Kubíková 2015	Guam	Stone	Cluster-ing between 20 to 60	26 to 75	18 to 38	Bi-conical
Korfman 1973:39	Various	Various	20 to 50	20 to 50		
Mixter 2001		Various	20 to 50			
York and York 2011	Marinas/ New World		40 to 80			Bi-conical

Lithic Materials

The sling stone study sample assemblage includes a range of locally available igneous, metamorphic and sedimentary lithic types (Figure 4) that were most likely obtained from river and stream channels and gravel bars within and surrounding Pitt Polder. About 33% of the sample is comprised of granite and grano-diorite pebbles, 25% are various meta-sediments, 23% are quartzite, and the remaining 19% includes miscellaneous igneous and unidentifiable rocks. These basic lithic type proportions are comparable to those found naturally in local glacio-fluvial and fluvial gravel deposit exposures, thus the study sample suggests that conscious targeting of any specific rock type(s) was probably not a significant factor influencing pre-contact period selection of sling stones.

Figure 4. The Pitt Polder sling stone study sample arranged to clearly show overall consistency in size and form, and variability in lithic materials.

Shape/Form

It has been experimentally shown that predictability and efficiency of sling range and accuracy is greatly improved by using consistently-sized and similarly-shaped projectiles (Mixter 2001). Richardson (1998) states that oval stones always travel farthest and are the best shape for equaling the performance of lead balls, but not bi-conical lead slingshot. Bi-conical forms constitute the majority of examples of modified and manufactured projectiles recovered from archaeological contexts (Craib 1988; Greep 1987; Hunter and Anderson 1994; Mixter 2001; York and York 2011). It was reasoned that similar formal patterns should be evident in the Pitt Polder study sample. Each specimen was visually assigned to one of five shape categories (round, ovoid/oval, tear drop, bi-conical/football, and other) (Figure 5) adapted from Kubíková (2015) and York and York (2011).

Results of the observational shape analysis are shown in Figure 6. They indicate a remarkably high incidence (60%) of ovoid shapes. While small ovoid pebbles are relatively common in most local fluvial gravel deposits, their overwhelming dominance of the study sample strongly suggests that pre-contact period slingers in Pitt Polder had a strong selective preference for using elongate rounded sling stone forms. Round (spherical) and tear-drop shapes are equally represented, but in much lower frequencies (17%). Bi-conical (football) forms are least represented (<1%), but this is not surprising, since in most gravel exposures this slightly more complex shape is much less common in natural gravel contexts than ovoid and rounded forms. It is worth noting, however, that ovoid and bi-conical shapes share an overall basic elongate form, and it is logical to assume that they probably behave in a similar spinning or tumbling manner when airborne as projectiles. These shapes also couch and balance well in sling cradles while being launched.

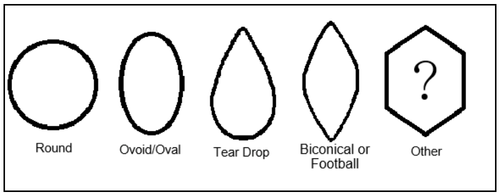

Figure 5. Shape categories used to describe the Pitt Polder sling stone assemblage.

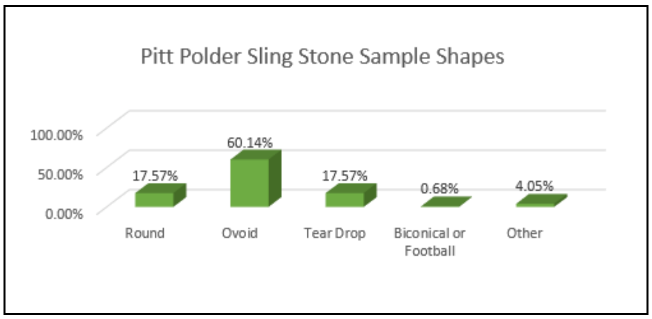

Figure 6. Relative proportions of basic sling stone shape categories represented in the Pitt Polder assemblage.

Weight/Mass

Using an experimental approach designed to explore, understand and explain the physics of slinging, Richard (1998) concluded that optimum weight ranges for sling projectiles can be roughly estimated based on consideration of simple criteria. Minimum sling stone weights typically fall just under the mass of the sling. If they are too light, the projectiles may not remain within the sling cradle prior to their desired release. If too heavy, they have less velocity and accuracy, and can cause physical discomfort when being launched (Richard 1998; Skov 2013).

Figure 7 shows a scatter-plot of individual weights to the nearest 0.01 gram for sling stones in the Pitt Polder sample assemblage. It also shows available comparative weight ranges calculated for archaeological sling projectile samples by several other researchers. It is easily seen that clustering of sling stone weights from the Pitt Polder closely matches most ranges recorded by others. Approximately 80% of the Pitt Polder sling stone weights fall between 40 and 90 grams, suggesting that this was the optimal mass range that was being observed by slingers while collecting projectiles.

