THE SUBSISTENCE ECONOMY OF THE LOCARNO BEACH CULTURE (3300 - 2400 B.P.)

by

Sheryl Kay Stiefel

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Department of Anthropology and Sociology

The University of British Columbia
1956 Main Mall
Vancouver, Canada
V6T 1Y3

Date: January 1985

ABSTRACT

This thesis is concerned with analysing vertebrate fauna (mammals, birds, and fish) from the Locarno Beach culture (3300-2400 B.P.) of the Fraser River Delta area in southern British Columbia. The principal objective is to reconstruct site level vertebrate exploitative patterns for the Locarno Beach culture components at the Locarno Beach (DhRt 6), Whalen Farm (DfRs 3), and Musqueam NE (DhRt 4) sites.

Qualitative and quantitative faunal analytic methods are employed to evaluate faunal data from each component. Data are also evaluated by seasonal availability and preferred habitat categories.

The results of the faunal analysis indicate that Locarno Beach culture populations exploited mainly riverine and foreshore resources. Salmon is the major vertebrate resource, followed by land mammals (deer and elk) and waterfowl (mainly diving species). Intensive herring, flatfish, and waterfowl exploitation took place at two sites (DhRt 6 and DfRs 3), probably in conjunction with shellfish harvesting during the late winter through early spring (February to April). DhRt 6 was also occupied during the spring to early summer (April to June) for surf smelt procurement. The third site (DhRt 4) was occupied from late winter through the summer and may have been a major

encampment for Fraser River salmon procurement. DhRt 4 also shares many attributes associated with Marpole and Late Prehistoric culture village sites.

It is concluded that the Locarno Beach culture vertebrate subsistence economy is part of the Northwest Coast pattern. The Locarno Beach culture is a development from the St. Mungo culture (4300 - 3300 B.P.) with greater emphasis on riverine resources, especially salmon.

Locarno Beach culture vertebrate fauna data indicate a range of site types, including seasonal resource extraction sites, salmon fishing sites, and possibly a winter village site. Similar to Marpole (2400-1600 B.P.) and Late Prehistoric (1600-1100 B.P.) cultures, Locarno Beach culture populations of the Fraser Delta exploited aggregated resources (e.g. herring, flatfish, waterfowl, and shellfish) at seasonally occupied camps during the late winter to early spring. The primary summer subsistence activity was salmon procurement. Preliminary evidence suggests that Fraser River sockeye salmon runs (late summer to fall) were intensively exploited with fishing nets near DhRt 4. Prolonged occupation at DhRt 4 during the winter may indicate that this site was a winter village, as well as a fishing site.

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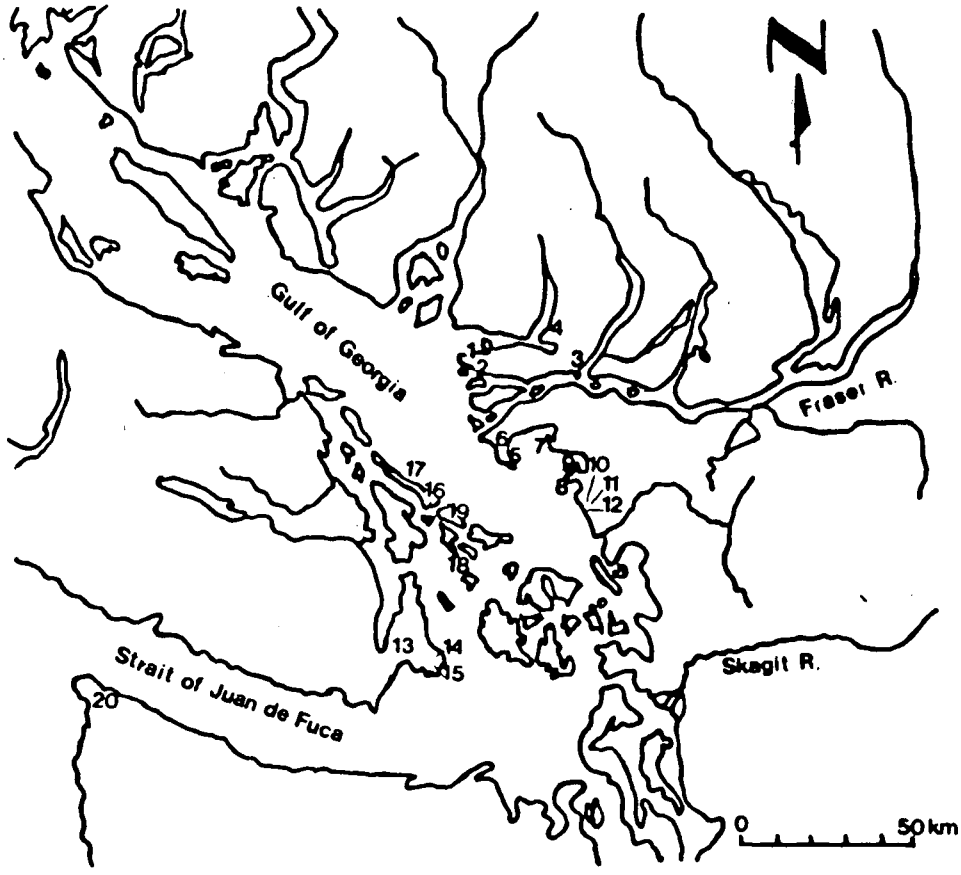
Chapter 1

INTRODUCTION AND THE PROBLEM

This study is an analysis of vertebrate faunal remains from three Locarno Beach culture components, each from a different site in the Fraser River Delta area.

