From Chipped to Ground:

the spatio-temporal systematics of 9000 years of archaeological change in southwest British Columbia

A thesis submitted to McGill University in partial fulfillment of the requirements of the degree of Master's of Arts

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ABSTRACT

Over the past 9000 years of prehistory on the southwest coast of British Columbia there was a technological transition from early artifact assemblages of chipped stone to more recent ones of ground and polished stone, bone, and antler. Current accepted explanations of this transition rely on relatively few sites and a deeply entrenched set of chronological phases. In this study, I combine the data being produced by archaeological consultants, known as “gray” literature, with academic sources and archived provincial reports, to assess the nature of the documented transition and determine if the phase concept is influencing the interpretation of archaeological change. The results show that current conceptions of a uniform and gradual transition from assemblages dominated by chipped stone to ones dominated by ground stone are inaccurate, highlighting the interpretive constraints of the phase concept for analyzing archaeological change and the need to conceptualize space and time as continuous variables.

Au cours des 9000 dernières années de la préhistoire sur la côte sud-ouest de la Colombie-Britannique il y a eu une transition technologique des assemblages composés principalement d’outils de pierre taillée vers des assemblages composés de pierre polie, d’os et d’andouiller. Les explications courantes de cette transition se fondent sur relativement peu d’assemblages et un concept de phases chronologiques profondément enraciné. Dans cette étude, je combine les données produite par les firmes archéologiques, connus sous le nom de littérature « grise », avec des sources académiques et des rapports provinciaux archivés, pour évaluer la nature de la transition et déterminer si le concept de phase influence l'interprétation du changement archéologique. Les conceptions actuelles d'une transition uniforme et progressive d’assemblages dominés par la pierre taillée vers les assemblages dominés par la pierre polie sont inexactes. Elles accentuent les contraintes interprétatives sur l’analyse du changement archéologique et elles démontrent la nécessité de conceptualiser l'espace et la chronologie comme variables continues plutôt que comme unités.

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INTRODUCTION

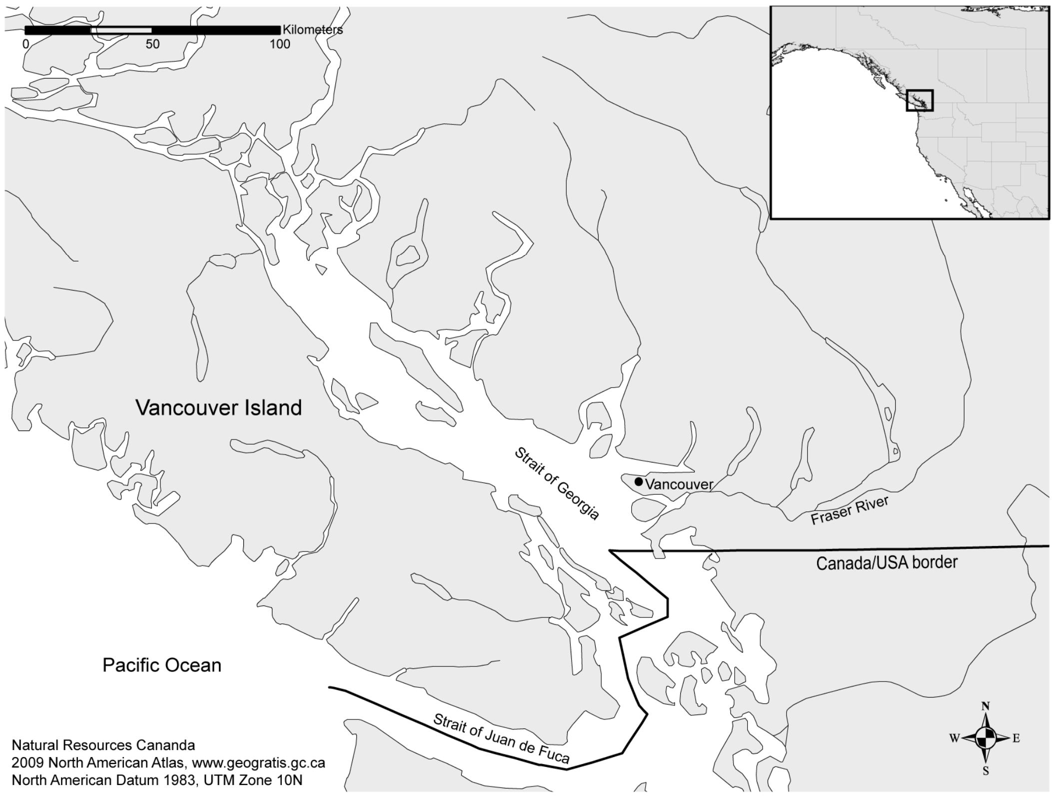
On the Northwest Coast of North America there is a documented transition from the earliest chipped stone assemblages, approximately 9000 to 11000 years ago (Carlson 1979, 1990a, Carlson and Bona 1995, Moss and Erlandson 1995), to the ground and polished stone, bone, and antler tools known from the ethnographic record (Barnett 1955, Suttles 1990). In the Gulf of Georgia[1] region (Figure 1, Mitchell 1971a), descriptions and explanations of this transition were developed using a handful of very thoroughly excavated sites with multiple components (Borden 1950, 1951, 1961, 1965, 1968b, 1975, Carlson 1960, 1990a, 1990b, Matson et al. 1991, Mitchell 1971a, 1990). Over the past few decades the archaeological record for this transition has grown substantially through additional academic research and rapidly expanding contract archaeology. Taking advantage of this bolstered regional archaeological record and the vastly under-published consulting or "gray" literature (Moss and Erlandson 1995), this study revisits the nature of the transition from chipped stone to ground stone and faunal tools in the Gulf of Georgia.

Although the relative decline of chipped stone proportions through time is often referred to as a "well-established generalization" (Mitchell 1971a:51), the progression of the transition is rarely discussed in detail. For example, von Krogh (1980:35) observes that "[o]n the whole, there is a general trend from more chipped stone to more ground stone" and this transition "begins with an exclusively chipped stone lithic industry and proceeds to an essentially ground stone lithic industry." Hobler (1990:304) states that after 4500 BP "the relative importance of stone flaking begins a slow decline" and "[a]though never totally absent in later excavated collections, flaked stone after about A.D. 200 [1750 BP] nowhere constitutes a significant item of technology." Both of these examples describe a regional and gradual transition between two endpoints of strictly chipped stone and strictly ground stone. However, neither author addresses exactly how this transition takes place, or what detailed evidence of the process actually exists. By amassing a substantial dataset of assemblages from the Gulf of Georgia that span the past 9000 years, this study

[1] Although officially the Strait of Georgia, it is most commonly referred to as the Gulf of Georgia region in the archaeological literature.

tests these assertions and asks whether or not the transition from chipped stone to ground stone, bone, and antler is gradual and spatially uniform.

Figure 1: Gulf of Georgia study area on the northwest coast of North America.



Where this study tests explanations of change through time it is inherently reliant on the characterization of the temporal variable. In archaeology there is a widespread and deeply entrenched history of categorizing the past into spatio-temporal units, known as phases, based on the similarity of their archaeological record (Burley 1980, Stein 1992, 2000, Willey and Philips 1958). On the Northwest coast this methodology has produced a generally accepted chronology that is almost exclusively used to organize and compare assemblages (Ames and Maschner 1999, Borden 1950, 1965, 1968a, 1968b, Burley 1980, 1989, Carlson 1954, 1960, Matson 1974, Matson and Coupland 1995, Mitchell 1971a, 1990, Stein 2000, 2001). Relying on phases for the interpretation of change through time creates two complicating factors. First, such a conception of temporal units obscures variability in the archaeological record of a period of time encompassed by a phase (Abbot 1972). Second, conceiving time as stacked blocks defined by particular assemblage types tends to emphasize sudden change from one static phase, or system state, to another. It tends to focus attention on the transitions between phases and de-emphasizes the treatment of time as a continuous variable. I believe that the gradualist descriptions of the Northwest Coast technological transition are the result of these two issues. Therefore, as a necessary corollary, I will examine the temporal and spatial pattern of the transition both with the phase concept as the temporal variable and without, relying solely on radiometric (^{14}C) dates. I am not only asking what is the spatial and temporal pattern of the transition from chipped stone to ground stone and faunal tools, I am also asking whether and to what degree the deeply entrenched phase concept influences our understanding of this archaeological change.

RESEARCH CONTEXT

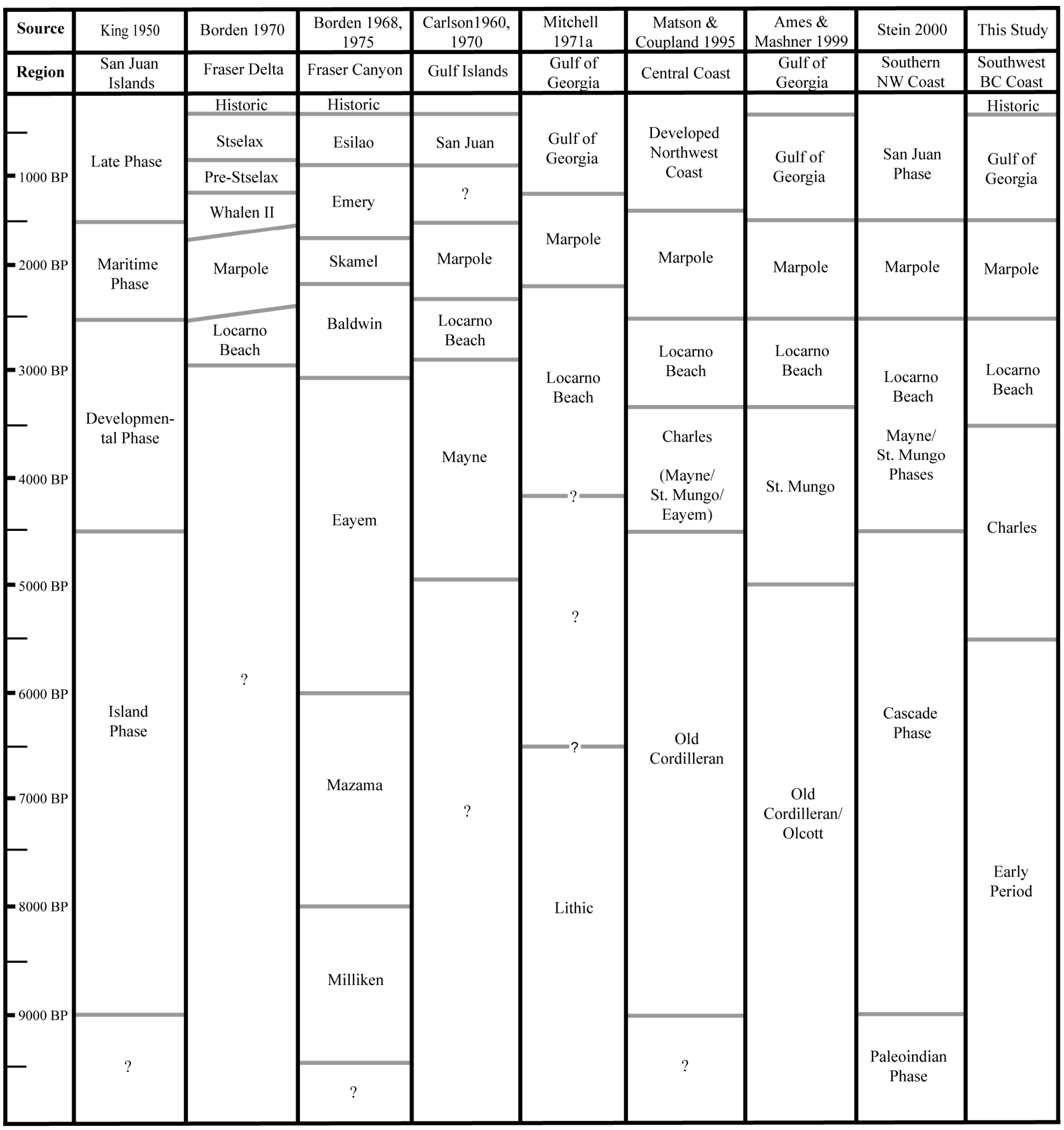
Although initial work dates to the late 19th century (Deans 1891, 1892, Hill-Tout 1895, 1932, Smith 1899, 1903), it was not until the work of Charles Borden (1950, 1951a, 1951b, 1961, 1962, 1962, 1968a, 1968b, 1970, 1975) in the Fraser Delta and Canyon and Arden King (1950) in the San Juan Islands that there was a systematic drive to document where people lived, how they lived, and when they lived in the Gulf of Georgia. This fundamentally culture historical approach (Trigger 2006) was a necessary step in the establishment of Northwest Coast archaeology. Without the creation of a chronological framework, the large-scale examination of subsistence patterns (e.g. Ham 1982, Matson et al. 1991), the emergence of cultural complexity (e.g. Ames 1981, Burley 1979, 1983, Blake 2004, Matson and Coupland 1995), and various other archaeological patterns (Burley 1980, Grier 1998, 1999, Thom 1995) would not have been possible. Although these studies are incredibly important contributions to our current understanding of Gulf of Georgia prehistory, they were all conducted within a firmly entrenched phase-based approach and have thus helped create definitions that typify each phase in the sequence. The result, when looking at long-term change in the Gulf of Georgia, is a sequence of stacked phases that proceed from one to another with change happening at the boundaries between them. This is an unrealistic conceptualization of social change and the archaeological record.

A History of Phases in the Gulf of Georgia

The creation of a cultural chronology in the Gulf of Georgia began almost contemporaneously with the sequences of Arden King (1950) at the Cattle Point site and Charles Borden in the Fraser Delta and Canyon (1950, 1968b, 1970, 1975). Over time Borden's Fraser Delta sequence became the most commonly used and is the foundation of the general chronology used today (Carlson 1990, Mitchell 1990, Stein 2000). The incentive behind Borden's classification scheme was to delineate the prehistoric populations and the influences leading to changes in the archaeological material. Clearly, as evidenced by his migration theories (1968a, 1968b, 1970, 1975, 1979) Borden understood there to be a connection between the delineation of chronological periods and groups of people. However, as Borden's chronology was adapted through time his initial logic was replaced by the Willey and Phillips (1958:22) definition of a phase: "an archaeological unit possessing traits sufficiently characteristic to distinguish it from all other units similarly conceived, whether the same or other cultures or civilizations, spatially limited to the order of magnitude of a locality or region and chronologically limited to a relatively brief interval of time." Even with this change in perspective and the explicit rejection of a connection between phases and culturally important social groups (Burley 1980, Pratt 1992), it should not be forgotten that the phases used today were initially developed as a proxy for some form of social grouping.

These original sequences were based on a very limited number of sites known at the time (Mitchell 1990). It was inevitable then that Borden's original sequence would undergo some modification, some of which was made by Borden himself (1968b, 1970, 1975). The primary changes include the addition of an older time period, the Charles phase (Carlson 1970, Mason 1994, Matson et al. 1991, Ormerod 2002, Ormerod and Matson 2000), removing the Whalen II phase (Thom 1992b), and defining the temporal boundaries of the phases using ^{14}C dating (Burley 1980, Matson and Coupland 1995, Mitchell 1971a). These changes did not happen all at once but were implemented as new sites were explored that did not fit clearly into the existing sequence. The result is numerous variants of the sequence at various scales of conceptualization, demonstrating that there remains considerable uncertainty about the regional chronological framework (Figure 2, Stein 2000).

Figure 2: Comparison of selected phase sequences for southwestern British Columbia.



This increasing variation in sub-regional chronologies did not go unnoticed, inspiring Mitchell's (1971a) comprehensive synthesis of the Gulf of Georgia chronology. In his attempt to consolidate the various sequences to the same scale he proposed that Culture Type replace the use of the term Phase. However, the difference in Mitchell's terminology is minimal, relying on a definition by Spaulding (1955) that has considerable similarities to the Willey and Phillips (1958) phase concept. For Mitchell, a culture type is defined as "a group of components distinguishable by the common possession of a group of traits" (Spaulding 1955:12, cited in Mitchell 1990:340). If you replace "group of components" with "archaeological unit" the phase and culture type definitions are practically inseparable. Despite Mitchell's intentions of reformulating the phase concept however, these two terms began to be used interchangeably very quickly (see Burley 1979) and still are today (Wilson et al. 2003). The result has been a continuation of the phase framework into contemporary research with little regional scale assessment of the concept itself or discussion of its benefit in interpreting past prehistoric social processes (but see Abbott 1972).

With such a rich history of chronology building and the carry over of terminology through time, it is important to clarify exactly which chronological sequence of phases will be used for the analysis in this study. My selection (Figure 2) is based on an overarching general application of the periodization in recent research (e.g. Lepofsky et al. 2000, Stein 2000) while trying to avoid confusing and contested terminology and maintain an appropriate level of generality. As a result, my sequence uses regional scale terms rather than local spatial variants. Preferring Charles phase rather than Mayne, St. Mungo, and Eayem, and Gulf of Georgia phase rather than San Juan, Stselax, and Esilao. For the oldest period, to avoid the debate surrounding the source of the first coastal inhabitants, I use Early Period rather than Pebble Tool Tradition (Carlson 1990a), Lithic Culture Type (Mitchell 1971a), or the Old Cordilleran (Matson and Coupland 1995).

Questioning Phases and Culture Types

Although there has been considerable focus on delineating the phases in Northwest Coast prehistory, there has also been some fine scale examination of variation. Studies have examined the within phase variation of the Marpole (Burley 1980) and the Gulf of Georgia (Thom 1992a) phases. These and similar less regional scale analyses (i.e. Pratt 1992 for the Charles phase) base their grouping of assemblages on the cultural historical framework, assuming that within phase variation is less than between phases. Even though the phase concept as articulated by Willey and Phillips (1958) is not meant to equate with social or behavioural groupings, Northwest Coast archaeologists often treat phases as prehistoric social phenomena (Abbott 1972). Without having an established cultural, social, or behavioural equivalent of the archaeological phase, and with the current availability of ^{14}C dating, there is no reason to rely on the chronology established under the culture history paradigm as an analytical unit.

Acknowledging the entrenchment of the culture history approach is not a novel realization. Carlson (1990b:107) believes that "culture history – the formulation of cultural chronology and the reconstruction of the Lifeways of past peoples – has been and continues to be the main goal of archaeological research on the Northwest Coast." Moss and Erlandson (1995:4) note that "[m]uch of the archaeology conducted along the Pacific Coast has been largely descriptive and culture historical." Although both comments were written more than a decade ago, the present day situation has not changed in the Gulf of Georgia. Whether providing a detailed site report and its place in the culture history (e.g. Burley 1989, Charlton 1980, Golder 2007, 2008, Murray 1982, etc.) or examining the characteristics of a particular phase (Burley 1980, Pratt 1992, Thom 1992a), the work still remains entrenched in the phase concept and, as a result, the culture history paradigm. Some recent work is moving beyond these bounds to document a higher resolution of the temporal and spatial distribution (McMillan et al. 2008), but these are only beginning to emerge and overall there has been very little critical examination of the phase concept since Abbott in 1972.

Many of Abbott's claims are as pertinent today as they were in 1972. Particularly Abbott's recognition that "*no one site may be expected to reflect the total culture of any* *group"* (Abbott 1972:273-4, emphasis in original). Following his criticisms, however, there has been little change in the application of the phase concept, and culture history has remained a predominant theme in Gulf of Georgia archaeology (Moss and Erlandson 1995). In fact, the phase concept, specifically for the Charles (Pratt 1992), Marpole (Burley 1980), and Gulf of Georgia (Thom 1992a), has been the foundation for assessing the inter-assemblage variation. Burley (1980:15) even defends "the concept of phase as an archaeological abstraction on the basis of its inherent flexibility and ambiguity." Exactly why flexibility and ambiguity helps us understand prehistoric social processes is unclear but I do agree with Burley that the phase concept is not useless as an archaeological construct, specifically for in-field organization and hypothesis formation. What is dangerous, however, is allowing ourselves to make assumptions about prehistoric behaviour and change based on a concept that still needs to be tested itself. In this vein, I completely agree with Abbott's (1972) affirmations about the utility of the phase concept. The concept is so firmly entrenched into archaeological practice, however, that without a thorough testing of the concept and suggesting a satisfactory alternative, denouncing the concept as an analytical unit will continue to be futile.

Through an examination of the transition from chipped stone to ground and faunal tools we can not only critically address one of the most recognized generalizations for Gulf of Georgia prehistory but also critically assess what constraints this cultural historical entrenchment is having on how archaeological change is interpreted. As mentioned, the predominance of a cultural historical approach on the Northwest Coast is widely recognized. However, there is also evidence to suggest that the uniformity of the transition is in question. Lepofsky et al. (2000:409) acknowledge that "Scowlitz [DhRl-15 & 16] differs from other sites in the Northwest Coast, where there is an increase in ground stone artifacts through time at the expense of chipped stone." By pointing out Scolwitz's divergence from the general pattern it acknowledges a degree of variation within the commonly cited general pattern for the transition, that over time "[p]ecked, ground, and polished stone steadily gained in frequency and appeared to be replacing flaked stone for wood working and other functions" (Hobler 1990:304). This study pursues this notion of variability and asks what is the regional pattern of the transition and is Scowlitz truly an anomaly and, if so, is it the only anomaly?