Length

All specimens in the sample assemblage were measured with calipers to obtain maximum lengths to the nearest 0.01 mm. A scatter-plot was generated for this attribute (Figure 8), and it shows that 80% of the collection falls in the 40 to 55 mm range, which is quite tight. Similar length ranges calculated by other researchers are compared to the Pitt Polder sample, there is an overlap with six of the eight results. This reflects a conscious effort to select sling projectiles with a fairly consistent and somewhat narrow length range in mind.

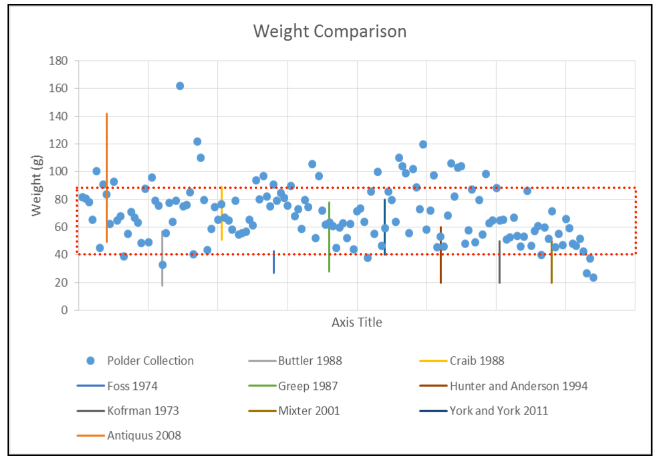

Figure 7. A scatter-plot diagram of Pitt Polder slingstone weights (mass), and similar ranges calculated by other researchers. About 80% of the sample weights fall in the red box.

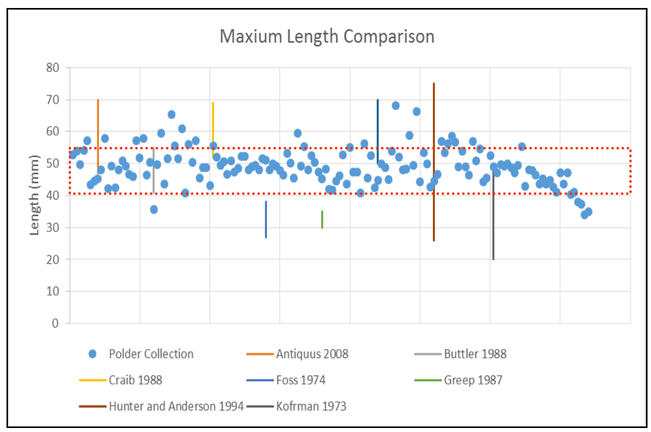

Figure 8. A scatter-plot diagram of Pitt Polder slingstone maximum lengths in mm, and ranges calculated by other researchers. About 80% of the sample weights fall in the area in the red box.

Diameter

Use of diameters for describing sling projectiles has been used by others, and typically the 'averaged' (L+W/2) dimension is used for cross-comparison. For the Pitt Polder assemblage metrics for width and thickness of each sling stone was recorded and averaged to provide an inferred diameter, and the data were generated into a scatter-plot (Figure 9). As with the other attributes mentioned above, a fairly tight clustering for diameters is indicated. About 80% of the diameters fall in the 25 to 35 mm range. This result coincides very well with four of the five of diameter range data generated by other researchers (Table 1).

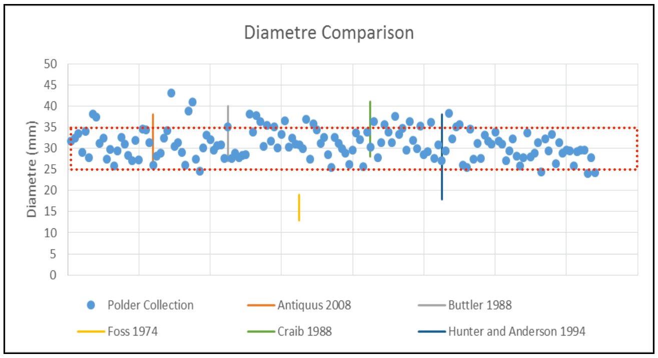

Figure 9. A scatter-plot diagram of Pitt Polder slingstone diameters in mm, and ranges calculated by other researchers. About 80% of the sample weights fall in the area in the red box.

In sum, the Pit Polder study sample suggests that pre-contact period slingers preferred and primarily collected pebbles for sling stone projectiles that had: (1) overall ovoid forms; (2) weights between 40 and 90 grams; (3) lengths from 40 to 55 mm; and (4) average diameters between 25 to 35 mm. There appears to have been an indifference for lithic material type, and this is not surprising, since shape, mass and size are more functionally important traits.