Locarno Beach culture (ca. 3300-2400 B.P.) components have a spatial configuration spread throughout most of the southern Gulf of Georgia region in British Columbia and northwestern Washington state (see Figure 1.1). However, little is known about the subsistence patterns of the Locarno Beach culture due to the incomplete documentation of both faunal and artifactual data. Descriptive information for faunal remains and artifact types was not reported in detail for Locarno Beach culture components at Locarno Beach and the Whalen Farm sites (Borden 1950b) where this culture was first recognized. Faunal types are listed for components at Dionisio Point (Mitchell 1971a), Montague Harbour (Mitchell 1971b), Musqueam NE (Borden and Archer 1975, Borden 1976), Georgeson Bay (Haggarty and Sendy 1976), and Bowker Creek (Mitchell 1979) sites. However, many of

Figure 1.1: Distribution of Locarno Beach Culture Components (after Ham 1982:85).



1	DhRt 6	Locarno Beach	2270 - 2450 B.P.
2	DhRt 4	Musqueam NE	2250 - 2970 B.P.
3	DhRq 21	Pitt River	2630 - 2960 B.P.
4	DhRr 6	Belcarra Park	1710 B.P. rejected
5	DfRs 3	Whalen Farm	2450 B.P.
6	DgRs 1	Beach Grove	2810 - 3200 B.P.
7*	DgRr 1	Crescent Beach	2350 - 3150 B.P.
8*	45WH48	Simonarson	3495 B.P.
9*	45WH17	Semiahmoo Spit	no dates
10*	45WH9	Birch Bay	3125 B.P.
11*	45WH74	Blackwood Add,	no dates
12*	45WH1	Cherry Point	2630 B.P.
13	DcRu 38	Quick's Pond	no dates
14	DcRt 10	Willow's Beach	2490 - 2630 B.P.
15	DcRt 13	Bowker Creek	2740 - 2910 B.P.
16	DfRu 23	Georgeson Bay	2820 B.P.
17	DfRu 13	Montague Harbour	2890 - 3160 B.P.
18	DcRt 2	Pender Canal	2200 B.P.
19*	DgRv 3	Dionisio Point	2450 B.P.
20	45Ca213	Hoko River	3000 B.P.

* poorly documented or questionable Locarno Beach culture components.

the identified Locarno Beach components illustrated in Figure 1.1 remain poorly reported. The overall lack of quantified faunal and artifactual data for the Locarno Beach culture has impeded intersite comparisons and consequently has seriously hampered the reconstruction of prehistoric subsistence patterns.

The Locarno Beach culture is temporally intermediate to the St. Mungo (4300-3300 B.P.) and Marpole (2400-1200 B.P.) cultures in Gulf of Georgia prehistory. The cultural relationship between these three successive coastal culture types is unclear (Table 1.1). There are questions as to whether the Locarno Beach culture subsistence pattern was an in situ Northwest Coast development from St. Mungo (as suggested by Mitchell 1971b, Burley 1979, and at times Borden 1968) or whether it was a marine mammal hunting economy introduced by "Eskimoid" migrations from the north (Borden 1951:46-49, Suttles 1952, Drucker 1955). While some Northwest Coast prehistorians agree that a maritime adaptation characterizes the Locarno Beach subsistence economy, there is disagreement on the kind of maritime adaptation or what maritime adaptation means (Borden 1975; Burley 1979, 1980; Matson 1976b, 1981a; Schalk 1977; Suttles 1979).

The present study is designed to contribute to our knowledge of Locarno Beach culture subsistence patterns and

Table 1.1: Summary of Known Characteristics of St. Mungo, Locarno Beach, and Marpole Cultures.

Date	Archaeological Culture Type	Social Structure	Residence	Subsistence Economy
2400 B.P.	Marpole	Ascribed rank (Matson 1981a:85) Elaborate antler art (Ham 1982:88) Pecked ground stone art (Ham 1982:88) Labret wear (Ham 1982:91) Cranial deformation (Ham 1982:91) Flexed and cairn burials (Ham 1982:91) Burials with grave goods (Ham 1982:91)	Large plankhouse dwellings (Burley 1980:29) Winter villages (Ham 1982:305) Sedentariness (Ham 1982:365)	Developed Preservation and storage technology (Burley 1980:70) Night-time winter shellfish gathering (Ham 1982:304) Specialized procurement technology for salmon (Burley 1980:71-72) Specialized camps for herring and shellfish (Matson et. al 1981:95-96) Root crop harvesting (Patenaude 1981)
3300 B.P.	Locarno Beach	At least high ranking males (Beattie 1980:194) Use of labrets, burials (Beattie 1980:190,206) Burials with grave goods (Mitchell 1971b:57) (Haggarty and Sendy 1976: 18, 66) Cranial deformation (Ham 1982:86) Carved wooden objects (Ham 1982:87) Basketry (Borden 1976:235) (Croes 1975) (Borden and Archer 1975) Gulf Island complex artifacts (Duff 1956) (Ham 1982:86) (Mitchell 1971b:57)	no documented evidence	Possibly specialized shellfish and herring harvesting camps (Ham 1982:366) Root crop harvesting (Patenaude 1981)
4300 B.P.	St. Mungo	Evidence too sparse to indicate established ranking Possibly cairn burial (Ham 1982:81)	Year-round site utilization (Matson 1981a:83)	Possibly the beginning of specialized shellfishing, fishing, and hunting (Matson 1981a:83)