In order to answer these questions it is important to recognize a major inhibiting factor to the advancement of academic archaeology on the Northwest Coast, the fact that "[v]ast amounts of archaeological data reside only in unpublished reports (the "gray literature") that are frequently difficult to access" (Moss and Erlandson 1995:4). Not only is this true in the Gulf of Georgia, but the amount of "gray" literature has increased over the past 15 years in response to urban and resource development in the greater Vancouver, Victoria, and Nanaimo areas and beyond. The resulting archaeological work, although relatively well-regulated by the BC Archaeology Branch, is producing stores of archived data that is almost entirely unpublished[2]. By amassing a substantial corpus of both published and unpublished data this study demonstrates the utility and need to integrate both academic and contract archaeological practice, particularly important on a larger scale considering that the majority of North American archaeology is conducted as Cultural Resource Management (Bergman and Doershuk 2003).

METHODOLOGICAL CONSIDERATIONS

Examining the transition from chipped stone to ground and polished stone, bone and antler in the Gulf of Georgia region and assessing the interpretive influence of the phase concept requires a dataset of assemblages with strong chronological control. Through archival research at the Laboratory of Archaeology at the University of British Columbia (UBC) and the Archaeology Branch in Victoria, BC I assembled a database of 75 assemblages distributed along the Fraser River, the coast, and in the Gulf Islands (Figure 3, Table 1, Appendix A). Each assemblage in the database has a geographic location, associated radiocarbon date(s), associated references, and artifact counts.

[2] It is necessary here to acknowledge that much of the data generated is not publishable due to its narrow focus, requiring considerable compilation and synthesis before publication would be considered. Also, there is no mandate to publish the information and, as a result, the funding and time necessary for it must be found outside of business hours.

The fundamental unit of comparison is the assemblage or component. Burley (1989:26) describes a component as "an assemblage of culturally affiliated items that are roughly associated in time" and that "[c]omponent definition is undertaken through the grouping of artifacts found within individual strata or in a combination of adjacent strata." Although, there are certain limitations to the concept of component (Abbott 1972, Burley 1980, Stein 1992, 2000), the delineation of components is ubiquitous in archaeological practice and is at present the most realistic and highest resolution we have for comparing different data sets from the region. The issue with the cultural component approach is that, as evidenced in Burley's description, there is a history on the Northwest Coast of using sediment divisions as component boundaries. In fact, these are two distinct types of stratigraphy, what Stein (1992) calls lithostratigraphy and ethnostratigraphy. I would also suggest that additional bias is introduced by the fact that each component represents not a discrete snapshot of occupation but a superimposed palimpsest of multiple or continuous occupation. Rather than not ask questions, however, we should ensure that we interpret the results in light of these potential biases.

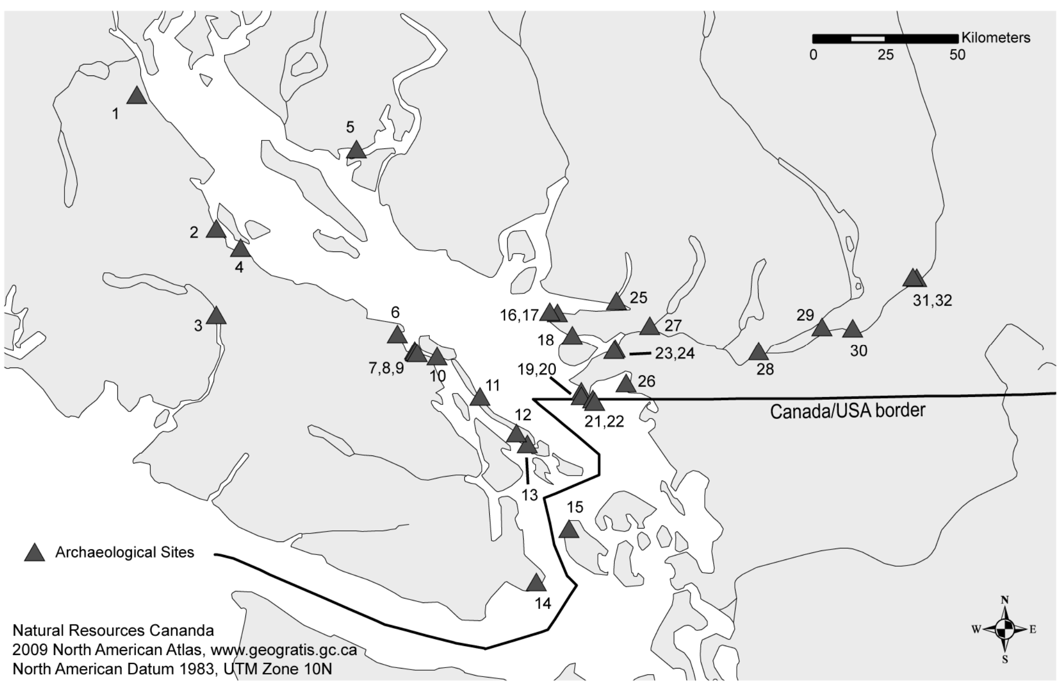
In an attempt to mitigate some of these biases, multiple excavations from the same site have not been merged into site-wide assemblages. Thus, original excavation reports were favoured over more recent syntheses. For example, Heather Pratt's (1992) synthesis of the Charles culture combines the artifact counts from multiple discrete excavations, producing master assemblages for the Glenrose, St. Mungo, and Crescent Beach sites. This analytical approach, although it can be appropriate, assumes that the phase to which each assemblage is assigned justifies combining the artifact counts and their radiocarbon dates. I have chosen to keep assemblages from the same site separate and test these assumptions imposed by the phase concept. Rather than using the periodization scheme to formulate artifact groupings, I feel it is best to use the radiometric data to test the scheme itself.

The Dataset

I combined a review of published literature with a search of the BC Heritage Register using the Remote Access to Archaeological Data (RAAD) online application. The Provincial Heritage Register contains general information for all archaeological sites in the province, allowing me to identify potential assemblages for use in this study and providing the basis for a detailed three-week archival research plan in BC. I obtained unpublished MA and PhD dissertations from the Laboratory of Archaeology at UBC and permit reports from the Archaeology Branch in Victoria, BC.

The dataset comprises 75 artifact assemblages from 32 sites (Figure 3, Table 1), each assemblage representing a single component from a particular excavation. The criteria for incorporating an assemblage into the database were: 1) accessible artifact counts that could be separated into the three primary technological groupings (chipped stone, ground stone, and faunal tools) with 2) confidently associated radiometric dates.

Figure 3: Archaeological sites that contribute assemblages to the dataset.



1 – DlSh-6, 2 – DjSf-13, 3 – DhSe-2, 4 – DiSe-7, 5 – DkSb-30, 6 – DhRx-16, 7 – DgRx-5, 8 – DgRx-11, 9 – DgRx-36, 10 – DgRw-4, 11 – DgRv-3, 12 – DfRu-13, 13 – DfRu-24, 14 – DcRt-10, 15 – 45SJ24, 16 – DhRt-5, 17 – DhRt-6, 18 – DhRs-1, 19 – DgRs-2, 20 – DgRs-9, 21 – DgRs-1, 22 – DfRs-3, 23 – DgRr-2, 24 – DgRr-6, 25 – DhRr-6, 26 – DgRr-1, 27 – DhRq-21, 28 – DgRn-23, 29 – DhRl-15&16, 30 – DhRk-8, 31 – DiRj-1, 32 – DiRi-38

Table 1: Assemblages in the dataset.

Site	Borden #	Component/Assemblage	Phase Attribution	Source
Beach Grove	DgRs-1	Ball 1979	Locarno Beach	Ball 1979
Beach Grove	DgRs-1	Block I – Locarno	Locarno Beach	Arcas 1996
Beach Grove	DgRs-1	Block I – St. Mungo	Charles	Arcas 1996
Beach Grove	DgRs-1	Block II – Marpole	Marpole	Arcas 1996
Beach Grove	DgRs-1	Block IV – St.Mungo	Charles	Arcas 1996
Beach Grove	DgRs-1	Matson et al. 1980	Marpole	Matson et al.1980
Beach Grove	DgRs-1	Smith 1963	Marpole	Smith 1963, 1964
Belcarra Park	DhRr-6	Component I	Locarno Beach	Charlton 1980
Belcarra Park	DhRr-6	Component II	Gulf of Georgia	Charlton 1980
British Camp	45SJ24	Ethnozone I	Marpole	Stein 1992
British Camp	45SJ24	Ethnozone II	Gulf of Georgia	Stein 1992
Buckley Bay	DjSf-13	Mitchell 1974	Marpole	Mitchell 1974, Mason and Hoffman 1998
Buckley Bay	DjSf-13	Whitlam 1974	Marpole	Whitlam 1974, Mason and Hoffman 1998
Crescent Beach	DgRr-1	Component I	Charles	Percy 1974
Crescent Beach	DgRr-1	Locarno Component – S Trench	Locarno Beach	Matson et al. 1991
Crescent Beach	DgRr-1	Locarno Component	Locarno Beach	Trace 1981
Crescent Beach	DgRr-1	St. Mungo Component – S Trench	Charles	Matson et al. 1991
Deep Bay	DiSe-7	Component I	Locarno Beach	Monks 1977
Deep Bay	DiSe-7	Component II	Marpole	Monks 1977
Deep Bay	DiSe-7	Component III	Gulf of Georgia	Monks 1977
Departure Bay	DhRx-16	Layer C	Locarno Beach	Arcas 1994
Departure Bay	DhRx-16	Layer D	Marpole	Arcas 1994
DgRx-11	DgRx-11	Component I/II	Marpole/Gulf of Georgia	Murray 1982
DgRx-36	DgRx-36	Component III	Gulf of Georgia	Murray 1982
DgRx-5	DgRx-5	Component I	Locarno Beach	Murray 1982
DgRx-5	DgRx-5	Component II	Marpole	Murray 1982
DgRx-5	DgRx-5	Component III	Gulf of Georgia	Murray 1982
Dionisio Point	DgRv-3	Component IIa/IIb	Gulf of Georgia	Mitchell 1971b
DkSb-30	DkSb-30	Component I	Early Period	Golder 2007
DkSb-30	DkSb-30	Component II	Charles	Golder 2007
False Narrows	DgRw-4	False Narrows II	Marpole	Burley 1989
Flood	DiRi-38	Component 1	Marpole	von Krogh 1980
Flood	DiRi-38	Component 2	Gulf of Georgia	von Krogh 1980
Georgeson Bay	DfRu-24	Georgeson Bay I	Locarno Beach	Haggarty and Sendey 1976
Georgeson Bay	DfRiu-24	Georgeson Bay II	Gulf of Georgia	Haggarty and Sendey 1976
Glenrose	DgRr-6	Eldridge 1991	Charles	Eldridge 1991
Glenrose	DgRr-6	Marpole Component	Marpole	Matson 1976
Glenrose	DgRr-6	Old Cordilleran Component	Early Period	Matson 1976
Glenrose	DgRr-6	St. Mungo Component	Charles	Matson 1976
Hatzic Rock	DgRn-23	Layer C	Charles	Ormerod and Matson 2000
Hatzic Rock	DgRn-23	Mason 1994	Charles	Mason 1994
Katz	DiRj-1	Zone A	Locarno Beach	Hanson 1973
Katz	DiRj-1	Zone B	Locarno Beach	Hanson 1973
Locarno Beach	DhRt-6	Layer 11	Locarno Beach	Arcas 1993
Locarno Beach	DhRt-6	Layer 7+	Locarno Beach	Arcas 1993
Locarno Beach	DhRt-6	Layer 8	Marpole	Arcas 1993

Locarno Beach	DhRt-6	Layer 9	Marpole	Arcas 1993
Marpole	DhRs-1	Layers 2,3,4,5	Marpole	Arcas 1989
Maurer	DgRk-8	Maurer House	Charles	Schaepe 1998, LeClair 1976
Montague Harbour	DfRu-13	Component I	Locarno Beach	Mitchell 1971a
Montague Harbour	DfRu-13	Component III	Gulf of Georgia	Mitchell 1971a
Oyster River	DlSh-6	Marpole Component	Marpole	Golder 1998
Pitt River	DhRq-21	Kroeker	Gulf of Georgia	Patenaude 1985
Pitt River	DhRq-21	Logodi – Charles Component	Charles	Patenaude 1985
Pitt River	DhRq-21	Logodi – Locarno Component	Locarno Beach	Patenaude 1985
Pitt River	DhRq-21	Mackenzie – Charles Component	Charles	Patenaude 1985
Pitt River	DhRq-21	Mackenzie – Locarno Component	Locarno Beach	Patenaude 1985
Point Grey	DhRt-5	Marpole Component	Marpole	Coupland 1991
Scowlitz	DhRl-15 & 16	BOD/Layer 44	Gulf of Georgia	Lepofsky et al. 1999; 2000a, 2000b
Scowlitz	DhRl-15 & 16	Structure 3	Marpole	Lepofsky et al. 1999; 2000a, 2000b
Shoemaker Bay	DhSe-2	Component I (Zone B,C,D)	Marpole	McMillan and St.Claire 1982
Shoemaker Bay	DhSe-2	Component II (Zone A)	Gulf of Georgia	McMillan and St.Claire 1982
St. Mungo	DgRr-2	Component I	Charles	Boehm 1973
St. Mungo	Dgrr-2	Component II	Marpole	Boehm 1973
St. Mungo	DgRr-2	ETD-Layer A	Gulf of Georgia	Eldridge 1984
St. Mungo	DgRr-2	ETD-Layers C,D,E	Marpole	Eldridge 1984
Tsawwassen	DgRs-2	Zone C (Layer CA, CB), Zone D (Layer DB, DD), Zone G (Layer GC, Ah)	Marpole/Gulf of Georgia	Arcas 1994b
Tsawwassen	DgRs-2	Zone C (Layer CC, CE, CD)	Marpole	Arcas 1994b
Tsawwassen	DgRs-2	Zone G (Layer DF, DG)	Charles	Arcas 1994b
Tsawwassen Beach	DgRs-9	Component I/II	Gulf of Georgia	Golder 2008
Whalen Farm	DfRs-3	Component I	Locarno Beach	Thom 1992, Thom 1997
Whalen Farm	DfRs-3	Component II	Marpole	Thom 1992, Thom 1997
Whalen Farm	DfRs-3	Hammon 1986	Marpole	Hammon 1986, Thom 1997
Willows Beach	DcRt-10	Zone A	Gulf of Georgia	Kenny 1974
Willows Beach	DcRt-10	Zone B	Locarno Beach/Marpole	Kenny 197

For a considerable number of sites I was unable to locate original reports with detailed artifact summaries. On some occasions, such as for the Pender Canal site (Carlson and Hobler 1993), the detailed reports did not include artifact tabulations. For others, like Ham et al.'s (1984) thorough excavation of the St. Mungo site, the artifact appendix was presented as a spreadsheet printout and the artifacts were grouped according to functional categories, making it impossible to organize them by chipped stone, ground stone, or faunal tools without going through the thousands of artifacts individually. As a result, these assemblages are not included in the database.

The availability of an associated radiometric date determined whether an assemblage was included or not. Three situations were frequently encountered: complete absence of radiometric dates, dates that had been rejected by the excavators, or pending radiometric results. In all such cases the assemblages were left out of the database. For all assemblages with associated radiometric dates, only the dates accepted by the excavators were included. Without doing a complete reanalysis of the stratigraphy for each assemblage, I have to assume that the original researcher has a far better understanding of the depositional context than myself. This includes dates rejected on the grounds of a discrepancy with the associated phase and not just contamination or stratigraphic inconsistency. Therefore, the dataset has a slight bias for dates that match the established periodization. Such a bias allows for greater confidence in any observed discrepancies between the with and without phase analyses as this type of bias should reduce differences rather than promote them.

I excluded any site whose phase attribution (i.e. chronological placement) is based solely on typological comparison with pre-existing assemblages. As a result, all sites analyzed by the phase concept can be analyzed strictly by radiometric dates, allowing for an explicit statement on the influence of the phase concept on the interpretation of archaeological change.

A number of factors required that assemblages satisfying both primary criteria be excluded from the dataset. One such factor is the assemblage sample size. Although the majority of assemblages have artifact counts in the hundreds or thousands, some assemblages did not. For example, Structure 4 from Scowlitz (12 artifacts, Lepofsky et al. 1999, 2000a, 2000b), the Stselax component from the Tsawwassen site (18 artifacts, Arcas 1991a, 1991b, 1994b, 1999), and Component III from DkSb-30 (19 artifacts, Golder 2007) were all excluded. In these examples, every artifact contributes more than 5% to the proportional values and their incorporation in the dataset could not be justified. I did, however, incorporate the handful of assemblages whose counts range between 30 and 60 artifacts (Appendix A). The benefit of maintaining a larger spatial and temporal resolution outweighs any potential pitfalls of incorporating these assemblages. The proportional change we are examining through time is far more substantial than the percentage that one artifact contributes to these assemblages.

Another of the factors for excluding assemblages was questionable or uncertain depositional integrity. This includes Component III from St. Mungo (Boehm 1973) and sections of Dionisio Point (Grier 1998, 1999) that had intrusive historic objects. This is not to suggest that any or all of the work done at these two sites is irrelevant. Both Components I and II of Boehm's work at St. Mungo are included in the dataset and Grier's work at Dionisio Point is one of the best examples of household archaeology on the Northwest Coast. However, rather than risk incorporating a bias into the temporal axis, the proportional tool categories for these sites were not included in the analysis as a precaution.

The result of these data screening criteria is a representative sample of Gulf of Georgia archaeological sites that are confidently distributed throughout the past 9000 years, allowing for robust interpretations of the spatial and temporal pattern of the transition from chipped stone tools to ground stone, bone, and antler tools.

The Analysis

The goal of the analysis is to answer two questions: 1) what is the spatio-temporal pattern of the transition from chipped stone to ground and polished stone, bone, and antler, and 2) does the phase concept influence the interpretation of this transition. The result is a three part analysis. First, the assemblages are grouped by phase attribution to understand the spatio-temporal pattern of change from phase to phase. Second, using radiometric dates as temporal control, the assemblages are ordered chronologically and the pattern of change is examined along continuous temporal and spatial axes. Finally, the results of both are compared to assess the influence of the phase concept on the interpretation of archaeological change.

Data Comparability

Where the analysis relies on the comparison of relative proportions of chipped stone, ground stone, and faunal tools through space and time, it is critical to discuss and assess the comparability of both the radiocarbon dates and the artifact assemblages. All radiocarbon dates were collected as uncalibrated age determinations then calibrated together using CalPal-2007 (Weninger et al. 2009, Appendix B). When possible the dates were taken from the original report and, if feasible, corroborated with Wilmeth's (1978) radiocarbon date compilation and the Canadian Archaeological Radiocarbon Database (Canadian Archaeological Radiocarbon Database 2009). If a discrepancy was encountered between any of these sources the original report was used. However, original reports were not used for dates with unclear or questionable information concerning the marine reservoir correction. For example, radiocarbon dates from DgRx-5 (Murray 1982) were calibrated to calendar years prior to being corrected for the marine reservoir effect. In this and similar cases, the normalized dates from CARD were used instead (Appendix B). That being said, if the correction was clearly stated and explained, such as the Arcas excavations at Beach Grove (Arcas 1996) and Departure Bay (Arcas 1994a), the original uncalibrated but corrected age estimates were used.

Determining the confidence in the comparability of the artifact assemblages required addressing two issues: stone and shell disc beads and debitage. It is common for comparative analyses on the NWC to omit disc beads because they dramatically skew the proportion of ground stone and shell categories (Burley 1980, Pratt 1992). For instance, Pratt (1992:89) does not include ground stone or shell disc beads in the artifact percentages because they "greatly skewed the percentages and did not allow for meaningful comparison between the three artifact assemblages." Similarly, Burley (1980) quantifies the assemblage compositions for multiple Marpole phase assemblages but also excludes slate and shell disc beads. His reasoning is that these artifact types are often discovered in large caches that substantially influence the proportions obtained. This is a valid point and is caused by disproportionate burial information between sites. Burley (1980:47) believes that, "aside from simple exclusion, an alternative for handling of this material was lacking." My solution is to conduct all analyses twice, once including the beads and once excluding the beads. Taking this approach allows a transparent assessment of the influence disc beads have on regional patterns. In fact, as we will see in the results section, disc beads do significantly alter the interpretation of the data in a very behaviourally relevant and thought provoking manner.

Along a similar line, it became apparent during the data entry that large variations exist in the amount of debitage and small lithics for each assemblage. Initially this observation was treated in the same manner as discussed for disc beads. However, plotting the year of excavation by the proportion of these tool categories made it apparent that the incidence of small lithics increases with the year of excavation (Figure 4 and 5). This observed trend is likely the product of methodological changes that saw the incorporation of systematic screening and a greater discipline-wide concern with the tool manufacturing processes, specifically debitage and refitting analyses (Andrefsky 2001, 2005). Furthermore, we should expect that debitage – the byproduct of flaking – would be present at any site where chipped stone tools are being made. Granted, there may be within site spatial variation or objects could be made off-site, leading to a lack of debitage. These interpretations, however, must be made by comparing assemblages excavated with similar site sampling strategies. Therefore, to avoid a major bias in the assemblage proportion of chipped stone, debitage and small lithic artifact categories such as micro-flakes have been excluded. This is further justified by the fact that there is no equivalent byproduct of manufacturing ground stone and faunal tools preserved in the artifact assemblage. Thus, incorporating debitage would automatically bias the proportions toward chipped stone.