Behavioural Implications for Sling Use in Pitt Polder

After several years of intensive archaeological investigations in Pitt Polder, it became readily apparent that sling stones were dispersed throughout the entire study area (Figure 1) at all depths in the Holocene sediments, and there are undeniably hundreds of thousands of them buried there. Their overall horizontal distribution conforms well with the logical expectation that their greatest densities should be clustered peripherally to established field camps and major settlements. The greatest densities lie within about 100 m of the extinct shoreline boundaries at many sites, which is about the maximum distance most accomplished slingers can achieve. This patterning indicates that most slings were launched from shoreline stances. Lower numbers of sling stones appear randomly in many areas between sites, and in very low density in areas where there are no sites. These latter projectiles were most probably launched from canoes, or perhaps on dry ground during the drier months when water levels were low.

Recent studies in other southern and western parts of Pitt Polder and similar tidal marshland contexts assert that some villages are established based on intensive landscape management involving the creation and maintenance of aquatic 'wapato gardens' (Darby 2005; Deur 2005; Hoffmann et al. 2016; Katzie 2010a; Spurgeon 2001; Skov 2013) (Chapters 16 and 28)). This same eco-cultivation activity pattern was undoubtedly practiced at many sites in the Pitt Polder study area. To promote propagation and increase success rates of wapato production, these gardens were meticulously maintained and involved considerable investments of time, energy and protective vigilance.

Wapato crop loss by waterfowl (Darby 2005; Deur 2005; Katzie 2010a; Spurgeon 2001; Skov 2013) was a common problem that was further compounded for wapato marsh-lands along major migratory waterfowl routes. Deur (2005) maintains that having an established village site adjacent to a managed crop in conjunction with regular harassment of waterfowl kept them away. Several others acknowledge a close association between waterfowl and wapato gardens, and mention that hunting and harassing birds with sling stones helped protect these estuarine gardens, and at the same time provide a secondary dietary benefit (Deur 2005; Spurgeon 2001; Skov 2013). Jeness (1922) also highlights the opportunistic repurposing of tumplines to throw stones at chance encounters with birds during other resource gathering activities.

Indeed, use of sling technology for hunting waterfowl translates well to the natural pre-contact period environment once found in Pitt Polder. Suttles (1955) indicates that Katzie people hunted ducks there in large numbers. Fisher (1976) recounts an informant who stated that an expert slinger could kill a water-fowl at a distance of up to ~180 m, but this may be exaggerated. Through my own observations, even a novice slinger stands a good chance of success when slinging at a close dense flock of rising or sitting birds. Migratory birds such as ducks, geese and swans all appear in many excavated regional archaeological faunal assem-blages. Birds and waterfowl were of course eaten, their down was woven into mats, and bones were used to make whistles, beads, straws, and bi-pointed fishing implements (Arcas 1991:154; Katzie 2010a; Stewart 1973).

Another behavioural consideration relates to sling-stone recycling. Projectiles that landed in the marshlands in high water conditions during the Spring to early Summer would have been submerged and temporarily unavailable for immediate recycling. However, during the late Summer, Fall and Winter when water levels were lower and much of the marshland drained, and tides rose and fell to expose the former marsh bottom, slingers undoubtedly walked around and gathered large numbers of them for later use in relatively short time. This can still be easily done today.

Conclusions and Remarks

Although evidence for use of sling technology is common in many Old World, South American and Pacific Island sites, it remains poorly acknowledged, or even completely ignored, in current Pacific Northwest artifact taxonomy (Korfmann 1973; Miles 1963; York and York 2011). First Nation ethnographic sources, oral narratives and place names mention slings and sling stones several times in their oral tradition, attesting that sling technology was widely known and used on the Northwest Coast. That it is mentioned several times in local First Nation Origin/Creation and Spiritual stories suggests a familiarity with sling technology going back many thousands of years.

Given that sling stone projectiles arguably have the same functional, behavioural, and economic importance as darts and arrows, it remains as to how they should be properly identified and recorded in the field. One problem is that they can only be effectively and confidently identified in homogenous silty or sandy stratigraphic contexts that are devoid of other gravels. Fortunately, former tidal marshland environments similar to Pitt Polder are found in many lowland localities in the Fraser Valley and Delta sub-regions, and future investigators should be vigilant for sling stones when conducting field surveys in these areas.

Since sling stones are currently not commonly or formally recognized as being a *bona fide* artifact 'type' (Korfmann 1973), their horizontal distribution peripheral and adjacent to camps and villages are not taken into consideration when defining and recording site boundaries. Inclusion would sometimes require that very large areas would be recorded as a single site (e.g., all of Pitt Polder), which is not a realistic or desirable recording strategy for a number of reasons. If sling stone clusters are encountered during marshland surveys, surficially exposed specimens should be GPS-referenced and indicated on field maps. Small representative samples (~75 to 100 specimens) should be collected for later descriptive analysis and comparison.

Awareness of the potential of finding direct evidence for sling use in tidal marshlands will eventually lead to more localities being identified, and contributing more important data. At the very least, fellow archaeologists should ponder a few seconds longer at that seemingly out-of-place ovoid pebble.