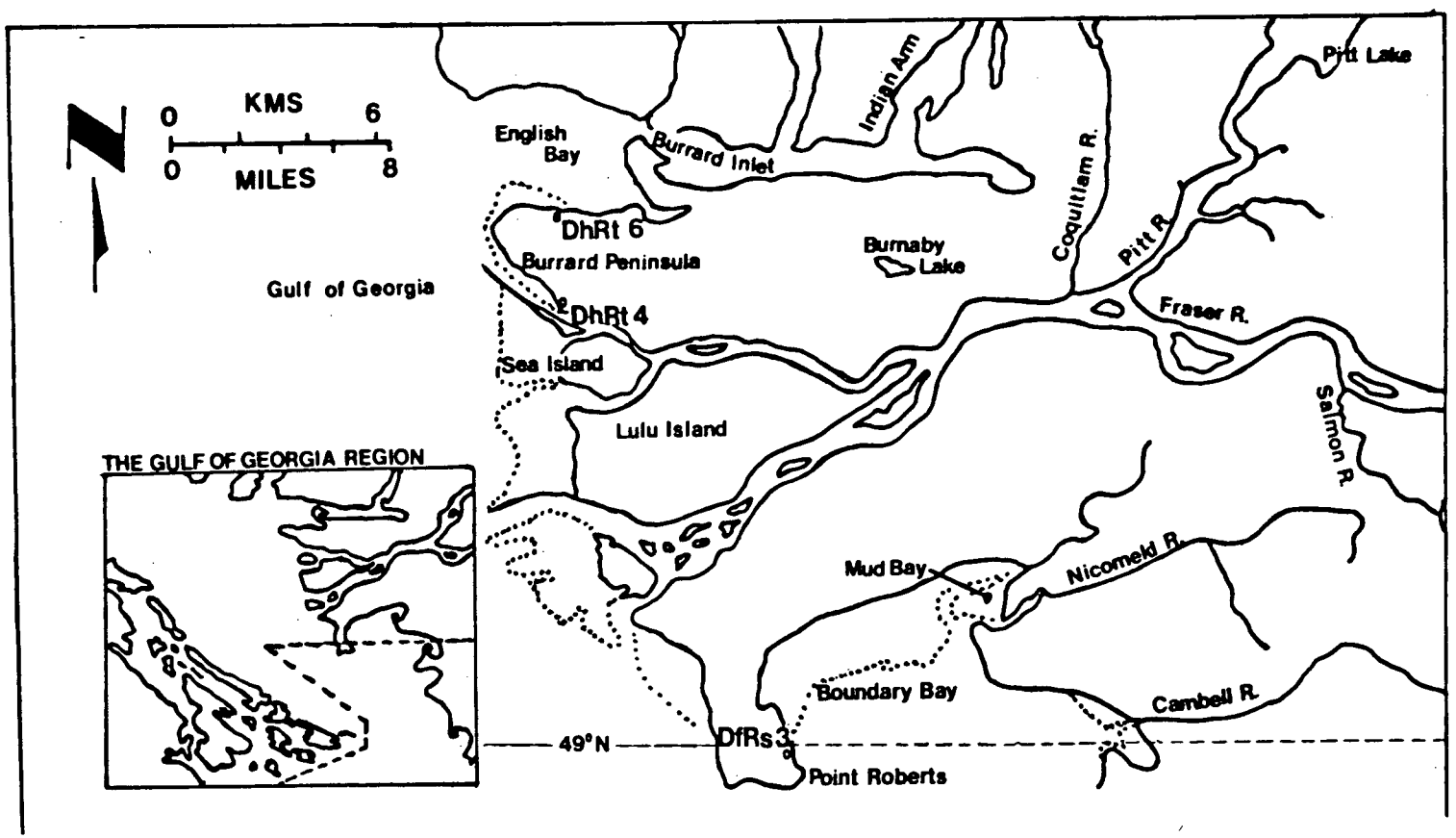
its relationship to earlier and later cultures. The main objective is the reconstruction of site level vertebrate subsistence patterns for Locarno Beach culture components at the Locarno Beach (DhRt 6), Whalen Farm (DfRs 3), and Musqueam NE (DhRt 4) sites in the Fraser Delta area of the Gulf of Georgia region (Figure 1.2). Ideally a study of the Locarno Beach culture subsistence economy should include an analysis of shellfish and floral remains. Unfortunately, limited funds and time precluded a thorough analysis of shellfish remains; floral samples were not collected at the time of each excavation. Thus, an analysis of shellfish and flora are excluded from this study.

Subsistence activities are reconstructed by a qualitative and quantitative faunal analysis of a sample of mammal, bird, and fish remains from each of the three sites. This study evaluates three specific hypotheses about Locarno Beach culture vertebrate subsistence economy and its relationship to the St. Mungo and Marpole culture patterns. The hypotheses are:

1. The Locarno Beach culture is characterized by a marine mammal hunting economy.

2. During the Locarno Beach culture, seasonality of vertebrate fauna suggests year round site utilization.

Figure 1.2: Location of sites with Locarno Beach Culture components that are sampled in this study.