RESULTS

Examining the transition from a phase-based perspective we encounter support for the accepted perception of the transition as incremental or gradual from phase to phase. However, closer scrutiny of the within phase variation questions the strength of this interpretation. In fact, analyzing the transition irrespective of cultural phases suggests that the critical period of transition is 4500 cal BP when we see the introduction of substantial proportions of both ground stone and faunal tools. Following this transition, there is no disappearance of assemblage types but rather a gradual increase in the variance of assemblage composition, particularly ground stone proportions. The pattern of faunal tools strongly suggests a dramatic preservation bias through space and time. Overall, the result suggests that the phase concept is influencing the interpretation of archaeological change on the southwest coast of BC and relying on continuous temporal and spatial variables is a more appropriate framework for assessing archaeological change.

Figure 4: Proportion of lithics identified as micro-lithics in relation to publication date.

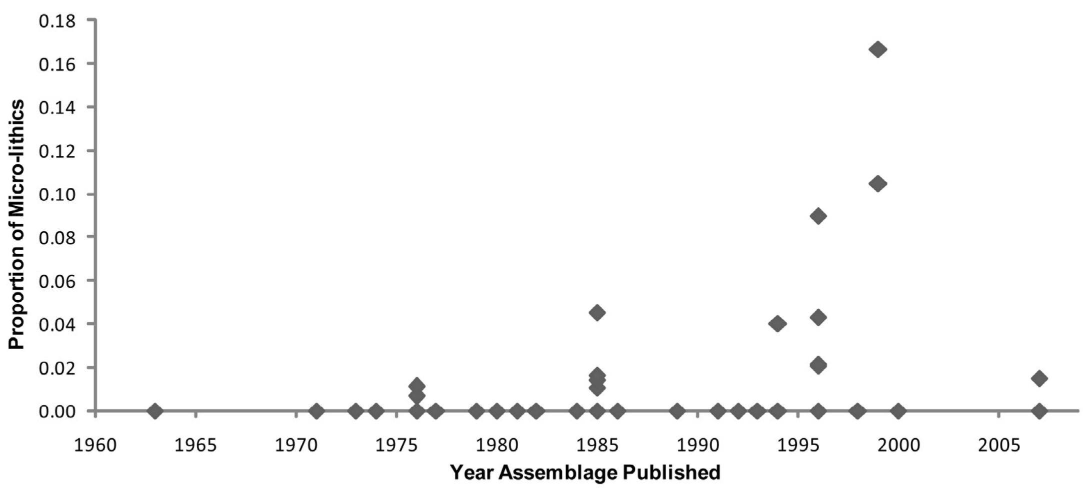
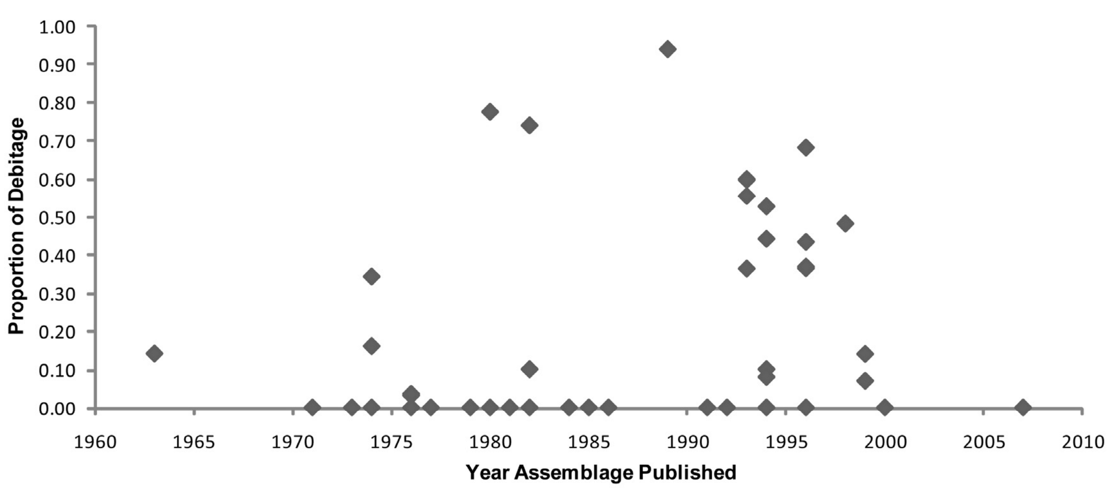


Figure 5: Proportion of lithics identified as debitage in relation to publication date.



A Phase-Based Transition

The Temporal Pattern

When we examine each phase according to the average proportions of chipped stone, ground stone, and faunal tools we find support for a gradual and incremental transition. In Table 2 we clearly see that as time advances from phase to phase there is an incremental decrease in chipped stone, an incremental increase in faunal tools, and an incremental increase in ground stone from the Early Period to the Locarno Beach phase, after which the proportion of ground stone plateaus. Here we have strong support for the transition as it has been discussed in the literature (Hobler 1990, Mitchell 1990, von Krogh 1980). However, solely relying on the average proportion for each phase masks two important factors. First, it ignores both the synchronic and diachronic range of variation within each phase and, second, the phases are not equal in the absolute time period they encompass, making this preliminary result inappropriate for assessing the extent to which the transition is gradual through time. What this result does allow us to conclude is that there is an observable decrease from phase to phase in the *average* proportion of chipped stone tools as the *average* proportion of faunal and ground stone tools increase.

Table 2: Average proportions of chipped stone, ground stone, and faunal tools in each phase.

	Early Period	Charles	Locarno Beach	Marpole	Gulf of Georgia
Chipped	0.90 (0.90)*	0.69 (0.78)	0.62 (0.69)	0.44 (0.53)	0.28 (0.31)
Ground	0.01 (0.01)	0.12 (0.07)	0.25 (0.18)	0.32 (0.25)	0.29 (0.25)
Faunal	0.08 (0.08)	0.18 (0.14)	0.13 (0.13)	0.24 (0.22)	0.43 (0.43)

*Numbers in brackets are the proportions if beads are excluded

When we consider the range of variation (i.e. the distribution) of the average proportions in each phase (Figure 6, Table 3), a number of questions arise concerning the simplicity of this transition. In Figure 6 we clearly see the same pattern as observed in Table 2 for the centers of the distributions; in this case the medians of chipped stone decrease as the ground stone and faunal medians increase through time. However, preserved in the boxplots is the range of each distribution, highlighting the importance of the internal variation in each phase. Aside from the Early Period, for which there are only two assemblages, the range of chipped stone proportions overlap considerably in all periods. It is possible, in any phase after the Early Period, to have an assemblage with almost no chipped stone, one with nearly 100% chipped stone, and anywhere in between. Therefore, broad generalizations about the increase in ground stone production at the expense of chipped stone production are not entirely accurate. It is more accurate to speak of the incorporation of a ground stone and faunal tool technology into a preexisting pattern of chipped stone assemblages.

Additional support for this perspective comes from an examination of how many assemblages are dominated by each technological category in each phase. At no point do ground stone assemblages dominate a phase (Table 4). The only period in which assemblages are not predominantly chipped stone is the most recent one, the Gulf of Georgia phase. At this time, assemblages dominated by faunal tools become predominant. Interpreting this increase in faunal technology through time is very difficult as it is strongly subject to preservation conditions (Carlson 1990a, Moss and Erlandson 1995, Stein 1992). Exactly what this means for the cultural importance of each of these tool categories is also difficult to interpret. Chipped stone is often an expedient tool that is produced and discarded as needed (Graesch 2007). Ground stone tools, however, require a greater time investment and would not likely be discarded in the same way (Binford 1973, 1979, Pratt 1992). As a result, simply having a higher proportion of chipped stone assemblages does not mean chipped stone was more culturally important at these times. The critical point, however, is that chipped stone dominated assemblages do not disappear through time and none of the phases are dominated by ground stone technology. Clearly, Hobler's (1990) statement is inaccurate that chipped stone becomes unimportant to the assemblage composition at 1750 BP – roughly the Gulf of Georgia phase.

Figure 6: Clustered boxplots demonstrating the range of chipped stone, ground stone, and faunal tools for each phase.

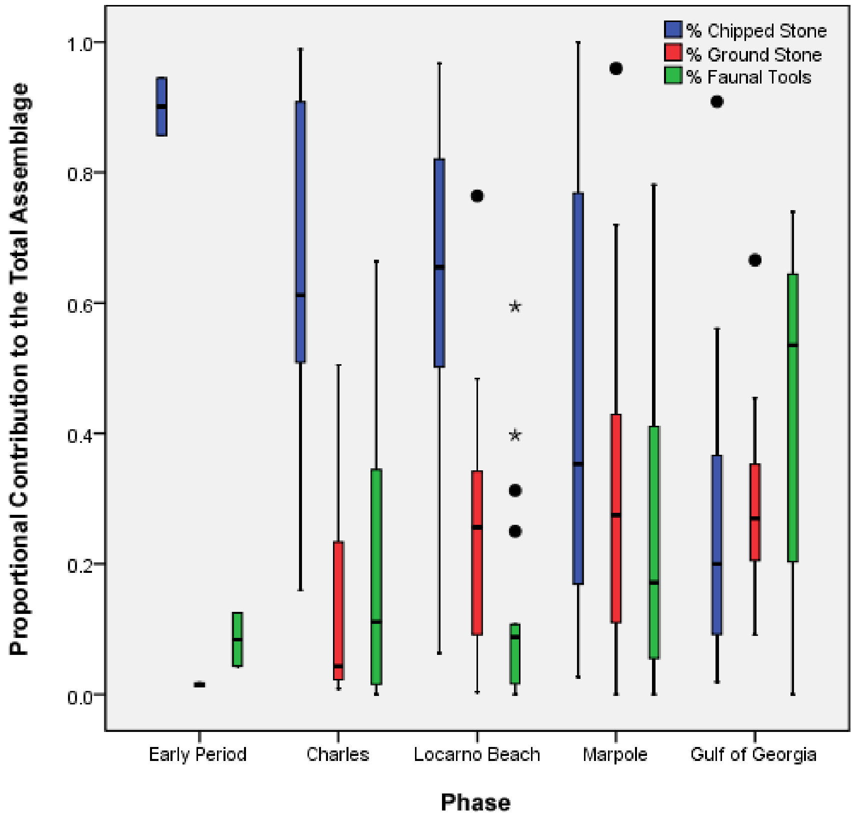


Table 3: Range of chipped stone, ground stone, and faunal tool proportions for each phase.

	Early Period	Charles	Locarno Beach	Marpole	Gulf of Georgia
Chipped	0.86 - 0.94	0.16 (0.31)* - 0.99	0.06 - 0.97	0.03 (0.14) - 1.0	0.02 - 0.91 (0.92)
Ground	0.01 - 0.02	0.01 - 0.51 (0.33)	0 - 0.76 (0.42)	0 - 0.96 (0.65)	0.09 (0.08) - 0.67
Faunal	0.04 - 0.10	0 - 0.66	0 - 0.59 (0.60)	0 - 0.78 (0.55)	0 - 0.74

*Numbers in brackets are the proportions if beads are excluded

Table 4: Proportion of assemblages dominated by chipped stone, ground stone, or faunal tools in each phase.

	# of Assemblages Comprised Predominantly of:		
	Chipped Stone	Ground Stone	Faunal Tools
Gulf of Georgia	20% (3)*	13% (2)	67% (10)
Marpole	42% (10)	33% (8)	25% (6)
Locarno Beach	82% (14)	6% (1)	12% (2)
Charles	86% (12)	7% (1)	7% (1)
Protowestern	100% (2)	0	0

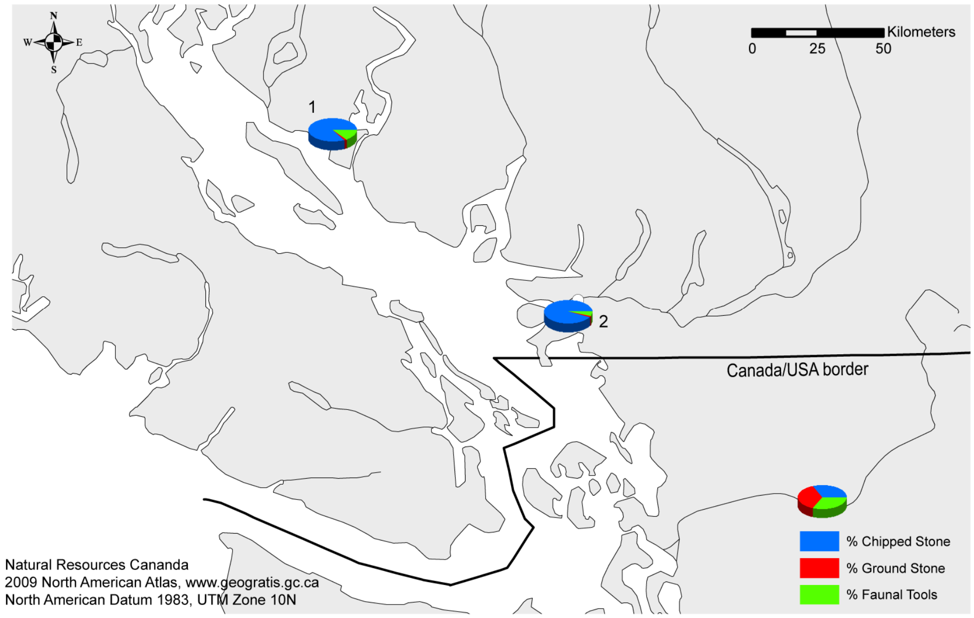
*Number in brackets is the raw number of assemblages

The Spatial Pattern

Figures 7-11 display some suggestive patterns in the spatial distribution of the transition. But the uncertainty of faunal preservation through time and space, substantial evidence for within site spatial variation, and the absence of discrete spatial grouping should temper any conclusions regarding the grouping of sub-regional variants at this scale of analysis.

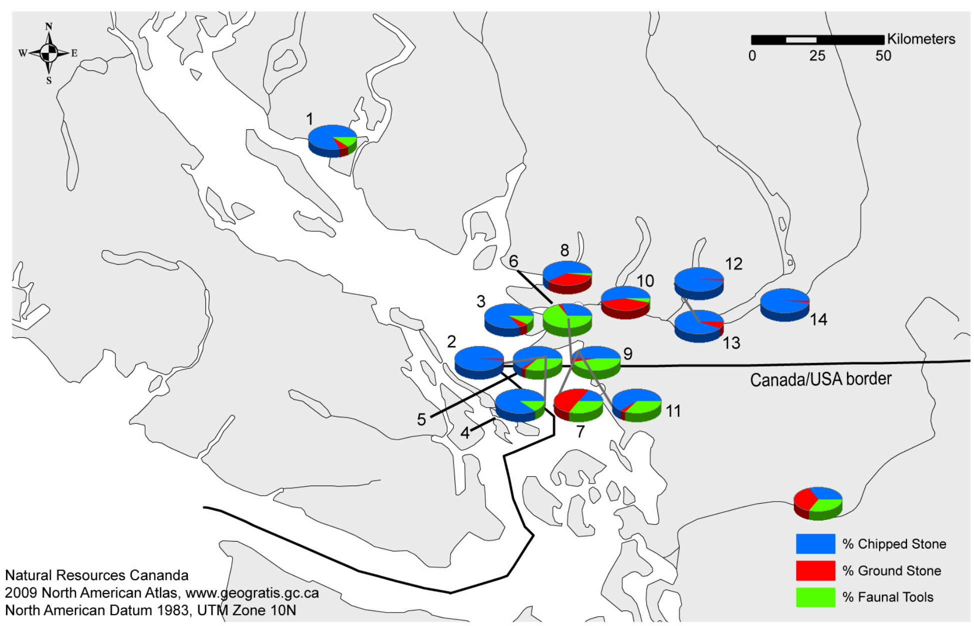
The Early Period (Figure 7) is difficult to assess because of the small sample size. Both assemblages contain more than 85% chipped stone and less than 2% ground stone. Although limited, the data that is available for the oldest phase suggests a predominance of chipped stone. However, in the following Charles phase (Figure 8), we see the first appearance of substantial proportions of ground stone, but more striking is the dramatic increase in assemblages with high, although not necessarily dominant, proportions of faunal tools. Worth noting here is that none of the three upriver assemblages (two assemblages from Hatzic Rock and one from Maurer) have substantial proportions of faunal material compared to some sites in the delta. All three of these upriver assemblages are dominated by chipped stone with only minute proportions of ground stone. This has suggested to some that these are sub-regional variants of the Charles phase (see Carlson 1970, Mason 1994, Matson et al. 1991, Ormerod 2002, Ormerod and Matson 2000, Pratt 1992, Schaepe 1998). We must acknowledge, however, that there are assemblages on the coast, specifically the Arcas (1996) assemblage from Beach Grove, which match the upriver assemblages. Also, Eldridge’s (1991) assemblage from the St. Mungo site has the same relationship between chipped and ground stone with a small addition of faunal tools. This again begs the question of differential preservation of faunal material based on differential sedimentary contexts and the presence of shell middens. Substantive contributions of ground stone technology appear in both riverine (Pitt River) and coastal (Crescent Beach) contexts in the Charles phase.

Figure 7: Spatial distribution of assemblage proportions for the Early Period.



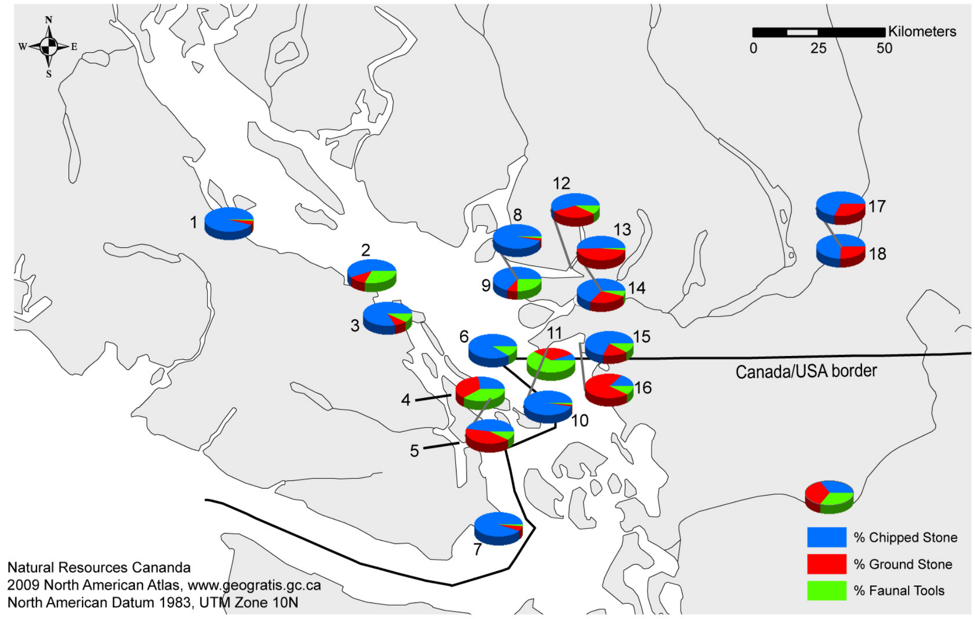
1 – DkSb-30, 2 – DgRr-6

Figure 8: Spatial distribution of assemblage proportions for the Charles phase.



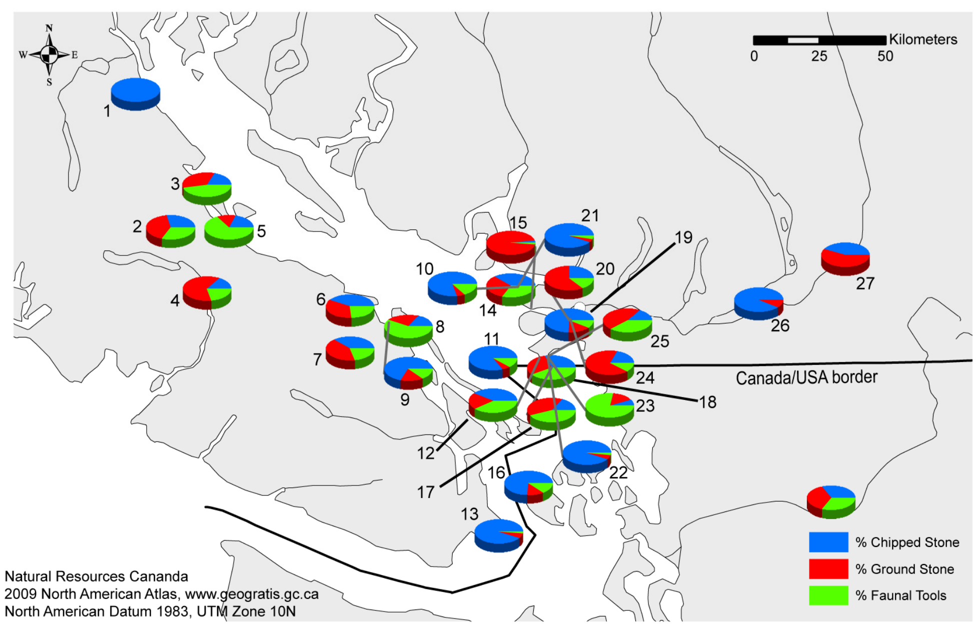
1 – DkSb-30, 2 – DgRs-1 Arcas Block I, 3 – DgRr-6 Eldridge 1991, 4 – DgRs-1 Arcas Block IV, 5 – DgRs-2, 6 – DgRr-2, DgRr-1, 8 – DhRq-21 Logodi, 9 – DgRr-6 Matson 1976, 10 – DhRq-21 Mackenzie, 11 – DgRr-1 Percy 1974, 12 – DgRn-23 Layer C, 13 – DgRn-23 Mason 1994, 14 – DhRk-8

Figure 9: Spatial distribution of assemblage proportions for the Locarno Beach phase.