3. During the Locarno Beach culture, salmon is the most abundant fish resource.

Hypothesis 1 tests the importance of marine mammal hunting during the Locarno Beach culture. Ethnographers report that many Coast Salish groups hunted marine or "sea" mammals (Suttles 1951, 1952, Barnett 1955, Drucker 1955). In these reports, marine mammal hunting focuses on the procurement of Cetecea (e.g. whales, porpoises, and dolphins) and Pinnipedia (e.g. seals, sea lions, and walruses). The aforementioned definition for marine mammal hunting is used in this study.

By clarifying the role of marine mammal hunting during the Locarno Beach culture, the Locarno Beach culture marine mammal exploitative pattern can be compared to that of the St. Mungo and Marpole cultures. If the Locarno Beach culture does not have significantly more marine mammals, it is unlikely that it is the result of a migration of "Eskimoid" sea mammal hunters, as suggested by Borden (1951), Suttles (1952), and Drucker (1955). If in fact it does have a relative abundance of marine mammals, it could possibly be the result of such a migration.

The seasonality of sites with Locarno Beach components is tested in Hypothesis 2. If the Locarno Beach culture is an <u>in situ</u> Northwest Coast development, one would expect its

seasonality to resemble either the preceeding St. Mungo culture or the succeeding Marpole culture, or have attributes of both cultures. Thus far, a faunal analysis of the St. Mungo component at the Glenrose Cannery site (DgRr 6) indicates that site occupation occurred "at varying seasons of the year rather than year round" (Matson 1976a:300). This is in agreement with Ham (1982:358-360) who hypothesizes that specialized seasonal procurement sites in the Gulf of Georgia region may go back to 5000 years B.P. At this time, a conservative approach would be to compare seasonality information from the Locarno Beach culture to the St. Mungo and Marpole cultures to check where the Locarno Beach culture site seasonality fits into the Northwest Coast pattern.

For Hypothesis 3, if Marpole is salmon oriented, as Mitchell (1971a), Burley (1980), and Matson (1981a, 1981b) suggest, and if salmon and the Northwest Coast pattern are linked as Matson (1976b, 1981a, 1981b), and Burley (1980) argue, the importance of salmon in the Locarno Beach culture may test this idea. If the relative abundance of salmon is intermediate between St. Mungo and Marpole, this would support the in situ hypothesis.

This study differs in two ways from previous attempts to reconstruct the Locarno Beach subsistence economy: (1) this is the first systematic investigation of faunal remains

from Locarno Beach culture components and (2) the faunal analysis of Locarno Beach culture material is compared to data for St. Mungo and Marpole assemblages located in the delta.

Chapter 2 reviews the physical environment of the study area. Present and past environments are described in terms of relevant climatology, geomorphology, flora, and fauna. Faunal behaviour is described in terms of habitat and seasonal availability.

Chapter 3 discusses the sample used for this study. A review of Borden's excavations and interpretations of the three sites is presented. Site location within the study area, excavation methodology, and available information concerning Borden's delineations of stratigraphy and cultural zone relationships at each site are described. A Locarno Beach culture association for each site's delineated component is verified through a comparison of artifact assemblages from each component with Locarno Beach, St. Mungo, and Marpole culture diagnostic archaeological features.

Chapter 4 outlines the methods used to identify and quantify the faunal remains, describes the faunal assemblages, and identifies their similarities and differences. Comparisons are made among faunal assemblages in terms of habitat selection and seasonal availability.

Chapter 5 compares the results and interpretations of the Locarno Beach culture vertebrate faunal analysis to known data for St. Mungo and Marpole components. Interpretations are offered for observed similarities and differences.

Chapter 6 evaluates this study in view of Northwest Coast prehistory to date.