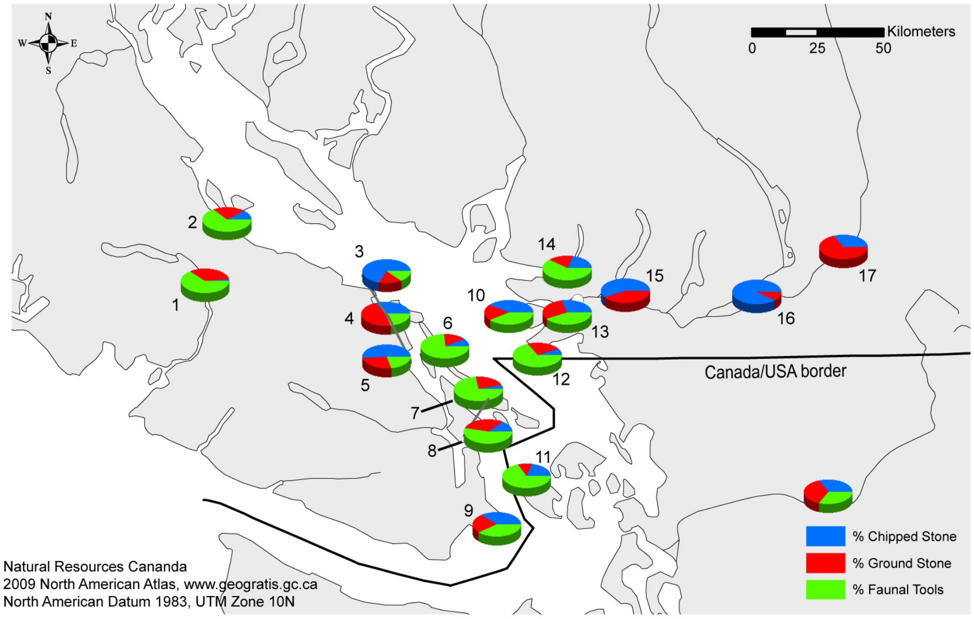
1 – DiSe-7, 2 – DhRx-16, 3 – DgRx-5, 4 – DfRu-13, 5 – DfRu-24, 6 – DgRs-1 Ball 1979, 7 – DcRt-10, 8 – DhRt-6 Layer 11, 9 – DhRt-6 Layer 7+, 10 – DgRs-1 Arcas Block I, 11 – DfRs-3, 12 – DhRr-6, 13 – DhRq-21 Logodi, 14 – DhRq-21 Mackenzie, 15 – DgRr-1 Trace 1981, 16 – DgRr-1 Matson *at al.* 1991, 17 – DiRj-1 Zone A, 18 – DiRj-1 Zone B

Figure 10: Spatial distribution of assemblage proportions for the Marpole phase.



1 – DlSh-6, 2 – DjSf-13 Mitchell 1974, 3 – DjSf-13 Whitlam 1974, 4 – DhSe-2, 5 – DiSe-7, 6 – DhRx-16, 7 – DgRx-5, 8 – DgRw-4, 9 – DgRx-11, 10 – DhRt-6 Layer 9, 11 – DgRs-2 Marpole, 12 – DgRs-2 Marpole/Gulf of Georgia, 13 - DcRt-10, 14 – DhRt-5, 15 – DhRs-1, 16 – 45SJ24, 17 – DfRs-3 Thom 1992 & 1997, 18 – DfRs-3 Hammon 1986, 19 – DgRr-2 Eldridge 1984, 20 – DgRr-2 Boehm 1973, 21 – DhRt-6 Layer 8, 22 – DgRs-1 Arcas Block II, 23 – DgRs-1 Smith 1963, 24 – DgRr-6, 25 – DgRs-1 Matson et al. 1980, 26 – DhRl-15&16, 27 – DiRi-38

Figure 11: Spatial distribution of assemblage proportions for the Gulf of Georgia phase.



1 – DhSe-2, 2 – DiSe-7, 3 – DgRx-11, 4 – DgRx-5, 5 – DgRx-36, 6 – DgRv-3, 7 – DfRu-13, 8 – DfRu-24, 9 – DcRt-10, 10 – DgRs-2 Marpole/Gulf of Georgia, 11 – 45SJ24, 12 – DgRs-9, 13 – DgRr-2, 14 – DhRr-6, 15 – DhRq-21, 16 – DhRl-15&16, 17 – DiRi-38

There is very little difference in the spatial distribution of assemblages between the Charles and Locarno Beach phases. One observable change is a greater prominence of higher proportions of ground stone technology in the Locarno Bach phase. However, the reduction is at the expense of faunal tools rather than chipped stone (Figure 9). This observation includes the two upriver assemblages from Katz (Zone A and Zone B) and although both are still predominantly chipped stone (65% and 60%) they contain higher proportions of ground stone than many sites in the delta and the Gulf Islands. Comparable assemblages are found at the Deep Bay site and the Mackenzie assemblage from the Pitt River site. Both assemblages from Katz and a number of other sites (Beach Grove, Deep Bay, Locarno Beach, and Pitt River) have produced assemblages with little or no faunal tools. Even though the majority of moderate and substantial proportions of faunal material are concentrated in the delta and coastal assemblages, the lack of a discrete spatial division in assemblages lacking faunal tools makes it necessary that we account for the role of preservation bias before conclusions are made on the absence of faunal technologies (Linse 1992, Stein 1992).

In the Marpole and then the Gulf of Georgia phases we observe a continuation of the trend that began at the Charles/Locarno Beach junction. Ground stone tools and faunal tools increase gradually until the average ground stone proportion matches the average chipped stone proportion in the Gulf of Georgia phase (Table 2). Furthermore, Figures 10 and 11 demonstrate a similar spatial pattern. Most striking is the continuation of increasing and more prevalent faunal tool proportions near the Fraser River delta and in the Gulf Islands. In the Marpole phase there are no faunal tools present in either of the upriver assemblages from Flood and Scowlitz. Yet both of these sites have analogs on the coast at Tsawwassen and Beach Grove (Arcas 1991a, 1991b, 1994b, 1996, 1999). Also important to note is that the Flood assemblage is dominated by ground stone whereas the Scowlitz one is predominantly chipped stone. Once again, and more pronounced through time, the distinguishing factor between the coastal sites and the upriver sites is the proportion of faunal tools. Nevertheless, we cannot ignore the presence of assemblages on the coast that have negligible proportions of faunal tools.

Once the Gulf of Georgia phase is reached (Figure 11) the most striking feature is the predominance of faunal tools. We have clearly observed an increase in the prevalence of faunal tools from phase to phase. What combination of preservation bias and actual increased use of faunal tools we are documenting remains to be seen. However, the pattern observed for chipped versus ground stone allows for more firm conclusions. There is clearly an increase in the frequency of ground stone tools from phase to phase. However, this increase is not in conjunction with a disappearance or decreased reliance on chipped stone. Rather, when considering the range of variation and the spatial distribution, we see that assemblages dominated by chipped stone are present for all phases and they are not restricted to any particular sub-region. What is occurring from phase to phase is the development of a more complex distribution of assemblage characteristics across the landscape. This is perhaps due to the elaboration of seasonal resource exploitation or perhaps due to emerging sub-regional divisions in social organization. However, testing these hypotheses requires much more regional-scale research focused on multiple different lines of evidence.

We should be wary of assuming the pattern we are observing is a product of sub-regional cultural variants without considerable supporting evidence. Our analysis of sites with multiple assemblages from the same phase suggests there can be considerable intra-site variability in the assemblage composition. Comparing the two Charles phase assemblages from the Glenrose Cannery site (Eldridge 1991, Matson 1976), it is clear that the contribution of chipped stone, ground stone, and faunal tools can change dramatically depending on the excavation location within a site. The chipped stone proportion from Eldridge's excavation is 85% compared to the 49% in Matson's assemblage. Both have negligible proportions of ground stone but there is a major discrepancy in faunal tools, 9% for Eldridge and 47% for Matson (Figure 7). A number of biases can be introduced due to spatial sampling. In this case it appears to be related to faunal preservation. However, it is equally likely that similar intra-site spatial variation is introduced by cultural factors (Abbott 1972) or shell midden formation (Burley 1980, Stein 1992). This is not entirely unexpected but requires us to be cautious when extrapolating single site sequences to the region as a whole.

Using a phase-based approach, the results demonstrate that there is indeed a decrease in the relative contribution of chipped stone through time. However, chipped stone assemblages do not disappear and are at least as prominent as ground stone dominated assemblages in all phases. There is a dramatic increase in faunal tools through time, but without much better understanding of faunal preservation from site to site, we cannot make any definitive claims about the phenomenon. These results may lead some to conclude a gradual transition. However, the limitations of the phase-based approach actually prohibit any confidence in this conclusion. As mentioned previously, the phases are not equal in chronological coverage (Figure 2) and analyzing change from one category to another ignores the potential change through time within phases. The result is an approach to archaeological change focused on differences between phases rather than treating time as a continuous variable.

Next, I will analyze the transition irrespective of culture phases/culture types, and will rely solely on radiometric dates for chronology. I will show that that a phase-based approach to change places interpretive constraints on the archaeological record.

Changing How We Look at Change

Figure 12 summarizes the calibrated radiocarbon dates for each assemblage in the dataset. Each point on the graph represents the median of the maximum and minimum estimate for all age determinations of an assemblage (see Table 5). The error bars represent the age range at one standard deviation when considering all accepted dates for a given assemblage. These are not individual radiocarbon ages but the combined range of radiocarbon estimates for a particular assemblage. For the sake of comparability the phases and the excavator's phase designation have been included. There are two important things to note. First, continuous temporal control only begins at 5500 cal BP and, therefore, only preliminary claims can be made concerning the relationship of assemblages before and after 5500 cal BP. Second, and suggestive of the need for a greater temporal resolution when analyzing change, the phase attributions are not discrete and overlap considerably at the boundaries of phases (Burley 1980, Kenny 1974, Mitchell 1971a, 1990).

The Temporal Pattern

In order to strictly assess the temporal pattern the assemblages have been plotted on a ternary diagram according to the relative proportions of chipped stone, ground stone, and faunal tools (Figure 13). A black to white color gradient has been applied to the symbols based on the median age estimate, black being the oldest and white the most recent. If the transition from chipped to ground stone is indeed gradual through time the color of assemblages on the diagram should change from light to dark as you move outward from the bottom left corner (i.e. as the proportion of chipped stone decreases). This is not the case. Rather, all except the darkest black (Early Period) assemblages appear in all parts of the graph. The distinct cluster of assemblages in the bottom left corner (greater than 90%

chipped stone) contains all shades from black to white. The only suggestive temporal pattern on this diagram is the increase in the occurrence of recent (i.e. lighter) assemblages as you approach 100% faunal tools. Neither of these patterns change if we remove disc beads from the analysis. The only change is an overall decrease in the number of assemblages with high proportions of ground stone tools (i.e. assemblages move away from the bottom right corner).

Figure 12: Calibrated radiocarbon age ranges for each assemblage (see Table 5 for associated components).

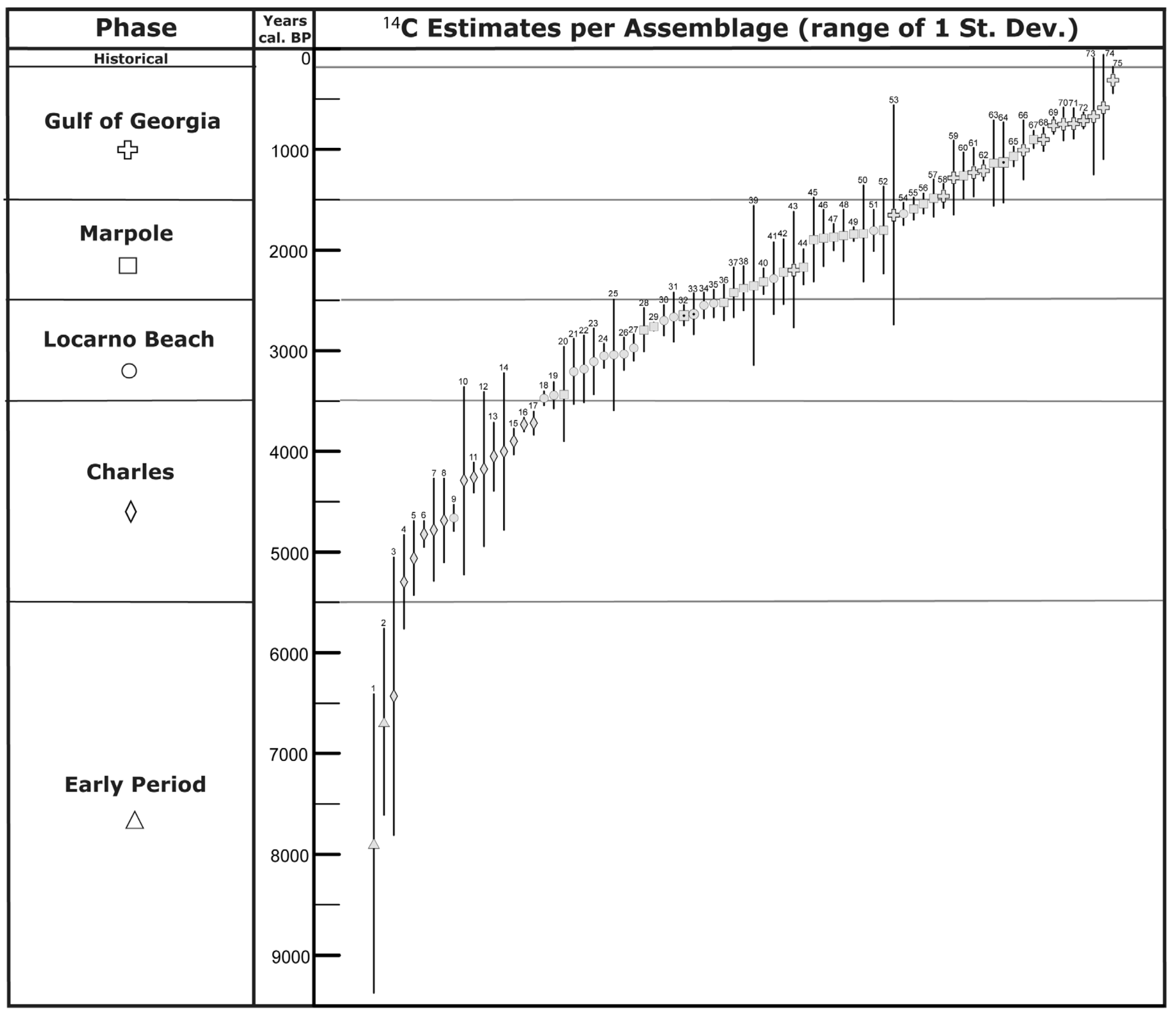


Table 5: Median age and age range for each assemblage in calibrated years BP.

					Calibrated ^{14}C Age Determinations		
	Borden #	Site Name	Assemblage	# Dates	Median Age	Max Age (1StDev)	Min Age (1StDev)
1	DgRr-6	Glenrose	Old Cordilleran Component	4	7890	9370	6410
2	DkSb-30	n/a	Component I	1	6685	7610	5760
3	DgRn-23	Hatzic Rock	Layer C	4	6430	7810	5050
4	DgRn-23	Hatzic Rock	Mason 1994	6	5295	5760	4830
5	DgRr-6	Glenrose	Eldridge 1991	4	5060	5430	4690
6	DgRr-1	Crescent Beach	Component I	1	4820	4950	4690
7	DhRk-8	Maurer	Maurer House	2	4780	5290	4270
8	DgRr-2	St. Mungo	Component I	3	4685	5100	4270
9	DgRx-5	n/a	Component I	1	4660	4790	4530
10	DhRq-21	Pitt River	Logodi – Charles Component	5	4290	5220	3360
11	DgRs-1	Beach Grove	Block IV - St. Mungo	4	4260	4410	4110
12	DgRr-6	Glenrose	St. Mungo Component	4	4175	4940	3410
13	DgRs-2	Tsawwassen	Zone G (Layers DF, DG)	4	4050	4390	3710
14	DhRq-21	Pitt River	Mackenzie – Charles Component	4	4000	4780	3220
15	DgRr-1	Crescent Beach	St. Mungo Component - S Trench	1	3900	4030	3770
16	DkSb-30	n/a	Component II	1	3730	3800	3660
17	DgRs-1	Beach Grove	Block I- St. Mungo	2	3715	3830	3600
18	DgRs-1	Beach Grove	Block I- Locarno	1	3470	3540	3400
19	DgRr-1	Crescent Beach	Locarno Component - S Trench	1	3440	3570	3310
20	DgRx-5	DgRx-5	Component II	2	3430	3900	2960
21	DfRu-13	Montague Harbour	Component I	2	3205	3530	2880
22	DgRs-1	Beach Grove	Ball 1979	2	3180	3510	2850
23	DhRt-6	Locarno Beach	Layer 11	2	3105	3430	2780
24	DhRq-21	Pitt River	Logodi – Locarno Component	1	3050	3170	2930
25	DgRr-1	Crescent Beach	Locarno Component (Trace 1981)	4	3040	3590	2490
26	DhRq-21	Pitt River	Mackenzie – Locarno Component	1	3030	3190	2870
27	DfRu-24	Georgeson Bay	Georgeson Bay I	1	2970	3100	2840
28	DjSf-13	Buckley Bay	Mitchell 1974	3	2795	3010	2580
29	DlSh-6	Oyster River	Marpole Component	1	2760	2800	2720
30	DiSe-7	Deep Bay	Component I	1	2700	2850	2550
31	DiRj-1	Katz	Zone B	2	2665	2910	2420
32	DgRx-11	n/a	Component I/II	1	2650	2750	2550
33	DcRt-10	Willows Beach	Zone B	2	2635	2840	2430
34	DhRt-6	Locarno Beach	Layer 7+	1	2550	2680	2420
35	DiRj-1	Katz	Zone A	1	2530	2670	2390
36	DfRs-3	Whalen Farm	Component I	1	2520	2700	2340
37	DhRl-15&16	Scowlitz	Structure 3	4	2420	2670	2170
38	DiRi-38	Flood	Component 1	1	2380	2600	2160
39	DhSe-2	Shoemaker Bay	Component I (Zone B, C, D)	3	2350	3140	1560
40	DhRt-6	Locarno Beach	Layer 9	1	2310	2440	2180
41	DfRs-3	Whalen Farm	Hammon 1986	3	2280	2640	1920
42	DgRr-6	Glenrose	Marpole Component	2	2215	2540	1890
43	DgRv-3	Dionisio Point	Component IIa/IIb	3	2195	2770	1620
44	DgRr-2	St. Mungo	ETD-Layer C,D,E	2	2165	2340	1990
45	DhRt-5	Point Grey	Marpole Component	3	1895	2310	1480
46	DgRs-2	Tsawwassen	Zone C (Layer CC, CE, CD)	4	1880	2160	1600

47	DiSe-7	Deep Bay	Component II	1	1870	2000	1740
48	DhRx-16	Departure Bay	Layer D	2	1855	2110	1600
49	DjSf-13	Buckley Bay	Whitlam 1974	1	1840	1910	1770
50	DhRs-1	Marpole	Layers 2,3,4,5	2	1835	2310	1360
51	DhRx-16	Departure Bay	Layer C	2	1805	2010	1600
52	DfRs-3	Whalen Farm	Component II	2	1800	2230	1370
53	DgRx-5	n/a	Component III	2	1650	2740	560
54	DhRr-6	Belcarra Park	Component I	2	1640	1750	1530
55	DgRw-4	False Narrows	False Narrows II	1	1590	1700	1480
56	DhRt-6	Locarno Beach	Layer 8	1	1540	1640	1440
57	DgRs-1	Beach Grove	Smith 1963	3	1485	1670	1300
58	DgRx-36	n/a	Component III	1	1460	1580	1340
59	DhRr-6	Belcarra Park	Component II	2	1280	1650	910
60	DgRs-1	Beach Grove	Matson et al. 1980	2	1260	1490	1030
61	DhSe-2	Shoemaker Bay	Component II (Zone A)	2	1225	1470	980
62	DiRi-38	Flood	Component 2	1	1210	1310	1110
63	45SJ24	British Camp	Ethnozone I	3	1135	1560	710
64	DgRs-2	Tsawwassen	Zone C (Layer CA, CB), Zone D (Layer DB, DD), Zone G (Layer GC, Ah)	15	1130	1530	730
65	DgRr-2	St. Mungo	Component II	1	1070	1170	970
66	DhRl-15&16	Scowlitz	BOD/Layer 44	4	1005	1300	710
67	DgRr-2	St. Mungo	ETD-Layer A	1	900	1020	780
68	DgRs-1	Beach Grove	Block II- Marpole	2	900	990	810
69	DiSe-7	Deep Bay	Component III	1	760	840	680
70	DgRs-9	Tsawwassen Beach	Component I/II	2	745	910	580
71	DfRu-13	Montague Harbour	Component III	2	740	890	590
72	DfRu-24	Georgeson Bay	Georgeson Bay II	1	710	790	630
73	DhRq-21	Pitt River	Kroeker	5	670	1250	90
74	45SJ24	British Camp	Ethnozone II	12	580	1100	60
75	DcRt-10	Willows Beach	Zone A	1	310	440	180

Although the ternary plot is strong support for a non-gradual or non-uniform transition from chipped to ground stone, it does not completely address the question. It remains to be seen specifically how the proportion of ground stone in the assemblage changes through time. Figure 14 shows the proportion of ground stone plotted against the median age estimate for each assemblage. Both the proportions including and excluding ground stone disc beads are included. Including disc beads has an impact on the nature of the curve. Without disc beads the *maximum proportion* of ground stone in any assemblage increases gradually beginning at roughly 5000 cal BP. Adding disc beads causes a jump in the proportions of ground stone at 5000 cal BP. Not only does this have an impact on how ground stone is introduced into the archaeological record but it suggests that some of the earliest substantial investments in ground stone technology are related to personal adornment, specifically beads. It can be said that once substantial investments in ground stone disc beads appear in the archaeological record the increase in the maximum proportion of ground stone tools gradually increases through time. However, ground stone does not overwhelm other tool types, and assemblages with low proportions of ground stone are present over the entire time scale. The transition we are observing is an increase in the variance of ground stone proportions through time.