Chapter 2

THE PHYSICAL ENVIRONMENT

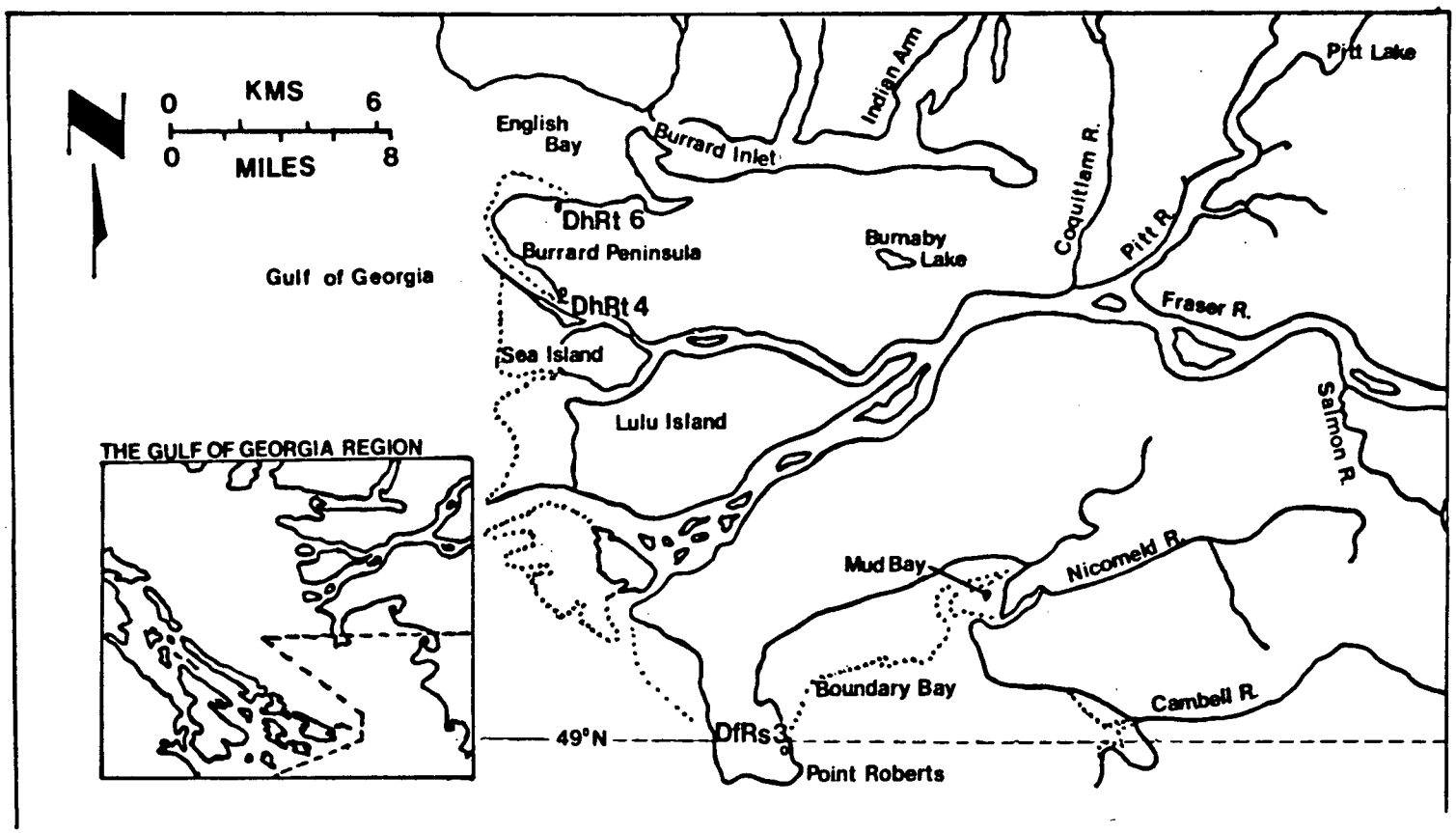
Introduction

This chapter reviews the physical environment of the study area. Past and present environments of the Fraser Delta area are described in terms of climatology, geomorphology, flora, and important prehistoric fauna. Faunal distribution is described by preferred habitat location and seasonal availability.

The Setting

The Fraser Delta area is located in southwestern British Columbia and northwestern Washington (Figure 2.1). The area falls within the Gulf of Georgia region, which has been described by Mitchell (1971b:2-18) and Burley (1980:2-4).

Figure 2.1: The Fraser Delta area of the Gulf of Georgia region (after Calvert 1970:56).



Climate

The climate of the area is a Csb Koeppen Mediterranean Type (Mitchell 1971b:7, Hoos and Packman 1974:30). It is characterized by wet winters and relatively dry summers. Active weather fronts prevail from the southwest and southeast during the fall, winter, and spring seasons; northwest winds occur throughout the year but mainly during the summer months (Mitchell 1971b:11).

Evidence for a post-Pleistocene warming period, or hypsithermal interval, ca. 8500-3000 B.P. dominated early palynological work for southwestern British Columbia (Hanson 1947, Heusser 1960, 1966). However, Mathewes and Rouse (1975) observed no evidence of a hypsithermal interval after the Mazama ash fall (ca. 6600 B.P.) in the Fraser Canyon area and suggest that the climate of the coastal area has remained relatively unchanged from 6600 B.P. to the present.

Landforms

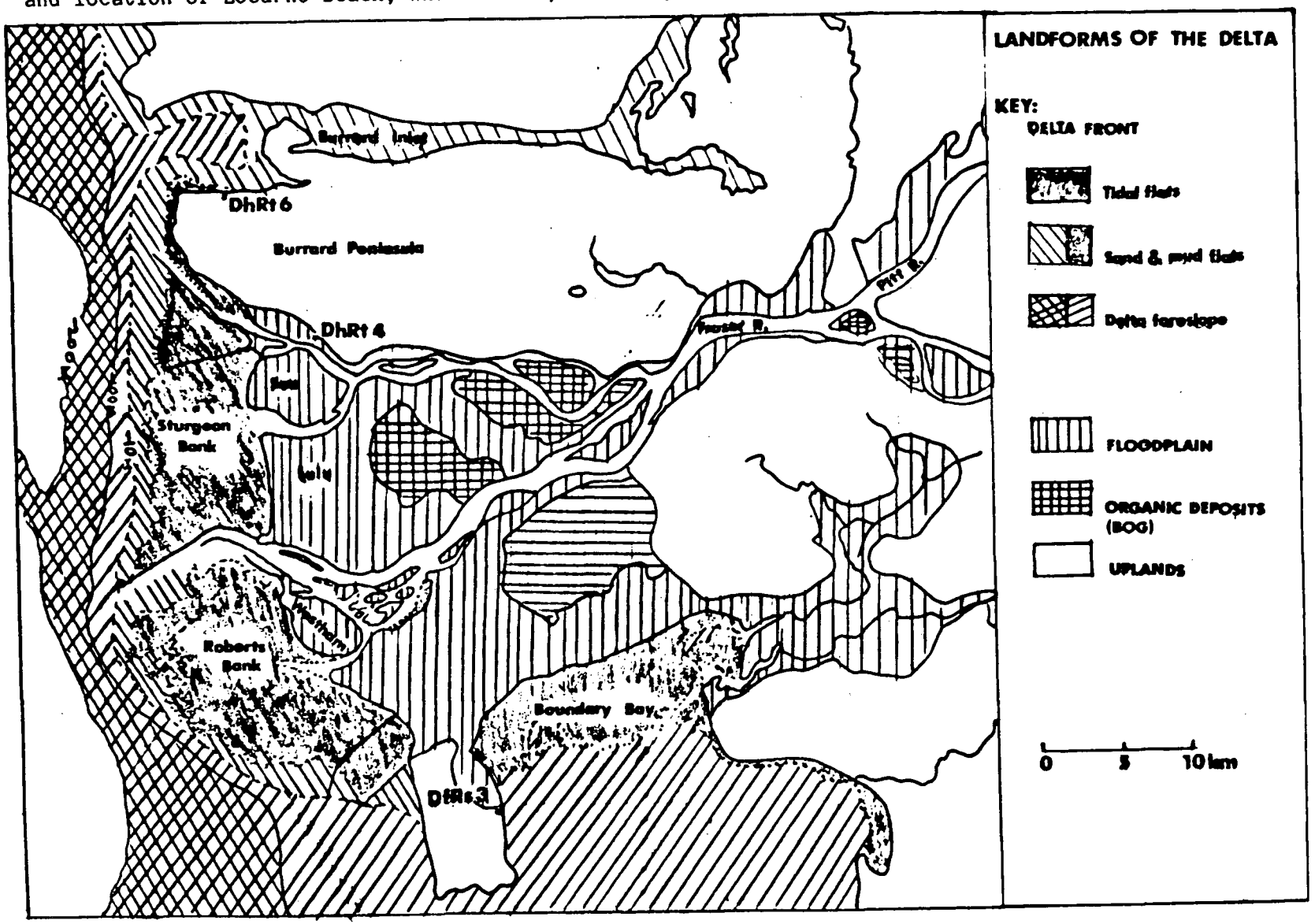
After Ward (1980), there are four prominent landforms in the Fraser Delta area: (1) uplands, (2) floodplains, (3) organic deposits, and (4) delta fronts (Figure 2.2).

The uplands are the higher land areas of the region. They include the Burrard Peninsula, as well as the Surrey, Tswassasan, and Point Roberts areas. At the termination of the last glacial period in southwestern British Columbia ca. 11,000 B.P., these areas were exposed (Hebda 1977:5, Ham 1982:17).

The floodplains border the Fraser River and form the bulk of the surface area in the region (Ward 1980:8). Prior to the construction of dykes, a layer of sandy to clayey sediment was deposited over the floodplain as the Fraser's floodwaters rose during winter high tides (December) and the spring to summer snow melt (Ward 1980:8). This process contributed to the growth of the floodplain by adding up to 9 to 10 meters to it each year. (Mathews and Shepard 1962, Borden 1962). Thus, the dimensions of the floodplain changed considerably during prehistory.

Organic deposits in the area are peat bogs of slowly decomposing organic material, which accumulated "when the top of the Fraser Delta was built high enough above sea level to avoid regular flooding by the river and sea (Clague et. al 1983:1320). Burns Bog, adjacent to the Surrey

Figure 2.2: Landforms of the Fraser Delta, ca. 1850 (after Ward 1980:9, North and Teversham n.d.) and location of Locarno Beach, Whalen Farm, and Musqueam NE sites.



Uplands and the Main Arm of the Fraser River, retains an important palynological record associated with the formation of the delta. Three pollen cores from undisturbed areas of Burns Bog have been analysed by Hebda (1977) and shed light on processes of sedimentation, delta growth, environmental change, and channel development. The implications of Hebda's work on the past physical environment of the delta are discussed later in this chapter.

The delta front is home to the majority of fish and waterfowl discussed in this study. It is geographically composed of two zones: the delta foreslope and the tidal flats. Composed of mainly fine sand and mud (Clague et. al 1983:1320), the delta foreslope is permanently submerged. It extends from the Gulf of Georgia marine basin to the tidal flats on the landward side (200m to 100m) (Ward 1980:8).