Figure 13: Ternary diagram of the artifact assemblage proportions.

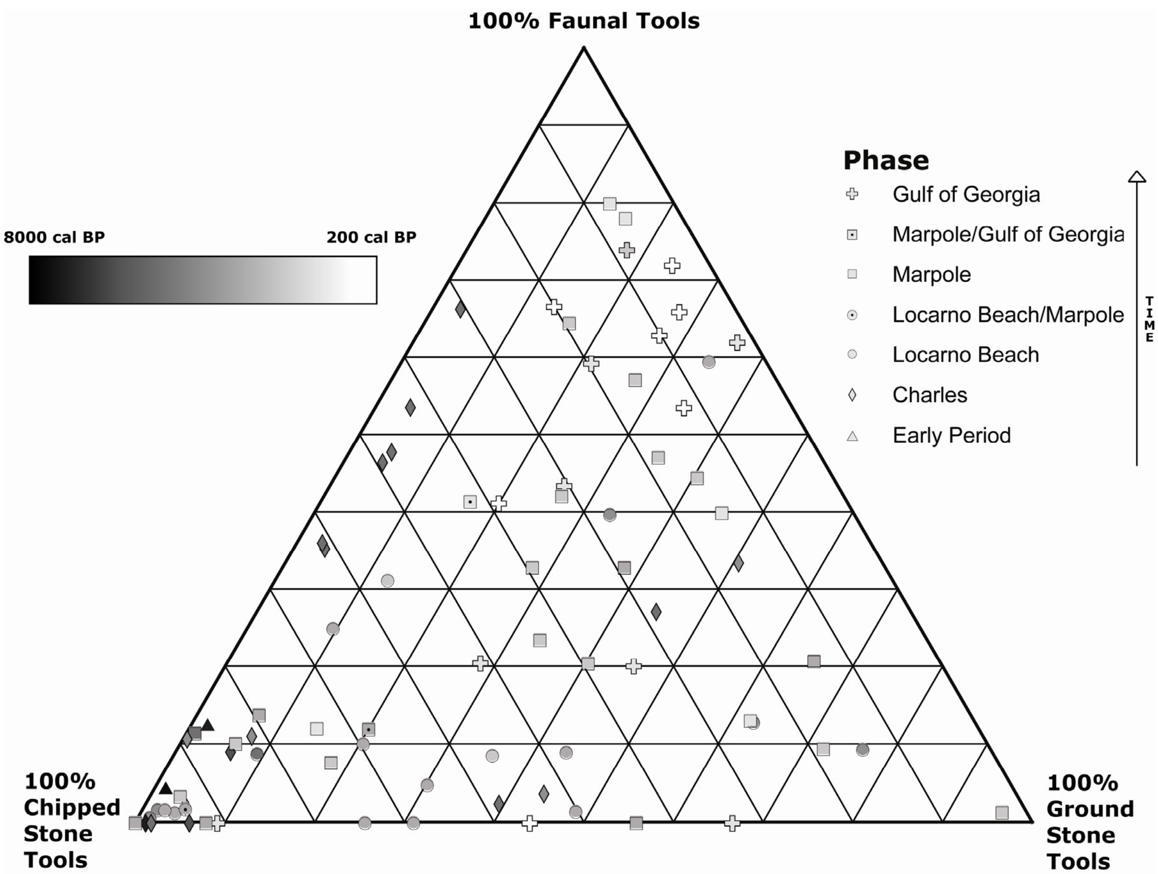
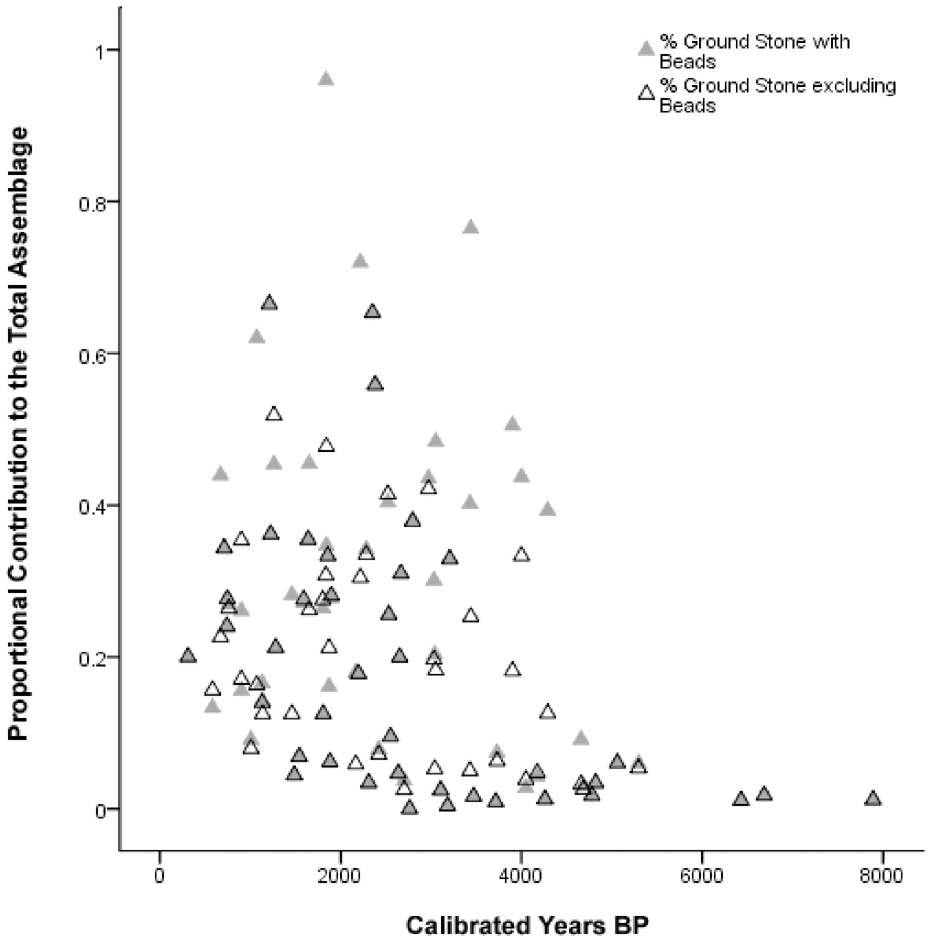


Figure 14: Proportion of ground stone with and without beads in relation to the median calibrated ^{14}C age.



The Spatial Pattern

Incorporating a spatial element into the analysis requires a method of presenting the spatial variability in conjunction with a number of other variables. In the Gulf of Georgia region we have the luxury of a predominantly east to west distribution of sites along the Fraser River, through the delta, and out into the Gulf Islands or up the coastline. As a result, the multiple dimensions of space have been re-classified according to the distance from the mouth of the Fraser River (Figure 15). Everything to the east of this point is given a distance eastward and everything to the west is given a distance westward. This spatial variable becomes the X-axis of an assemblage scatter plot for which the Y-axis is the median radiocarbon estimate with each assemblage symbolized according to a third variable (Figure 16a-c and 17). In the end I have a graph that displays the spatial and temporal patterning of changes in the technological composition of each assemblage. A comparison of Figure 15 to any of these scatter plots shows how the spatial distribution breaks down into the upriver sites (east of 50km E), sites in the delta (clustered near 0km), and coastal and Gulf Island sites (west of 50km W).

Figure 15: Graphical demonstration of the measure of Euclidian distance from the mouth of the Fraser River.

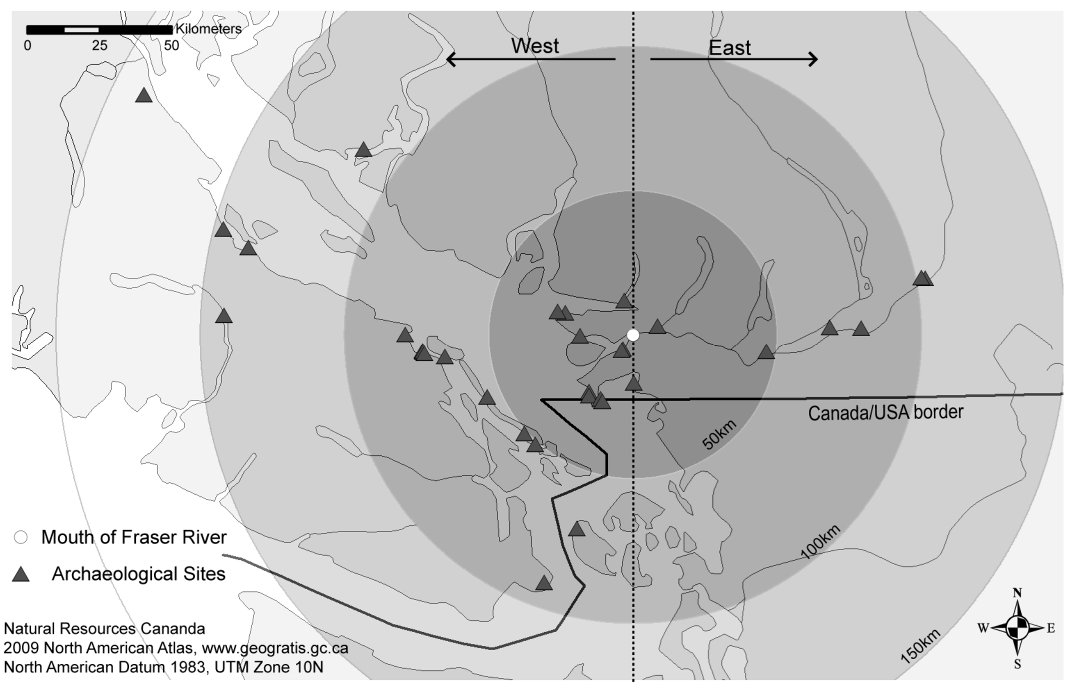


Figure 16a-c: Plotting a) chipped stone, b) ground stone, and c) faunal tool proportions on continuous spatial and temporal axes.

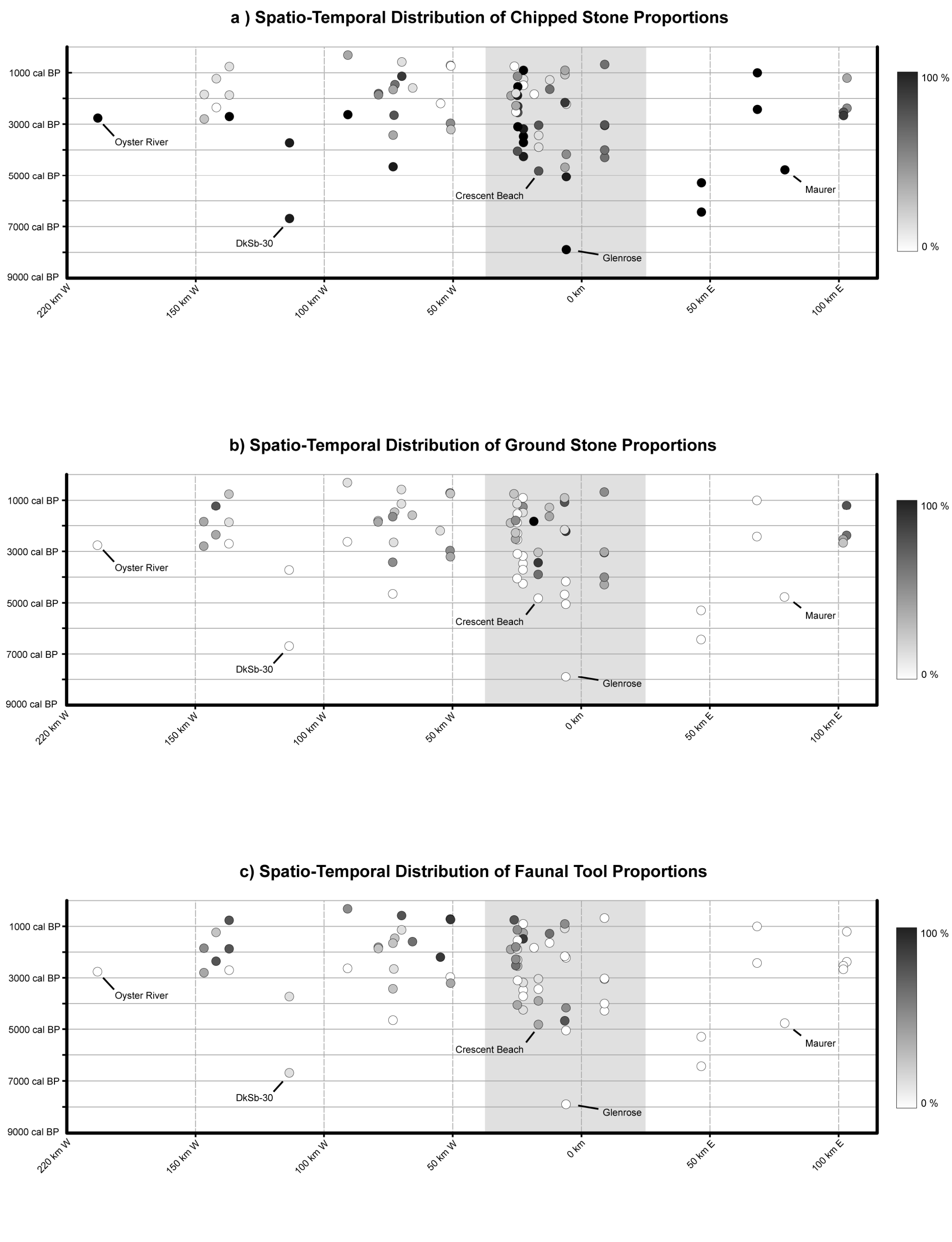
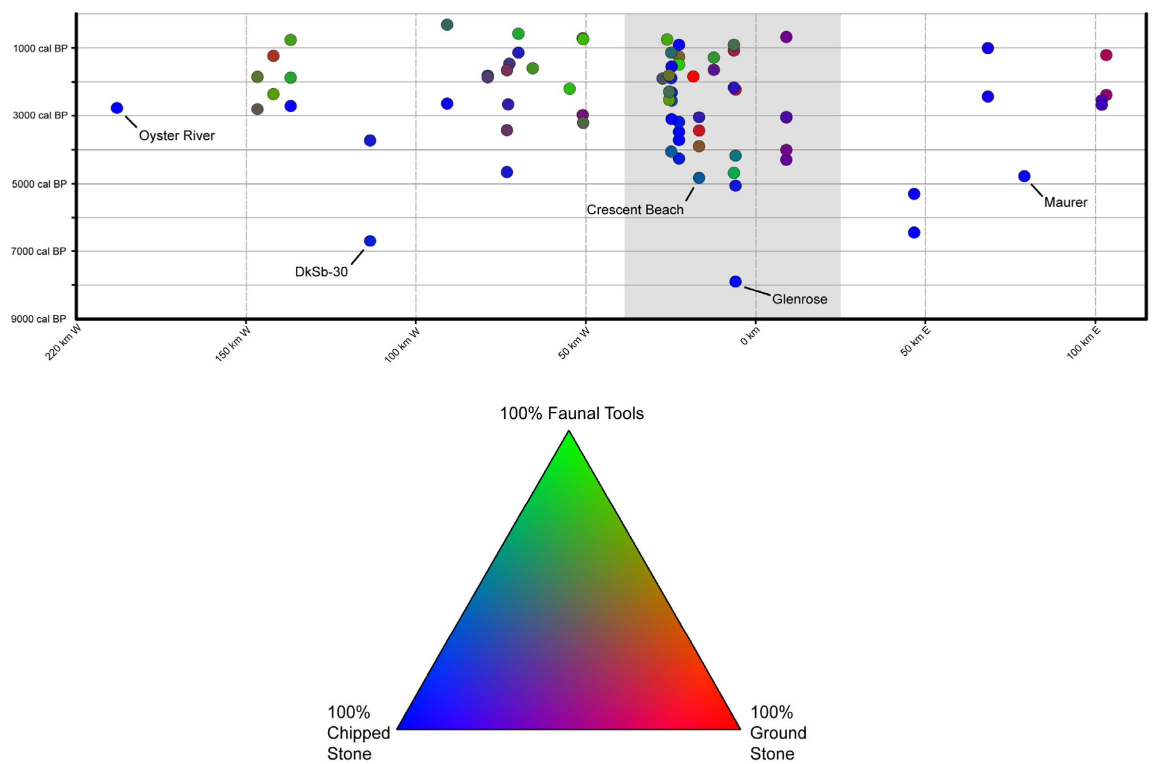


Figure 17: Spatio-temporal distribution of assemblages with an RGB composite representing ground stone, faunal tools, and chipped stone proportions.



An examination of the scatter plots suggests one overarching pattern through space and time at approximately 5000 years cal BP. Prior to this time chipped stone predominates and ground stone and faunal tools are absent everywhere. After 5000 cal BP we begin to see a decrease in the proportions of chipped stone in the cluster of points around 0km (i.e. in the Fraser River delta) due to the appearance faunal tools in observable proportions. Slightly later, approximately 4500 cal BP, ground stone makes its first contribution to the assemblage composition and almost immediately becomes present in all three areas (Figure 16a-c). It may occur a few hundred years earlier in the delta but there are too few assemblages that fall between 3000 and 5000 cal BP to make this a firm statement. Whether it actually appears earlier in the delta remains to be seen as research continues to grow the dataset.

As we continue through time we see that after 4000 cal BP, both ground and chipped stone maintain a considerable level of variation in their relative contributions to assemblages in all three areas. There is also a clearly defined spatial division reflected in the disproportionate amounts of faunal tools in upriver assemblages and near the coast. In fact, this pattern of increasing faunal proportions through time matches the expectation of a preservation bias. It is known that shell middens promote the preservation of bone and antler. It is also known that shell middens are coastal features and therefore it is more likely for bone and antler to preserve in these regions (Carlson 1990a, Linse 1992). We cannot rule out that the distribution of faunal tool proportions over the past 9000 years is significantly influenced by preservation.

Summary of Results

In discussing the phase-based results it is evident that the average or median technological proportions provide support for a gradual transition, or at least incremental change from phase to phase. However, this is the closest the evidence comes to supporting the current explanations in the literature. Rather, the evidence suggests a need to reframe the transition not as a disappearance of chipped stone but rather as the appearance and incorporation of ground stone into the existing technology. In no phase is chipped stone less prominent than ground stone. Instead, there is an increase in the variance of ground stone and faunal tool proportions through time.

The same increase in variance is observed from a strictly ^{14}C perspective as well. Not only does this approach provide a more detailed picture of change through space and time but the higher temporal resolution allows us to assess the appearance of each technological category in the region, none of which correlate to current phase divisions. Instead, we see a distinct division in the proportions of chipped and ground stone near 4500 cal BP. Prior to this date there is a clear predominance of chipped stone tools with minimal variance after which there is a gradual increase in the variance of assemblage composition through time. This is in conjunction with a clear spatial and temporal preservation bias in the distribution of faunal tool proportions. As a result, statements that imply a gradual and widespread replacement of an early chipped stone industry by a ground stone industry are inaccurate. After 4500 cal BP the Gulf of Georgia experiences a gradual incorporation of ground stone technology into an established chipped stone industry, with disc beads likely being the first major investment in ground stone technology. Chipped stone does not disappear and does experience stylistic changes that require similar types of analysis. However, the results presented above demonstrate that there is a very prominent diachronic increase in the synchronic variation of artifact assemblage composition. Clearly, the strictly ^{14}C analysis raises some questions about the utility of the phase concept as a means of grouping assemblages for analytical purposes. There is no evidence to suggest that the transition from chipped stone to ground stone, bone and antler, when examined using radiocarbon dates, fits into the established Gulf of Georgia chronology.

DISCUSSION

Even though there is considerable evidence to suggest the phase concept is influencing archaeological interpretation, I am not suggesting the phase concept be discarded or that it is irrelevant for archaeologists. Having a generally defined chronology is important during fieldwork and preliminary analyses for formulating hypotheses about the temporality of an assemblage. It is critical, however, that we openly evaluate its limitations. Particularly, we should avoid assuming the age of an assemblage based on its relative artifact composition. While assemblage composition is a good indicator of age, there remains a probability that age will not match composition. The range of assemblage types overlap dramatically from 5000 cal BP onward, meaning that similar assemblages can be considerably different in age and “not all lithic assemblages are early” (Monks 1977:241). As a result, we should always seek tests on independent evidence, such as carbon, when hypothesizing the age of an assemblage based on typology.