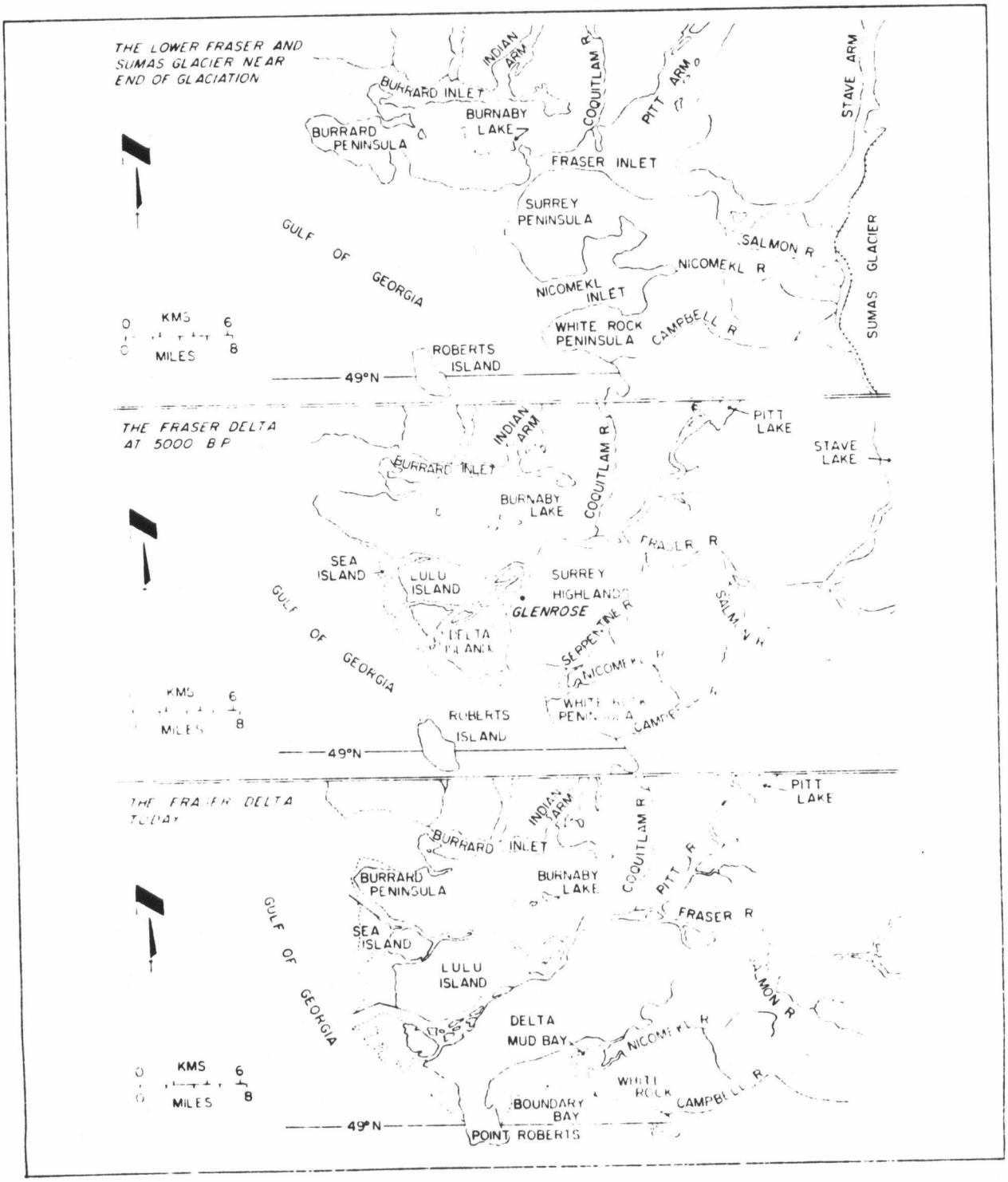
The tidal flats include the mud and sand flats of the delta (Clague et. al 1983:1320). This zone extends from the landward edge of the delta front (100m) to the low tide mark. It encompasses the delta's marshlands, as well as Spanish, Sturgeon, Roberts, and Boundary Banks.

Evolution of the Landforms

Recent research suggests that the location and dimensions of the four prominent landforms of the Fraser Delta have changed relative to the formation of the delta (Hebda 1977, Clague et. al 1983). Clague et. al (1983:1320) suggests that the southwestern mainland coast of Canada was composed of numerous inlets, bays, coves, and lakes when the glaciers retreated at 11,000 B.P. (Figure 2.3). Due to the annual deposition of sand, silt, and clay by the Fraser's floodwaters, the delta's floodplain prograded westward (Clague et. al 1983:1323). The accumulation of sediments has reduced the length of the coastline during post-glacial times.

The Fraser Delta has been emerging since at least 8000 B.P. (Ward 1980, Hebda 1977, Ham 1973). Evidence of wood (6600 ± 90 B.P., GSC - 2714) found 3m below the sea floor and 2km northwest of Point Grey suggests that Point Grey on the Burrard Peninsula protruded farther out into the Gulf of Georgia in the past (Clague et. al 1983:1324). Sediment from both the Fraser River and the eroding uplands of Point Grey might have been carried and deposited along the north shore of the peninsula, possibly creating shallow water beaches and grasslands at Spanish Banks and Jericho Beach in more recent times (personal communication Ham, January 1982, Harris 1978). However, there has not been any

Figure 2.3: Hypothesized evolution of the Fraser Delta: 10000 B.P., 5000 B.P., and Today (Bunyan 1978:21).



paleoecological research in this area which could support this claim.

By 5000 B.P., enough sediment had settled to form Lulu Island and Burns Bog (Clague et. al 1983:1325) (Figure 2.3). Ham (1973:11) suggests that Sea Island was a sand bar, similar to Iona Island today. By 5000 B.P., the North and Middle Arms of the river had formed (Ham 1973:11).

How and when the southern portion of the Fraser Delta developed has been the subject of study and dispute (Blunden 1975, Hebda 1977, Clague et. al 1983). By approximately 5000 B.P., extensive tidal flats emerged in the eastern Fraser Delta, which is now occupied by organic deposits (bogs) (Hebda 1977:155-170). The Fraser Estuary was developed by the time of the St. Mungo culture (4300-3300 B.P.). As the delta prograded westward, the estuary grew, changing in some areas from freshwater-brackish marsh to salt marsh (Clague et. al 1983:1320, 1325).

Hebda (1977:170,172) has suggested that by 4000 B.P. a submerged delta front (-10m) reached the lower slopes of the Point Roberts Uplands, blocking the Fraser River's flow into Boundary Bay. However, archaeological evidence from Crescent Beach site (Ham 1982:17-18) and Beach Grove site (Ball 1979:49) suggests that freshwater continued to discharge into Boundary Bay possibly until 2500 B.P. Just how long ago Boundary Bay was cut off from freshwater

flowing from the Fraser River will remain in question until more paleoecological work is done in this geologically complex area.