Carlson (1990b) divides the history of research on the Northwest Coast into pre- and post-radiocarbon dating. In the first half, the creation of chronologies relied exclusively on artifact typologies and seriation to place archaeological assemblages in sequence. When radiocarbon dating arrived it quickly became an invaluable tool for archaeologists and was incorporated into the existing paradigm. Radiocarbon dating provided a means to increase the understanding of the chronological sequence in calendar years rather than actually creating a new chronology. And, although some modifications were made to the existing cultural sequence and temporal boundaries were corrected, radiocarbon dating more or less became absorbed into the pre-existing culture history paradigm and the associated Gulf of Georgia chronology. Radiocarbon age estimates have, on occasion, been discounted because they do not fit the expectations of the phase attribution based on the artifact types and it has been acknowledged that the phases overlap considerably at their temporal boundaries (Kenny 1974, Mitchell 1971a, 1990). However, there has been resistance to disentangling ^{14}C dates from the culture history paradigm and using them to test the assumptions inherent in the chronology itself. It is time we add a new section to Carlson's history of research in Northwest Coast archaeology, one that moves beyond the phase-based approach to prehistory and critically tests assumptions about the relationship between the chronological groupings and prehistoric behaviour and social organization. The phase concept should not be used to test the legitimacy of radiocarbon dates but rather the ^{14}C dates should be used to test questions about the phase concept.

The results of this study have shown that in terms of basic technological categories, the phase approach to the past changes our perception of change through time. Although a very low resolution study in terms of assemblage composition, it served two purposes beyond assessing the concept of phases. First, it tested the current understanding of the transition from chipped stone to ground stone, bone, and antler and, second, it highlighted the utility of incorporating the under-published "gray" literature into archaeological analysis. At the outset, it was hoped to systematically incorporate a higher resolution of assemblage composition. However, it quickly became apparent that the typological inconsistencies from report to report made any type of comparative project futile without a hands-on reclassification of all 75 assemblages. As we now know, there are considerable changes to the perception of Gulf of Georgia prehistory when considered regionally and therefore we should be conducting all work with the regional scale analyses in mind (even though not everyone should be conducting regional scale analysis). It is crucial that we develop a framework for comparison that avoids the typological pitfalls but allows us to combine the currently disparate academic and cultural resource management archaeological endeavours. We need to develop an integrated framework that can help us study more detailed information along continuous axes of space and time.

One certainty about the archaeological record is that it changes through time. Regardless of whether we seek to describe a prehistoric lifeway, define the boundaries of prehistoric populations, or explain the incorporation of a new technology, it is necessary to understand the long-term trajectory of change. Without this understanding we cannot justifiably delineate the past into any type of culturally relevant or socially meaningful groupings. We should seek to understand how and why change happens. Just as the past is a record of change the future will be the same, producing its own archaeological record. It is to our species-wide interest to better understand how, why, and by what mechanisms our social organizations evolve. This requires the amalgamation of local, high resolution studies of spatial and temporal variability (see McMillan et al. 2008) with longer term studies of change. The two together provide a multi-scalar understanding of change over time and provide valuable information about cultural evolution.

CONCLUSION

This study began with two questions: what is the spatio-temporal pattern of the transition from chipped stone to ground stone, bone, and antler and does the phase concept influence our interpretation of this transition? The answer to the latter is yes. The result of our analyses show that there are limitations in the analytical power of the phase concept and it is best to conceive of time and space as continuous variables. As a result, we have shown that current conceptions of a uniform and gradual transition from assemblages dominated by chipped stone to ones dominated by ground stone are inaccurate. Rather, at 4500 cal BP ground stone disc beads appear in considerable quantities suggesting they are the first formidable investment in ground stone technology. Following this appearance the types of assemblages present on the coast increase in variability, with the maximum proportion of ground stone in any assemblage increasing gradually. However, chipped stone continues throughout the entire time span, often in considerable proportions, and after 4500 cal BP no one assemblage type is ubiquitous. The appearance of faunal tools is slightly earlier at roughly 5000 cal BP, a phenomenon previously acknowledged by Moss and Erlandson (1995) and Carlson (1979, 1990a). However, the gradual increase in proportions through time corresponds with the increase in shell middens providing clear evidence for a severe preservation bias. Exactly how much of the increase through time is the product of preservation or actual changes in technology remains to be seen and is one of the most under studied avenues of research on the coast (but see Stein 1992, 2001).

The pattern presented should not be unexpected. There is known ethnographic data demonstrating a seasonally variable resource strategy that involves considerable diversity in the technology used to carry out the various activities (Barnett 1955, Suttles 1990). We should expect the archaeological record for the region to contain variability as well and not be fully represented by any one site or small group of sites (Abbott 1972). If we truly seek to understand the populations living in the Gulf of Georgia in the past we must consider the entire region and neighbouring regions and the long-term trajectory of cultural change. Our result suggests that at least following the 4500 cal BP mark we have a record of in situ cultural evolution that can provide valuable information about the emergence of social complexity. Although previously recognized as a defining characteristic of Northwest Coast archaeology (Matson and Coupland 1995), without removing the segmentation imposed on this continuous change by the phase concept, we will never take full advantage of this rich archaeological record and pursue its considerable contribution to our understanding of social processes.

REFERENCES CITED

Abbott, Donald N.

1972 The Utility of the Concept of Phase in the Archaeology of the Southern Northwest Coast. *Syesis* 5:267-278.

Ames, Kenneth M.

1981 The Evolution of Social Ranking on the Northwest Coast of North America. *American Antiquity* 46, 789-805.

Ames, Kenneth M. and Herbert G. Maschner

1999 *Peoples of the Norwest Coast: their archaeology and prehistory*. Thames and Hudson, New York.

Andrefsky, William

2001 *Lithic Debitage Analysis: Context, Form, Meaning.* University of Utah Press, Salt Lake City, Utah.

2005 *Lithics: Macroscopic Approaches to Analysis*. 2nd ed. Cambridge University Press, New York.

Arcas Consulting Archaeologists Ltd.

1991a *Archaeological Investigations at Tsawwassen, B.C.*, Vol. I. Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1989-041,Victoria, BC.

1991b *Archaeological Investigations at Tsawwassen, B.C.*, Vol. II. Manuscript on file, Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1989-041,Victoria, BC.

1993 *1993 Archaeological Investigations at the Locarno Beach Site (DhRt 6),* *Vancouver, B.C.* Manuscript on file, Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1993-104,Victoria, BC.

1994a *Archaeological Investigations at the Departure Bay Site (DhRx 16), Nanaimo B.C.* Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1993-103, Victoria, BC.

1994b *Archaeological Investigations at Tsawwassen, B.C.*, Vol. III. Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1989-041,Victoria, BC.

1996 *Archaeological Investigation at the Beach Grove Site (DgRs 1), Tsawwassen, B.C.* Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1995-016, Victoria, BC.

1999 *Archaeological Investigations at Tsawwassen, B.C.*, Vol. IV. Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, , Permit 1989-041,Victoria, BC.

Ball, Bruce F.

1979 *Archaeological Investigation of the Beach Grove Site: A Site Evaluation.* Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permits 1979-017 and 1979-017V1, Victoria, BC.

Barnett, Homer G.

1955 *The Coast Salish of British Columbia.* University of Oregon Monographs, Studies in Anthropology No. 4. University of Oregon, Eugene.

Bergman, Christopher A. and John F. Doershuk

2003 Cultural Resource Management and the Business of Archaeology. In *Ethical Issues in Archaeology*, edited by L. J. Zimmerman, K. D. Vitelli and J. Hollowell-

Zimmer, pp. 85-98. Altamira Press, Walnut Creek, CA.

Binford, Lewis

1973 Interassemblage Variability: The Mousterian and the "Functional Argument". In *The Explanation of Culture Change: Models in Prehistory*, edited by Colin Renfrew, pp. 227-254. Duckworth, London.

1979 Organization and Formation Processes: Looking at Curated Technologies. *Journal of Anthropological Research* 33:255-273.

Blake, Michael

2004 Fraser Valley Trade and Prestige as Seen from Scowlitz. In *Complex Hunter Gatherers: Evolution and Organization of Prehistoric Communities of the Plateau of Northwestern North America,* edited by W.C. Prentiss and I. Kuijt, pp. 103-112. University of Utah Press, Salt Lake City.

Boehm, Sheila G.

1973 *Cultural and non-cultural variation in the artifact and faunal samples from the St. Mungo Cannery site, DgRr 2.* Unpublished Master's Thesis, Department of Anthropology, University of British Columbia, Vancouver.

Borden, Charles E.

1950 Notes on the Pre-history of the Southern Northwest Coast. *British Columbia Historical Quarterly* 14(4):241-246.

1951a Facts and Problems of Northwest Coast Prehistory. In *Anthropology in British Columbia* 2:35-52

1951b Fraser Delta Archaeological Findings. *American Antiquity* 16(3):263.

1961 *Fraser River Archaeological Project*. Anthropology Papers No. 1, National

Museum of Canada, Department of Northern Affairs and National Resources, Ottawa, Canada.

1962 Part I: West Coast Crossties with Alaska. *Arctic Institute of North America, Technical Paper No. 11*:9-181.

1965 Radiocarbon and Geological Dating of the Lower Fraser Canyon Archaeological Sequence. *Proceedings of the Sixth International Conference in Radiocarbon and Tritium Dating*, Pullman, Washington, June 7-11. Manuscript on file, Department of Anthropology, University of British Columbia, Vancouver.

1968a New Evidence of Early Cultural Relations Between Eurasia and Western North America. *VIII International Congress of Anthropological and Ethnological Sciences*, Tokyo, Japan. Manuscript on file, Department of Anthropology, University of British Columbia, Vancouver.

1968b Prehistory of the lower mainland. In *Lower Fraser Valley: Evolution of a Cultural Landscape,* edited by A.H. Siemens, pp. 9-26. B.C. Geographical Series 9, University of British Columbia, Vancouver.

1970 Cultural History of the Fraser Delta Region: An Outline. In A*rchaeology in British Columbia, New Discoveries,* edited by Roy Carlson, pp.95-112. B.C. Studies No. 6.

1975 *Origins and Development of Early Northwest Coast Culture to about 3,000 B.C.* Archaeological Survey of Canada Paper No. 45, National Museum of Man Mercury Series, Ottawa.

1979 Peopling and Early Culture of the Pacific Northwest. *Science* 203:963-971.

Burley, David

1979 Specialization and the Evolution of Complex Society in the Gulf of Georgia Region. *Canadian Journal of Archaeology* 3:131-143.

1980 *Marpole: Anthropological Reconstructions of a Prehistoric Northwest Coast Culture Type.* Department of Archaeology Publication No. 8. Simon Fraser University, Burnaby, BC, Canada.

1983 Cultural Complexity and evolution in the development of coastal adaptations among the Micmac and Coast Salish. In *The evolution of maritime cultures on the Northeast and Northwest Coasts of America,* edited by R. Nash, pp. 157-172. Department of Archaeology Publication No. 11, Simon Fraser University, Burnaby, BC, Canada.

1989 *Senewe'lets: Culture History of the Nanaimo Coast Salish and the False Narrows Midden.* Royal British Columbia Memoir No. 2., Royal British Columbia Museum, Victoria, BC. Canada.

Canadian Archaeological Radiocarbon Database (CARD)

2009 Online Database of Canadian ^{14}C dates and their associated archaeological context, compiled by Richard Morlan and Matthew Betts, Canadian Museum of Civilization, Ottawa, http://card.canadianarchaeology.ca/localc14/c14search.htm, March 9, 2009.

Carlson, Roy L.

1954 *Archaeological Investigations in the San Juan Islands.* Unpublished Master's Thesis, University of Washington, Seattle.

1960 Chronology and Culture Change in the San Juan Islands, Washington. *American Antiquity* 25:562-586.

1970 Excavations at Helen Point on Mayne Island. In *Archaeology in British*

Columbia, new discoveries, edited by R.L. Carlson, pp. 41-58. BC Studies No. 6.

1979 The early period on the central coast of British Columbia. *Canadian Journal of Archaeology* 3:211-228.

1990a Cultural Antecedents. In *Northwest Coast*, edited by Wayne Suttles, pp. 60-69. Handbook of North American Indians, Vol. 7, William C. Sturtevant, general editor, Smithsonian Institution, Washington, D.C.

1990b History of Research in Archaeology. In *Northwest Coast*, edited by Wayne Suttles, pp. 107-115. Handbook of North American Indians, Vol. 7, William C. Sturtevant, general editor, Smithsonian Institution, Washington, D.C.

Carlson, Roy L. and Luke R.D. Bona
1995 *Early Human Occupation in British Columbia.* UBC Press, Vancouver.

Carlson, Roy L. and Philip M. Hobler
1993 The Pender Canal Excavations and the Development of Coast Salish Culture. In *Changing Times: British Columbia Archaeology in the 1980s,* edited by Knut Fladmark, pp. 25-52. BC Studies 99.

Charlton, Arthur S.
1980 *The Belcarra Park Site*. Department of Archaeology Publication No. 9, Simon Fraser University, Burnaby, BC, Canada.

Coupland, Gary C.
1991 The Point Grey Site: A Marpole Spring Village component. *Canadian Journal of Archaeology* 15:59-73.

Deans, James
1891 Burial Mounds of Vancouver Island and Their Relics. *American Antiquarian*

and Oriental Journal 13(3):171-172.

1892 The Antiquities of British Columbia. *American Antiquarian and Oriental Journal* 14(1):41-44.

Eldridge, Morley

1984 *1984 Archaeological Investigations at St. Mungo Cannery, DgRr 2.* Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1984-41, Victoria, BC.

1991 *The Glenrose Cannery Wet Component: a Significance Assessment.* Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1980-024, Victoria, BC.

Golder Associates Ltd.

1998 *Archaeological Mitigation of DlSh-6 Oyster River Crossing, Oyster River, B.C. Vancouver Island Highway Project H.C.A Permit No. 1997-227.* Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture, and the Arts, Permit 1997-227, Victoria, BC.

2007 *Report on Archaeological Mitigation of DkSb-30 Saltery Bay, B.C. Telus North Island Ring Project.* Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 2004-120, Victoria, BC.

2008 *Archaeological Mitigation and Monitoring at 822 and 832 Tsawwassen Beach Road, Delta, B.C.* Manuscript on file, Golder Associates Ltd., Permit 2004-372, Burnaby, BC, Canada.

Graesch, Anthony P.

2007 Modeling ground slate knife production and implications for the study of household labor contributions to salmon fishing on the Pacific Northwest Coast.

Journal of Anthropological Archaeology 26(4):576-606.

Grier, Colin

1998 *Household Archaeology at Dionisio Point. (DgRv 3)*. Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1997-146, Victoria, BC.

1999 *Household Archaeology at Dionisio Point: Report on the 1998 Excavations at the Dionisio Point Site (DgRv 3), Galiano Island, BC conducted under Heritage Investigation Permit 1998-187.* Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1998-187, Victoria, BC.

Ham, Leonard C.

1982 *Seasonality, shell midden layers, and Coast Salish subsistence strategies at the Crescent Beach Site, DgRr 1.* Unpublished Ph.D. Dissertation, Department of Anthropology, University of British Columbia, Vancouver.

Ham, Leonard C., Arlene J. Yip, and Leila Kullar

1984 *A Charles Culture Salmon Fishing Village: A Mitigation Report on the 1982/83 Excavations at the St. Mungo Site (DgRr-2).* Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1982-21, Vol. 1-6 and Appendices 1 and 2. Victoria, BC.

Hammon, Dimity

1986 The Whalen Farm Site: 1985 Excavations at DgRs 14. *The Midden* 18(3):3-6.

Hanson, Gordon W.

1973 *The Katz Site: A prehistoric pithouse settlement in the lower Fraser valley, British Columbia.* Unpublished Master's thesis, Department of Anthropology, University of British Columbia, Vancouver. Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1971-045. Victoria, BC.

Hill-Tout, Charles

1895 Late Prehistoric Man in British Columbia. *Transactions of the Royal Society of Canada, 2nd ser.,* Vol. 1(2):103-122.

1932 British Columbian Ancestors of the Eskimo? *Illustrated London News* January:90-92.

Hobler, Philip M.

1990 Prehistory of the Central Coast of British Columbia. In *Northwest* Coast, edited by Wayne Suttles, pp. 298-305. Handbook of North American Indians, Vol. 7, William C. Sturtevant, general editor, Smithsonian Institution, Washington, D.C.

Kenny, Raymond

1974 *Archaeological investigations at the Willows Beach site, Southeastern Vancouver Island.* Unpublished Master's thesis, Department of Archaeology, University of Calgary, Calgary, Alberta, Canada.

King, Arden

1950 Cattle Point: A Stratified Site in the Northwest Coast Region. *American Antiquity* Memoir 7, Supplement to Vol. 15:1-94.

LeClair, R.

1976 Investigation at the Maurer site near Agassiz. In *Current Research Reports,* edited by R.L. Carlson, pp. 33-42. Department of Archaeology Publication No. 3, Simon Fraser University, Burnaby, BC, Canada.

Lepofsky, Dana, Douglas Brown, Sandra Morrison, and Natasha Lyons

1999 *Report on the 1998 Excavations at the Scowlitz Site (DhRl 16) Fraser Valley, B.C.* Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1998-103, Victoria, BC.

Lepofsky, Dana, Michael Blake, Douglas Brown, Sandra Morrison, Nicole Oakes and Natasha Lyons

2000a The Archaeology of the Scowlitz Site, SW British Columbia. *Journal of Field Archaeology* 27(4):391-416.

Lepofsky, Dana, Douglas Brown, Nicole Oakes, Sandra Morrison, Michael Blake and Tracy Rogers

2000b *Report on the 1999 Excavations at the Scowlitz Site (DhRl 16) Fraser Valley, B.C.* Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture, and the Arts, Permit 1999-112, Victoria, BC.

Linse, A.R.

1992 Is Bone Safe in a Shell Midden? In *Deciphering a Shell Midden*, edited by Julie K. Stein, pp. 327-345. Academic Press, San Diego.

Mason, Andrew

1994 *The Hatzic Rock site: A Charles culture settlement.* Unpublished Master's Thesis, Department of Anthropology, University of British Columbia, Vancouver.

Matson, R.G.

1974 Clustering and scaling of Gulf of Georgia sites. *Syesis* 7:101-114.

Matson, R.G. (editor)

1976 *The Glenrose Cannery Site.* Archaeological Survey of Canada Paper No. 52, National Museum of Man Mercury Series, National Museums of Canada, Ottawa.

Matson, R.G. and Gary Coupland

1995 *The Prehistory of the Northwest Coast.* Academic Press, San Diego.

Matson, R.G., Deanna Ludowicz, and William Boyd

1980 *Excavations at Beach Grove in 1980*. Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1980-014, Victoria, BC.

Matson, R. G., Heather Pratt and L. Rankin

1991 *1989 and 1990 Crescent Beach excavations, final report: the place of the Locarno Beach Phase.* Manuscript on file, Laboratory of Archaeology, University of British Columbia, Vancouver, and BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1990-067, Victoria, BC.

McMillan, Alan .D., Iain McKechnie, Denis E. St. Claire, and S.Gay Frederick

2008 Exploring Variability in Maritime Resource Use on the Northwest Coast: A Case Study from Barkley Sound, Western Vancouver Island. *Canadian Journal of Archaeology* 32:214-238.

McMillan, Alan D. and Denis E. St. Claire

1982 *Alberni Prehistory: Archaeological and Ethnographic Investigations on Western Vancouver Island.* Theytus Books, Penticton, BC, Canada.

Mitchell, Donald H.

1971a Archaeology of the Gulf of Georgia, a natural region and its cultural types. *Syesis 4* (Supplement No. 1).

1971b The Dionisio Point Site and Gulf Island Culture History. *Syesis* 4:145-168.

1974 *Salvage Archaeology 1974: DjSf-13, DjSf-14 Site Report.* Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1974-18 vol 3, Victoria, BC.

1990 Prehistory of the Coasts of Southern British Columbia and Northern Washington. In *Northwest Coast*, edited by Wayne Suttles, pp. 340-358. Handbook of North American Indians, Vol. 7, William C. Sturtevant, general editor, Smithsonian Institution, Washington, D.C.

Monks, Gregory

1977 *An Examination of relationships between artifact classes and food resources at Deep Bay, DiSe 7.* Unpublished Ph.D. Dissertation, Department of Anthropology, University of British Columbia, Vancouver.

Moss, Madonna L. and Jon M. Erlandson

1995 Reflections on North American Pacific Coast Prehistory. *Journal of World Prehistory* 9:1-45.

Murray, Rebecca

1982 *Analysis of Artifacts from Four Duke Point Area Sites, near Nanaimo, B.C.: An Example of Cultural Continuity in the Southern Gulf of Georgia Region.* Archaeological Survey of Canada Paper No. 113, National Museums of Canada. Mercury Series, National Museum of Man, Ottawa.

Natural Resources Canada

2009 *North American Atlas – Boundaries*. Electronic spatial data, ftp://ftp. geogratis.gc.ca/frameworkdata/North_America_Atlas10M/boundaries/, accessed February 23, 2009.

2009 *North American Atlas – Hydrography*. Electronic spatial data, ftp://ftp. geogratis.gc.ca/frameworkdata/North_America_Atlas10M/hydrography/, accessed February 23, 2009.

Ormerod, Patricia

2002 *Reading the Earth: Multivariate analysis of feature functions at X̲a:ytem (The Hatzic Rock Site, DgRn 23), British Columbia.* Unpublished Master's Thesis, Department of Anthropology, University of British Columbia, Vancouver, Canada.

Ormerod, Patricia and R.G. Matson

2000 *Excavations at DgRn 23 in 1997 and 1999.* Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1997-088, Victoria, BC.

Patenaude, Valerie C.

1985 *The Pitt River Archaeological Site DhRq 21: A Coast Salish Seasonal camp on the Lower Fraser River, Vol. I-II.* Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1980-06, Victoria, BC.

Percy, Richard C.W.

1974 *The Prehistoric Cultural Sequence at Crescent Beach, British Columbia*. Unpublished Masters' Thesis, Department of Archaeology, Simon Fraser University, Burnaby, BC. Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1972-005v1. Victoria, BC.

Pratt, Heather

1992 *The Charles culture of the gulf of Georgia: A reevaluation of the Charley culture and its three sub-phases*. Unpublished Master's Thesis, Department of Anthropology, University of British Columbia, Vancouver.

Remote Access to Archaeological Data (RAAD)

2009 Electronic database of archaeological permits in British Columbia, http://www.tca.gov.bc.ca/archaeology/accessing_archaeological_data/obtaining_access.htm. BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Victoria, BC.

Schaepe, David M.

1998 *Recycling Archaeology: Analysis of Material from the 1973 Excavation of an Ancient House at the Maurer Site.* Unpublished Master's Thesis, Department of Archaeology, Simon Fraser University, Burnaby, BC. Canada.

Smith, Derek G.

1963 *Preliminary Report on Archaeological Investigations at Site DgRs-001 near Beach Grove, British Columbia 1962*. Manuscript on file, Laboratory of Archaeology, Department of Anthropology, University of British Columbia, Vancouver.

1964 *Archaeological Excavations at the Beach Grove Site, DgRs1 During the Summer of 1962.* Manuscript on file, Laboratory of Archaeology, Department of Anthropology, University of British Columbia, Vancouver.

Smith, Harlan I.

1899 Archaeological investigations on the north Pacific coast of America. *Science* N.S., Vol. IX, No.224, pp. 535-539. Available electronically through Early Canadiana Online, http://canadiana.org/ECO/ItemRecord/16160, November 24, 2008.

1903 Shell-Heaps of the Lower Fraser River, British Columbia. In *Memoir of the American Museum of Natural History* 2(4), edited by Franz Boas, pp. 133-192. Knickerbrocker Press, New York.

Spaulding, Albert C.

1955 Prehistoric Cultural Development in the Eastern United States. In *New Interpretations of Aboriginal American Culture History,* pp. 12-27. Anthropological Society of Washington, Washington, D.C.

Stein, Julie K. (editor)

1992 *Deciphering a shell midden*. Academic Press, San Diego.

Stein, Julie K.

2000 *Exploring Coast Salish Prehistory: The Archaeology of San Juan Islands.* University of Washington Press, Seattle.

2001 Archaeological Sediments in Cultural Environments. In *Sediments in Archaeological Context*, edited by Julie K. Stein and William R. Farrand, pp. 1-28. University of Utah Press, Salt Lake City. Pp. 1-28.

Suttles, Wayne

1990 Central Coast Salish. In *Northwest Coast*, edited by Wayne Suttles, pp. 453-475. Handbook of North American Indians, Vol. 7, William C. Sturtevant, general editor, Smithsonian Institution, Washington, D.C.

Thom, Brian

1992 *Archaeological Investigations at the Whalen Farm Site (DfRs 3), 1949-50: Re-contextualizing Borden's Whalen Farm*. Unpublished Bachelor's of Arts Honours Thesis, Department of Anthropology, University of British Columbia, Vancouver.

1995 *The Dead and the Living: Burial Mounds and Cairns and the Development of Social Classes in the Gulf of Georgia Region*. Unpublished Master's Thesis, Department of Anthropology, University of British Columbia, Vancouver.

1997 *The Whalen Farm Site*. Electronic document, http://home.istar.ca/~bthom/whalen-new.htm, December 10, 2008.

Trace, Andrew A.

1981 *An examination of the Locarno Beach Phase as represented at the Crescent Beach site, DgRr 1, British Columbia.* Unpublished Master's Thesis, Department of Archaeology, Simon Fraser University, Burnaby, BC, Canada. Canada Theses on Microfiche, Ottawa.

Trigger, Bruce

2006 *A History of Archaeological Though, 2nd ed.* Cambridge University Press, Cambridge.

von Krogh, Henning

1980 *Archaeological Investigation at the Flood and Pipeline Sites, near Hope, British Columbia.* Occasional Papers of the Heritage Conservation Branch of British Columbia No. 4. Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1974-23vol3, Victoria, BC.

Weninger, B., Jöris, O., Danzeglocke, U.

2009 *CalPal-2007*. Cologne Radiocarbon Calibration & Palaeoclimate Research Package. http://www.calpal.de/, accessed 2009-05-12.

Whitlam, Robert

1974 *1974 Salvage Excavation at the Buckley Bay Site (DjSf 13) and the Tsable River Bridge Site (DjSf 14): A Preliminary Report.* Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 1974-18 vol 4, Victoria, BC.

Willey, Gordon R. and Philip Phillips

1958 *Method and Theory in American Archaeology*. University of Chicago Press, Chicago.

Wilmeth, Roscoe

1978 *Canadian Archaeological Radiocarbon Dates (Revised Version).* Archaeological Survey of Canada Paper No. 77, National Museum of Man Mercury Series, Ottawa, Canada.

Wilson, Ian R., Andrew Hickok, and Margaret Rogers

2003 *Emergency Archaeological Salvage DiSe 7 Deep Bay, Vancouver Island.* Manuscript on file, BC Archaeology Branch, Ministry of Tourism, Culture and the Arts, Permit 2003-071, Victoria, BC.

APPENDIX A

This Appendix presents the final proportions calculated from the artifact lists for all assemblages in the dataset. The proportions are included for when all artifacts are considered, all except for debitage and micro-lithics, and all except debitage, micro-lithics, and beads. For more information as to why these three proportions were computed see the Methodological Considerations section in the text.

					Proportions with all Objects Included			Proportions Excluding Debitage and Micro-lithics			Proportions Excluding Debitage, Micro-lithics and Beads		
Site Name	Borden #	Assemblage	Phase	References	Chipped Stone	Ground Stone	Faunal Tools	Chipped Stone	Ground Stone	Faunal Tools	Chipped Stone	Ground Stone	Faunal Tools
Beach Grove	DgRs-5	Ball 1979	Locarno Beach	Ball 1979	0.89	0.00	0.11	0.89	0.00	0.11	0.90	0.00	0.09
Beach Grove	DgRs-1	Block I- Locarno	Locarno Beach	Arcas 1996	0.98	0.01	0.01	0.97	0.02	0.02	0.97	0.02	0.02
Beach Grove	DgRs-2	Block I- St. Mungo	Charles	Arcas 1996	0.99	0.01	0.00	0.98	0.01	0.01	0.98	0.01	0.01
Beach Grove	DgRs-3	Block II- Marpole	Marpole	Arcas 1996	0.98	0.01	0.01	0.93	0.04	0.02	0.93	0.04	0.02
Beach Grove	DgRs-4	Block IV - St. Mungo	Charles	Arcas 1996	0.92	0.01	0.07	0.88	0.01	0.11	0.88	0.01	0.11
Beach Grove	DgRs-6	Matson et al. 1980	Marpole	Matson et al. 1980	0.43	0.30	0.27	0.15	0.45	0.40	0.17	0.52	0.31
Beach Grove	DgRs-7	Smith 1963	Marpole	Smith 1963, 1964	0.06	0.16	0.78	0.06	0.16	0.78	0.15	0.35	0.50
Belcarra Park	DgRs-8	Component I	Locarno Beach	Charlton 1980	0.56	0.35	0.09	0.56	0.35	0.09	0.56	0.35	0.09
Belcarra Park	DgRs-9	Component II	Gulf of Georgia	Charlton 1980	0.20	0.21	0.59	0.20	0.21	0.59	0.20	0.21	0.59
British Camp	45SJ24	Ethnozone I	Marpole	Stein 1992	0.74	0.14	0.12	0.74	0.14	0.12	0.78	0.13	0.10
British Camp	45SJ25	Ethnozone II	Gulf of Georgia	Stein 1992	0.20	0.13	0.67	0.20	0.13	0.67	0.23	0.16	0.61
Buckley Bay	DjSf-13	Mitchell 1974	Marpole	Mitchell 1974, Mason and Hoffman 1998	0.29	0.38	0.33	0.29	0.38	0.33	0.29	0.38	0.33
Buckley Bay	DjSf-13	Whitlam 1974	Marpole	Whitlam 1974, Mason and Hoffman 1998	0.18	0.35	0.47	0.18	0.35	0.47	0.27	0.48	0.26
Crescent Beach	DgRr-1	Component I	Charles	Percy 1974	0.61	0.03	0.35	0.61	0.03	0.35	0.61	0.03	0.35
Crescent Beach	DgRr-1	Locarno Component - S Trench	Locarno Beach	Matson et al. 1991	0.16	0.75	0.09	0.14	0.76	0.09	0.63	0.25	0.11
Crescent Beach	DgRr-1	Locarno Component	Locarno Beach	Trace 1981	0.70	0.20	0.10	0.70	0.20	0.10	0.84	0.05	0.11
Crescent Beach	DgRr-1	St. Mungo Component - S Trench	Charles	Matson et al. 1991	0.16	0.51	0.34	0.16	0.51	0.34	0.70	0.18	0.11
Deep Bay	DiSe-7	Component I	Locarno Beach	Monks 1977	0.95	0.04	0.01	0.95	0.04	0.01	0.96	0.03	0.01

Deep Bay	DiSe-7	Component II	Marpole	Monks 1977	0.19	0.16	0.65	0.19	0.16	0.65	0.28	0.21	0.51
Deep Bay	DiSe-7	Component III	Gulf of Georgia	Monks 1977	0.10	0.27	0.63	0.10	0.27	0.63	0.10	0.26	0.63
Departure Bay	DhRx-16	Layer C	Locarno Beach	Arcas 1994a	0.59	0.12	0.29	0.56	0.13	0.31	0.56	0.13	0.31
Departure Bay	DhRx-16	Layer D	Marpole	Arcas 1994a	0.43	0.33	0.24	0.43	0.33	0.24	0.43	0.33	0.24
DgRx-11	DgRx-11	Component I/II	Marpole/Gulf of Georgia	Murray 1982	0.68	0.20	0.12	0.68	0.20	0.12	0.68	0.20	0.12
DgRx-36	DgRx-36	Component III	Gulf of Georgia	Murray 1982	0.51	0.28	0.21	0.51	0.28	0.21	0.63	0.13	0.25
DgRx-5	DgRx-5	Component I	Locarno Beach	Murray 1982	0.82	0.09	0.09	0.82	0.09	0.09	0.91	0.03	0.06
DgRx-5	DgRx-5	Component II	Marpole	Murray 1982	0.39	0.40	0.21	0.39	0.40	0.21	0.86	0.05	0.09
DgRx-5	DgRx-5	Component III	Gulf of Georgia	Murray 1982	0.34	0.45	0.20	0.34	0.45	0.20	0.47	0.26	0.26
Dionisio Point	DgRv-3	Component IIa/IIb	Gulf of Georgia	Mitchell 1971b	0.08	0.18	0.74	0.08	0.18	0.74	0.08	0.18	0.74
DkSb-30	DkSb-30	Component I	Protowestern	Golder 2007	0.86	0.02	0.13	0.86	0.02	0.13	0.86	0.02	0.13
DkSb-30	DkSb-30	Component II	Charles	Golder 2007	0.82	0.07	0.11	0.81	0.07	0.11	0.84	0.06	0.10
False Narrows	DgRw-4	False Narrows II	Marpole	Burley 1989	0.13	0.23	0.64	0.16	0.27	0.57	0.17	0.28	0.55
Flood	DiRi-38	Component 1	Marpole	von Krogh 1980	0.44	0.56	0.00	0.44	0.56	0.00	0.44	0.56	0.00
Flood	DiRi-38	Component 2	Gulf of Georgia	von Krogh 1980	0.33	0.67	0.00	0.33	0.67	0.00	0.34	0.66	0.00
Georgeson Bay	DfRu-24	Georgeson Bay I	Locarno Beach	Haggarty and Sendey 1976	0.48	0.43	0.09	0.47	0.44	0.09	0.49	0.42	0.09
Georgeson Bay	DfRu-24	Georgeson Bay II	Gulf of Georgia	Haggarty and Sendey 1976	0.12	0.34	0.53	0.12	0.34	0.54	0.12	0.34	0.54
Glenrose	DfRu-24	Eldridge 1991	Charles	Eldridge 1991	0.85	0.06	0.09	0.85	0.06	0.09	0.85	0.06	0.09
Glenrose	DgRr-6	Marpole Component	Marpole	Matson 1976	0.19	0.72	0.09	0.19	0.72	0.09	0.47	0.30	0.22
Glenrose	DgRr-6	Old Cordilleran Component	Protowestern	Matson 1976	0.94	0.01	0.04	0.94	0.01	0.04	0.94	0.01	0.04
Glenrose	DgRr-6	St. Mungo Component	Charles	Matson 1976	0.49	0.04	0.47	0.49	0.04	0.47	0.58	0.05	0.38
Hatzic Rock	DgRn-23	Layer C	Charles	Ormerod and Matson 2000	0.99	0.01	0.00	0.99	0.01	0.00	0.99	0.01	0.00
Hatzic Rock	DgRn-23	Mason 1994	Charles	Mason 1994	0.94	0.06	0.00	0.94	0.06	0.00	0.95	0.05	0.00
Katz	DiRj-1	Zone A	Locarno Beach	Hanson 1973	0.65	0.35	0.00	0.69	0.31	0.00	0.69	0.31	0.00
Katz	DiRj-1	Zone B	Locarno Beach	Hanson 1973	0.60	0.40	0.00	0.74	0.26	0.00	0.74	0.26	0.00
Locarno Beach	DhRt-6	Layer 11	Locarno Beach	Arcas 1993	0.98	0.01	0.01	0.96	0.02	0.02	0.96	0.02	0.02
Locarno Beach	DhRt-6	Layer 7+	Locarno Beach	Arcas 1993	0.83	0.05	0.13	0.65	0.10	0.25	0.65	0.10	0.25
Locarno Beach	DhRt-6	Layer 8	Marpole	Arcas 1993	0.96	0.02	0.02	0.93	0.03	0.03	0.97	0.03	0.00
Locarno Beach	DhRt-6	Layer 9	Marpole	Arcas 1993	0.90	0.03	0.06	0.79	0.07	0.14	0.79	0.07	0.14
Marpole	DhRs-1	Layers 2,3,4,5	Marpole	Arcas 1989	0.31	0.68	0.01	0.03	0.96	0.01	0.46	0.31	0.23
Maurer	DgRk-8	Maurer House	Charles	Schaepe 1998, LeClair 1976	0.98	0.02	0.00	0.98	0.02	0.00	0.98	0.02	0.00
Montague Harbour	DfRu-13	Component I	Locarno Beach	Mitchell 1971a	0.27	0.33	0.40	0.27	0.33	0.40	0.27	0.33	0.40
Montague Harbour	DfRu-13	Component III	Gulf of Georgia	Mitchell 1971a	0.04	0.24	0.72	0.04	0.24	0.72	0.04	0.24	0.72
Oyster River	DlSh-6	Marpole Component	Marpole	Golder 1998	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00

Pitt River	DhRq-21	Kroeker	Gulf of Georgia	Patenaude 1985	0.56	0.44	0.00	0.56	0.44	0.00	0.77	0.23	0.00
Pitt River	DhRq-21	Logodi - Charles Component	Charles	Patenaude 1985	0.59	0.39	0.02	0.58	0.39	0.02	0.84	0.13	0.03
Pitt River	DhRq-21	Logodi - Locarno Component	Locarno Beach	Patenaude 1985	0.51	0.47	0.01	0.50	0.48	0.01	0.79	0.18	0.02
Pitt River	DhRq-21	Mackenzie - Charles Component	Charles	Patenaude 1985	0.53	0.43	0.04	0.53	0.44	0.04	0.62	0.33	0.04
Pitt River	DhRq-21	Mackenzie - Locarno Component	Locarno Beach	Patenaude 1985	0.65	0.30	0.05	0.65	0.30	0.05	0.75	0.20	0.06
Point Grey	DhRt-5	Marpole Component	Marpole	Coupland 1991	0.39	0.28	0.33	0.39	0.28	0.33	0.41	0.28	0.31
Scowlitz	DhRl-15 & 16	BOD/Layer 44	Gulf of Georgia	Lepofsky et al. 1999, 2000a, 2000b	0.92	0.08	0.00	0.91	0.09	0.00	0.92	0.08	0.00
Scowlitz	DhRl-15 & 16	Structure 3	Marpole	Lepofsky et al. 1999, 2000a, 2000b	0.94	0.06	0.00	0.92	0.08	0.00	0.93	0.07	0.00
Shoemaker Bay	DhSe-2	Component I (Zone B,C,D)	Marpole	McMillan and St. Claire 1982	0.38	0.47	0.15	0.14	0.65	0.21	0.14	0.65	0.21
Shoemaker Bay	DhSe-2	Component II (Zone A)	Gulf of Georgia	McMillan and St. Claire 1982	0.02	0.36	0.62	0.02	0.36	0.62	0.02	0.36	0.62
St. Mungo	DgRr-2	Component I	Charles	Boehm 1973	0.30	0.03	0.67	0.31	0.03	0.66	0.31	0.03	0.66
St. Mungo	DgRr-2	Component II	Marpole	Boehm 1973	0.25	0.61	0.14	0.25	0.62	0.13	0.55	0.16	0.29
St. Mungo	DgRr-2	ETD-Layer A	Gulf of Georgia	Eldridge 1984	0.30	0.26	0.43	0.30	0.26	0.43	0.34	0.17	0.49
St. Mungo	DgRr-2	ETD-Layers C,D,E	Marpole	Eldridge 1984	0.74	0.18	0.08	0.74	0.18	0.08	0.85	0.06	0.09
Tsawwassen	DgRs-2	Zone C (Layer CA, CB), Zone D (Layer DB, DD), Zone G (Layer GC, Ah)	Marpole/Gulf of Georgia	Arcas 1994b	0.56	0.12	0.31	0.42	0.17	0.41	0.60	0.14	0.26
Tsawwassen	DgRs-2	Zone C (Layers CC, CE, CD)	Marpole	Arcas 1994b	0.92	0.03	0.05	0.84	0.06	0.10	0.85	0.06	0.09
Tsawwassen	DgRs-2	Zone G (Layer DF, DG)	Charles	Arcas 1994b	0.64	0.03	0.33	0.61	0.03	0.36	0.85	0.04	0.12
Tsawwassen Beach	DgRs-9	Component I/II	Gulf of Georgia	Golder 2008	0.06	0.28	0.66	0.06	0.28	0.66	0.06	0.28	0.66
Whalen Farm	DfRs-3	Component I	Locarno Beach	Thom 1992, Thom 1997	0.07	0.34	0.59	0.06	0.34	0.59	0.06	0.34	0.60
Whalen Farm	DfRs-3	Component II	Marpole	Thom 1992, Thom 1997	0.15	0.40	0.44	0.15	0.40	0.44	0.16	0.41	0.43
Whalen Farm	DfRs-3	Hammon 1986	Marpole	Hammon 1986, Thom 1997	0.31	0.26	0.42	0.31	0.26	0.42	0.33	0.28	0.40
Willows Beach	DcRt-10	Zone A	Gulf of Georgia	Kenny 1974	0.43	0.19	0.38	0.39	0.20	0.41	0.39	0.20	0.41
Willows Beach	DcRt-10	Zone B	Locarno Beach/Marpole	Kenny 1974	0.96	0.03	0.01	0.94	0.05	0.02	0.94	0.05	0.02

APPENDIX B

Appendix B presents the radiocarbon dates used for the analysis in this study, including the ^{14}C age estimates and the calibrated dates. For more information on why or why not certain dates were included see the Methodological Considerations section in the body of the text.

Site Name	Assemblage	References	Method	Sample #	^{14}C Years BP	Error (1 St. Dev)	cal BP	Error (1 St. Dev)
Beach Grove	Ball 1979	Ball 1979	^{14}C	WAT 561	2810	70	2940	90
Beach Grove	Ball 1979	Ball 1979	^{14}C	SFU 1	3200	70	3440	70
Beach Grove	Block I – Locarno	Arcas 1996	^{14}C (Shell - corrected)	B-89695	3230	60	3470	70
Beach Grove	Block I - St. Mungo	Arcas 1996	^{14}C	B-83111	3470	60	3750	80
Beach Grove	Block I - St. Mungo	Arcas 1996	^{14}C (Shell - corrected)	B-89696	3440	80	3710	110
Beach Grove	Block II - Marpole	Arcas 1996	^{14}C	B-83112	1010	50	920	70
Beach Grove	Block II - Marpole	Arcas 1996	^{14}C	B-83113	970	70	880	70
Beach Grove	Block IV - St. Mungo	Arcas 1996	^{14}C	B-83115	3890	60	4320	90
Beach Grove	Block IV - St. Mungo	Arcas 1996	^{14}C	B-83116	3900	50	4330	70
Beach Grove	Block IV - St. Mungo	Arcas 1996	^{14}C	B-83117	3900	60	4330	80
Beach Grove	Block IV - St. Mungo	Arcas 1996	^{14}C	B-83118	3800	60	4210	100
Beach Grove	Matson et al. 1980	Matson et al. 1980	^{14}C	SFU 41	1270	160	1180	150
Beach Grove	Matson et al. 1980	Smith 1963, 1964	^{14}C	SFU 42	1480	80	1410	80
Beach Grove	Smith 1963	Smith 1963, 1964	^{14}C	UW-42	1390	25	1320	20
Beach Grove	Smith 1963	Smith 1963, 1964	^{14}C	UW-43	1540	130	1480	130
Beach Grove	Smith 1963	Smith 1963, 1964	^{14}C	UW-44	1603	120	1540	130
Belcarra Park	Belcarra Park I	Charlton 1980	^{14}C	GaK 3903	1710	90	1640	110
Belcarra Park	Belcarra Park II	Charlton 1980	^{14}C	GaK 3905	1620	90	1540	110
Belcarra Park	Belcarra Park II	Charlton 1980	^{14}C	GaK 3904	1070	90	1010	100
British Camp	Ethnozone I	Stein 1992	^{14}C	WSU-3519	1585	70	1490	70
British Camp	Ethnozone I	Stein 1992	^{14}C	QL-4156	830	70	790	80
British Camp	Ethnozone I/II	Stein 1992	^{14}C	WSU-3151	1070	80	1010	90
British Camp	Ethnozone II	Stein 1992	^{14}C	WSU-3517	535	80	580	60

British Camp	Ethnozone II	Stein 1992	^{14}C	WSU-3518	670	70	640	60
British Camp	Ethnozone II	Stein 1992	^{14}C	WSU-3152	885	65	830	70
British Camp	Ethnozone II	Stein 1992	^{14}C	WSU-3514	160	60	170	110
British Camp	Ethnozone II	Stein 1992	^{14}C	WSU-3153	355	50	420	70
British Camp	Ethnozone II	Stein 1992	^{14}C	WSU-3515	370	70	420	80
British Camp	Ethnozone II	Stein 1992	^{14}C	WSU-3516	450	50	490	50
British Camp	Ethnozone II	Stein 1992	^{14}C	QL-4153	430	40	470	60
British Camp	Ethnozone II	Stein 1992	^{14}C	QL-4154	810	80	780	80
British Camp	Ethnozone II	Stein 1992	^{14}C	QL-4155	1000	40	910	60
British Camp	Ethnozone II	Stein 1992	^{14}C	QL-4157	900	40	840	60
Buckley Bay	Mitchell 1974	Mitchell 1974, Mason and Hoffman 1998	^{14}C (Shell - corrected)	GaK 7347	2640	90	2710	130
Buckley Bay	Mitchell 1974	Mitchell 1974, Mason and Hoffman 1998	^{14}C (Shell - corrected)	GaK 7348	2770	90	2910	100
Buckley Bay	Mitchell 1974	Mitchell 1974, Mason and Hoffman 1998	^{14}C	CAMS-54729	2240	50	2250	70
Buckley Bay	Whitlam 1974	Whitlam 1974, Mason and Hoffman 1998	^{14}C	TO 1108	1890	60	1840	70
Crescent Beach	Component I	Percy 1974	^{14}C	GaK 4925	4270	80	4820	130
Crescent Beach	Locarno Component	Trace 1981	^{14}C	WSU 1948	2570	90	2620	130
Crescent Beach	Locarno Component	Trace 1981	^{14}C	WSU 1702	2980	80	3160	120
Crescent Beach	Locarno Component	Trace 1981	^{14}C	WSU 1703	3030	80	3220	110
Crescent Beach	Locarno Component	Trace 1981	^{14}C	WSU 1701	3260	80	3500	90
Crescent Beach	Locarno Component - S Trench	Matson et al. 1991	^{14}C	WSU 4247	3210	110	3440	130
Crescent Beach	St. Mungo Component - S Trench	Matson et al. 1991	^{14}C	WSU 4245	3590	85	3900	130
Deep Bay	Component I	Monks 1977	^{14}C	GaK 6038	2630	100	2700	150
Deep Bay	Component II	Monks 1977	^{14}C	GaK 6037	1910	110	1870	130
Deep Bay	Component III	Monks 1977	^{14}C	GaK 6035	790	80	760	80
Departure Bay	Layer C	Arcas 1994a	^{14}C (Shell - corrected)	Beta-69026	1749	64	1680	80
Departure Bay	Layer C	Arcas 1994a	^{14}C (Shell - corrected)	Beta-69028	1959	67	1930	80
Departure Bay	Layer D	Arcas 1994a	^{14}C (Shell - corrected)	Beta-69025	1749	64	1680	80
Departure Bay	Layer D	Arcas 1994a	^{14}C (Shell - corrected)	Beta-69027	2049	67	2030	80
DgRx-11	Component I/II	Murray 1982	^{14}C	WSU-2237	2580	60	2650	100
DgRx-11	Component III	Murray 1982, CARD 2009	^{14}C (Shell - normalized)	WSU-2233	2530	120	2590	150

DgRx-11	Component III	Murray 1982, CARD 2009	^{14}C (Shell - normalized)	WSU-2230	1940	155	1910	190
DgRx-36	Component III	Murray 1982	^{14}C	WSU-2236	1520	130	1460	120
DgRx-5	Component I	Murray 1982	^{14}C	WSU-2234	4130	100	4660	130
DgRx-6	Component II	Murray 1982, CARD 2009	^{14}C (Shell - normalized)	WSU-2229	3490	100	3770	130
DgRx-7	Component II	Murray 1982, CARD 2009	^{14}C (Shell - normalized)	WSU-2235	2940	105	3110	150
DgRx-8	Component III	Murray 1982	^{14}C	WSU-2231	1060	60	1000	60
DgRx-9	Component III	Murray 1982	^{14}C	WSU-2232	680	150	680	120
Dionisio Point	Component IIa/IIb	Murray 1982, CARD 2009	^{14}C (Shell - normalized)	Gak-2762	2290	115	2340	170
Dionisio Point	Component IIa/IIb	Murray 1982, CARD 2009	^{14}C (Shell - normalized)	Gak-2763	2570	115	2620	150
Dionisio Point	Component IIa/IIb	Murray 1982, CARD 2009	^{14}C (Shell - normalized)	Gak-2950	1810	115	1750	130
DkSb-30	Component I	Golder 2007	^{14}C	Beta-200179	6700	40	7570	40
DkSb-31	Component I	Golder 2007	^{14}C	Beta-200180	5950	40	6790	60
DkSb-32	Component I	Golder 2007	^{14}C	Beta-203641	5070	40	5820	60
DkSb-33	Component II	Golder 2007	^{14}C	Beta-206715	3450	40	3730	70
DkSb-34	Component III	Golder 2007	^{14}C	Beta-203642	480	40	530	30
False Narrows	False Narrows II	Burley 1989	^{14}C	Gak 2754	1670	90	1590	110
Flood	Component 1	von Krogh 1980	^{14}C	Gak-5430	2310	150	2380	220
Flood	Component 2	von Krogh 1980	^{14}C	Gak-5429	1300	100	1210	100
Georgeson Bay	Georgeson Bay I	Haggarty and Sendey 1976	^{14}C	Gak-2753	2820	100	2970	130
Georgeson Bay	Georgeson Bay II	Haggarty and Sendey 1976	^{14}C	Gak-2752	750	90	710	80
Glenrose	Eldridge 1991	Eldridge 1991	^{14}C	Beta-38808	4590	50	5280	150
Glenrose	Eldridge 1991	Eldridge 1991	^{14}C	Beta-38810	4260	70	4800	110
Glenrose	Eldridge 1991	Eldridge 1991	^{14}C	Beta-38811	4370	60	4970	80
Glenrose	Eldridge 1991	Eldridge 1991	^{14}C	Beta-38807	4440	80	5090	150
Glenrose	Marpole Component	Matson 1976	^{14}C	Gak 4646	2310	105	2370	170
Glenrose	Marpole Component	Matson 1976	^{14}C	Gak 4647	2030	95	2010	120
Glenrose	Old Cordilleran Component	Matson 1976	^{14}C	Gak 4646	6430	340	7260	350
Glenrose	Old Cordilleran Component	Matson 1976	^{14}C	Gak 4650	5730	125	6540	130
Glenrose	Old Cordilleran Component	Matson 1976	^{14}C	Gak 4865	6780	135	7660	120
Glenrose	Old Cordilleran Component	Matson 1976	^{14}C	Gak 4866	8150	250	9050	320
Glenrose	St. Mungo Component	Matson 1976	^{14}C	Gak 4648	4240	110	4780	160
Glenrose	St. Mungo Component	Matson 1976	^{14}C	Gak 4683	3280	105	3530	120

Glenrose	St. Mungo Component	Matson 1976	^{14}C	Gak 4867	3570	95	3880	130
Glenrose	St. Mungo Component	Matson 1976	^{14}C	S 788	4185	105	4700	130
Hatzic Rock	Layer C	Ormerod and Matson 2000	^{14}C	Beta-77758	4840	110	5570	130
Hatzic Rock	Layer C	Ormerod and Matson 2000	^{14}C	Beta-76984	4970	50	5730	80
Hatzic Rock	Layer C	Ormerod and Matson 2000	^{14}C	Beta-77759	6880	80	7730	80
Hatzic Rock	Layer C	Ormerod and Matson 2000	^{14}C	Beta-111764	4540	90	5190	140
Hatzic Rock	Mason 1994	Mason 1994	^{14}C	Nuta-1452	4420	180	5060	230
Hatzic Rock	Mason 1994	Mason 1994	^{14}C	SFU-888	4490	70	5140	120
Hatzic Rock	Mason 1994	Mason 1994	^{14}C	Beta-46708	4800	70	5510	90
Hatzic Rock	Mason 1994	Mason 1994	^{14}C	WSU-4327	4930	70	5690	70
Hatzic Rock	Mason 1994	Mason 1994	^{14}C	WSU-4328	4590	70	5270	160
Hatzic Rock	Mason 1994	Mason 1994	^{14}C	Beta-47260	4530	120	5190	180
Katz	Zone A	Hanson 1973	^{14}C	I-6191	2430	90	2530	140
Katz	Zone B	Hanson 1973	^{14}C	I-6190	2475	90	2550	130
Katz	Zone B	Hanson 1973	^{14}C	I-6189	2695	90	2830	80
Locarno Beach	Layer 11	Arcas 1993	^{14}C	Beta-71115	2730	90	2870	90
Locarno Beach	Layer 11	Arcas 1993	^{14}C	Beta-71116	3120	90	3320	110
Locarno Beach	Layer 7+	Arcas 1993	^{14}C	Beta-70602	2460	80	2550	130
Locarno Beach	Layer 8	Arcas 1993	^{14}C	Beta-70603	1630	80	1540	100
Locarno Beach	Layer 9	Arcas 1993	^{14}C	Beta-70604	2290	90	2310	130
Marpole	Layers 2,3,4,5	Arcas 1993	^{14}C	Beta-27928	2120	170	2110	200
Marpole	Layers 2,3,4,5	Arcas 1989	^{14}C	Beta-27929	1540	110	1470	110
Maurer	Maurer House	Schaepe 1998, LeClair 1976	^{14}C	Gak-4919	4220	100	4740	130
Maurer	Maurer House	Schaepe 1998, LeClair 1976	^{14}C	Gak-4922	4240	380	4780	510
Montague Harbour	Component I	Mitchell 1971a	^{14}C	GSC-406	2890	140	3060	180
Montague Harbour	Component I	Mitchell 1971a	^{14}C	GSC-437	3160	130	3370	160
Montague Harbour	Component III	Mitchell 1971a	^{14}C	GSC-423	790	130	770	120
Montague Harbour	Component III	Mitchell 1971a	^{14}C	GSC-436	730	130	710	120
Oyster River	Marpole Component	Golder 1998	^{14}C	Beta-108539	2630	50	2760	40
Pitt River	Kroeker	Patenaude 1985	^{14}C	SFU 6	216	180	270	180
Pitt River	Kroeker	Patenaude 1985	^{14}C	Gak 7821	300	90	330	130
Pitt River	Kroeker	Patenaude 1985	^{14}C	Gak 7819	420	90	450	90
Pitt River	Kroeker	Patenaude 1985	^{14}C	WSU 2351	820	60	780	70
Pitt River	Kroeker	Patenaude 1985	^{14}C	Gak 7820	1190	110	1130	120
Pitt River	Logodi - Charles Component	Patenaude 1985	^{14}C	WSU 2466	3330	200	3600	240
Pitt River	Logodi - Charles Component	Patenaude 1985	^{14}C	WSU 2352	3610	100	3930	140

Pitt River	Logodi - Charles Component	Patenaude 1985	^{14}C	WSU 2469	4030	190	4510	270
Pitt River	Logodi - Charles Component	Patenaude 1985	^{14}C	WSU 2464	4090	100	4620	150
Pitt River	Logodi - Charles Component	Patenaude 1985	^{14}C	WSU 2468	4390	110	5050	170
Pitt River	Logodi - Locarno Component	Patenaude 1985	^{14}C	SFU 7	2890	80	3050	120
Pitt River	Mackenzie - Charles Component	Patenaude 1985	^{14}C	SFU 106	3300	270	3560	340
Pitt River	Mackenzie - Charles Component	Patenaude 1985	^{14}C	SFU 92	3560	180	3890	240
Pitt River	Mackenzie - Charles Component	Patenaude 1985	^{14}C	Gak 8245	3750	110	4130	160
Pitt River	Mackenzie - Charles Component	Patenaude 1985	^{14}C	Gak 8244	4100	100	4630	150
Pitt River	Mackenzie - Locarno Component	Patenaude 1985	^{14}C	SFU 91	2860	120	3030	160
Point Grey	Marpole Component	Coupland 1991	^{14}C	Gak 1480	1970	90	1940	110
Point Grey	Marpole Component	Coupland 1991	^{14}C	WSU 3573	2210	90	2200	110
Point Grey	Marpole Component	Coupland 1991	^{14}C	WSU 3574	1690	120	1620	140
Scowlitz	BOD/Layer 44	Lepofsky et al. 1999, 2000a, 2000b	^{14}C	WSU 5020	830	70	790	80
Scowlitz	BOD/Layer 44	Lepofsky et al. 1999, 2000a, 2000b	^{14}C	Beta 91909	1000	80	920	90
Scowlitz	BOD/Layer 44	Lepofsky et al. 1999, 2000a, 2000b	^{14}C	WSU-5019	1080	70	1020	70
Scowlitz	BOD/Layer 44	Lepofsky et al. 1999, 2000a, 2000b	^{14}C	WSU-5050	1310	45	1250	50
Scowlitz	Structure 3	Lepofsky et al. 1999, 2000a, 2000b	^{14}C	Beta-91911	2270	60	2260	80
Scowlitz	Structure 3	Lepofsky et al. 1999, 2000a, 2000b	^{14}C	Cams 61998	2250	70	2250	80
Scowlitz	Structure 3	Lepofsky et al. 1999, 2000a, 2000b	^{14}C	WSU-4542	2460	90	2540	130
Scowlitz	Structure 3	Lepofsky et al. 1999, 2000a, 2000b	^{14}C	Beta-91910	2450	60	2540	130
Shoemaker Bay	Component I (Zone B,C,D)	McMillan and St. Claire 1982	^{14}C	Gak-5107	1730	80	1670	100
Shoemaker Bay	Component I (Zone B,C,D)	McMillan and St. Claire 1982	^{14}C	Gak-5106	1730	90	1670	110
Shoemaker Bay	Component I (Zone B,C,D)	McMillan and St. Claire 1982	^{14}C	Gak-5104	2860	90	3010	130
Shoemaker Bay	Component II (Zone A)	McMillan and St. Claire 1982	^{14}C	Gak-5432	1130	85	1080	100
Shoemaker Bay	Component II (Zone A)	McMillan and St. Claire 1982	^{14}C	Gak-5108	1450	80	1390	80
St. Mungo	Component I	Boehm 1973	^{14}C	I-4053	4310	110	4910	190
St. Mungo	Component I	Boehm 1973	^{14}C	I-4685	3970	105	4440	170
St. Mungo	Component I	Boehm 1973	^{14}C	I-4688	4240	105	4780	150
St. Mungo	Component II	Boehm 1973	^{14}C	I-4689	1120	95	1070	100
St. Mungo	ETD-Layer A	Eldridge 1984	^{14}C	Beta-11384	960	120	900	120
St. Mungo	ETD-Layers C,D,E	Eldridge 1984	^{14}C	Beta-11385	2090	60	2070	80
St. Mungo	ETD-Layers C,D,E	Eldridge 1984	^{14}C	Beta-11386	2270	60	2260	80
Tsawwassen	Zone C (Layer CA, CB), Zone D (Layer DB, DD), Zone G (Layer GC, Ah)	Arcas 1994b	^{14}C	Beta-40983	860	60	810	80
Tsawwassen	Zone C (Layer CA, CB), Zone D (Layer DB, DD), Zone G (Layer GC, Ah)	Arcas 1994b	^{14}C	Beta-40984	1160	80	1100	100
Tsawwassen	Zone C (Layer CA, CB), Zone D (Layer DB, DD), Zone G (Layer GC, Ah)	Arcas 1994b	^{14}C	Beta-38350	1260	60	1190	70

Tsawwassen	Zone C (Layer CA, CB), Zone D (Layer DB, DD), Zone G (Layer GC, Ah)	Arcas 1994b	^{14}C	Beta-38351	1350	60	1270	60
Tsawwassen	Zone C (Layer CA, CB), Zone D (Layer DB, DD), Zone G (Layer GC, Ah)	Arcas 1994b	^{14}C	SFU-583	1410	60	1340	40
Tsawwassen	Zone C (Layer CA, CB), Zone D (Layer DB, DD), Zone G (Layer GC, Ah)	Arcas 1994b	^{14}C	Beta-38352	1520	50	1440	70
Tsawwassen	Zone C (Layer CA, CB), Zone D (Layer DB, DD), Zone G (Layer GC, Ah)	Arcas 1994b	^{14}C	Beta-38355	1150	60	1090	80
Tsawwassen	Zone C (Layer CA, CB), Zone D (Layer DB, DD), Zone G (Layer GC, Ah)	Arcas 1994b	^{14}C	Beta-39277	1160	50	1090	70
Tsawwassen	Zone C (Layer CA, CB), Zone D (Layer DB, DD), Zone G (Layer GC, Ah)	Arcas 1994b	^{14}C	Beta-39230	1400	50	1330	40
Tsawwassen	Zone C (Layer CA, CB), Zone D (Layer DB, DD), Zone G (Layer GC, Ah)	Arcas 1994b	^{14}C	Beta-39229	1410	60	1340	40
Tsawwassen	Zone C (Layer CA, CB), Zone D (Layer DB, DD), Zone G (Layer GC, Ah)	Arcas 1994b	^{14}C	Beta-40986	1500	60	1420	70
Tsawwassen	Zone C (Layer CA, CB), Zone D (Layer DB, DD), Zone G (Layer GC, Ah)	Arcas 1994b	^{14}C	Beta-39231	1550	60	1460	70
Tsawwassen	Zone C (Layer CA, CB), Zone D (Layer DB, DD), Zone G (Layer GC, Ah)	Arcas 1994b	^{14}C	Beta-40987	1280	70	1200	80
Tsawwassen	Zone C (Layer CA, CB), Zone D (Layer DB, DD), Zone G (Layer GC, Ah)	Arcas 1994b	^{14}C	Beta-39225	1430	60	1360	40
Tsawwassen	Zone C (Layer CA, CB), Zone D (Layer DB, DD), Zone G (Layer GC, Ah)	Arcas 1994b	^{14}C	Beta-39226	1500	50	1420	70
Tsawwassen	Zone C (Layers CC, CE, CD)	Arcas 1994b	^{14}C	Beta-34783	1750	60	1680	80
Tsawwassen	Zone C (Layers CC, CE, CD)	Arcas 1994b	^{14}C	Beta-34782	1780	100	1720	120
Tsawwassen	Zone C (Layers CC, CE, CD)	Arcas 1994b	^{14}C	Beta-34784	1840	60	1790	70
Tsawwassen	Zone C (Layers CC, CE, CD)	Arcas 1994b	^{14}C	Beta-40985	2060	90	2050	110
Tsawwassen	Zone G (Layer DF, DG)	Arcas 1994b	^{14}C	Beta-39228	3500	60	3780	70
Tsawwassen	Zone G (Layer DF, DG)	Arcas 1994b	^{14}C	Beta-38354	3800	60	4210	100
Tsawwassen	Zone G (Layer DF, DG)	Arcas 1994b	^{14}C	Beta-38607	3850	60	4280	100
Tsawwassen	Zone G (Layer DF, DG)	Arcas 1994b	^{14}C	Beta-38353	3880	50	4310	80
Tsawwassen Beach	Component I/II	Golder 2008	^{14}C	Beta-200789	900	60	840	70
Tsawwassen Beach	Component I/II	Golder 2008	^{14}C	Beta-205115	660	60	630	50
Whalen Farm	Component I	Thom 1992, Thom 1997	^{14}C	S-18	2450	160	2520	180
Whalen Farm	Component II	Thom 1992, Thom 1997	^{14}C	S-19	1580	140	1520	150
Whalen Farm	Component II	Thom 1992, Thom 1997	^{14}C	WSU-4340	2110	65	2120	110
Whalen Farm	Hammon 1986	Hammon 1986, Thom 1997	^{14}C	Beta-14123	2360	120	2440	200

Whalen Farm	Hammon 1986	Hammon 1986, Thom 1997	^{14}C	Beta-14124	2100	70	2100	110
Whalen Farm	Hammon 1986	Hammon 1986, Thom 1997	^{14}C	Beta-14125	2060	110	2060	140
Willows Beach	Zone A	Kenny 1974	^{14}C	GaK 5101	270	65	310	130
Willows Beach	Zone B	Kenny 1974	^{14}C	GaK 5102	2630	95	2700	140
Willows Beach	Zone B	Kenny 1974	^{14}C	GaK 5103	2490	85	2560	130