Delta progradation continued throughout the later prehistoric and historic periods (Clague et. al 1983:1323, 1325). The only major change occurred after 2500 B.P. when the South Arm of the Fraser River penetrated the Greater Lulu Island-Delta peat bog (Blunden 1975, Hebda 1977:5) (Figure 2.3). Thus, the size of the estuary and marshes increased in late prehistoric times as a result of the deposition of sediment carried by the South Arm of the Fraser River and also the Nicomekl and Serpentine Rivers near Crescent Beach.

Flora

The type of flora in the delta has not changed for at least 7000 years B.P. However, the location and extent of the communities has shifted with the formation of the delta (Hebda 1977:170, 172, Clague et. al 1983:1320).

Coniferous forests dominated the upland areas. A succession of alder (Alnus oregona), Douglas fir (Pseudotsuga menziesii), cedar (Thuja plicata), and hemlock (Tsuga heterophylla) characterizes this community with willow (Salix sp.), berry bushes, and grass (Digitara sp.)

present in well drained areas near streams (Ham 1973:5, 7).

Two types of estuarine marshes covered the floodplain and tidal flats regions of the delta. Freshwater-brackish marsh species dominated the northern part of the delta, influenced by freshwater flowing from the Fraser River (Hebda 1977:170, Clague et. al 1983:1320). With the diversion of the Fraser River by Sea Island and other sand bars, the river probably began to deposit alluvium in the Musqueam area forming marshlands by approximately 4000 B.P. (Ham 1973:13). Vegetation in this area might have included tall, reed-like plants such as cattail (Typha latifolis), sedge (Carex vulpinoidea), and bulrush (Scripus sp.).

The second type of estuarine floral community is the saltmarsh. As noted earlier, when and exactly where saltmarshes developed in the southern delta area is not known. It is possible that they would have first pioneered on the "eastern half of Boundary Bay" between 5000 B.P. and 2500 B.P. (Clague et. al 1983:1324). Unlike freshwater-brackish species, saltmarsh flora appear like a flat mat of tangled leaves and include saltwort (Glaux maritima), saltgrass (Pistrchlis sp.), and arrowgrass (Trigluchin sp.). Eelgrass (Zostera sp.), which attracts many varieties of fish including herring, starry flounder, staghorn sculpin, would have been more abundant in the saline environment of the Boundary Bay area rather than at the mouth of the Fraser

River.

Similarly, eelgrass might have been present in the Locarno Beach site locality, influenced by the protected, shallow saltwater beaches on the southern shore of English Bay. However, this is speculatory. Eelgrass is not present at Locarno Beach today, and this locality lacks any paleoecological documentation.

A grassland environment may have existed at both the Jericho Beach and delta island-sand bar localities. Clover (Trifolium sp.), dandelion (Taraxacum sp.), and grass (Digitara sp.) may have been the dominant varieties of flora (Ham 1973:26, Figure 13).

Vertebrate Fauna of the Fraser Delta Area

The stability of the climate and flora of the Fraser Delta suggests that the vertebrate fauna present in the study area have also remained relatively unchanged for at least 5000 years. Archaeological reports (Imamoto 1974, 1976; Casteel 1976b; Matson 1981a) indicate that the mammals, birds, fish, and shellfish of delta archaeological sites dating to the St. Mungo culture are not too different from those available in the area today. However, as with the vegetation, the location of particular animal communities (e.g. shellfish) has altered with the gradual

formation of the delta (Ham 1976, Grabert and Larson 1978).

This section describes the natural history of the present-day vertebrate fauna in the Fraser Delta area. Information is derived from a synthesis of historical wildlife sources and classifications of historical data used in previous archaeological reports for the area. In turn, this information will be helpful in reconstructing Locarno Beach culture hunting-fishing activities.

The present study employs a methodological approach formulated by Calvert (1980), where mammals, birds, and fish of the Fraser Delta are categorized by two types of animal behaviours: preferred habitat location and seasonal availability.

For this study, the first list describes the preferred habitat location of vertebrate fauna. The classification of archaeological fauna by preferred habitat location is used to reconstruct habitat selectivity (i.e. the extent to which animals associated with particular environmental settings were exploited during Locarno Beach times). Because non-sedentary animals are adapted to a range of habitats, "the optimal habitat, and therefore, the optimal areas for species groupings" are described for species of the Fraser Delta area (Calvert 1980:20). The fauna that are optimally available in more than one habitat in the region at different times of the year (e.g. anadromous fish) are

indicated.

The second list describes the time of the year species groupings most likely occur in the Fraser Delta. The classification of archaeological fauna by seasonal availability is used to reconstruct the seasonality of each site's Locarno Beach culture component.

The advantage of using Calvert's qualitative approach to habitat selectivity and site seasonality is that it reduces detailed information about specific present-day fauna into categories that are useful in detecting patterns in archaeofaunal data, especially in prehistoric procurement strategies. The disadvantage is that it uses information on faunal behaviour that was collected in historic times. Due to the recent effects of industrialization and human colonization on predator-prey relationships, habitat adaptability, and animal availability in the area, this type of wildlife information should be used cautiously since it may be different than the prehistoric distributions of the fauna (Will 1982).

Information to place species in habitat and seasonal availability categories for this study was obtained from lists of historically available fauna from Ham (1973, 1982), Boucher (1976), Cowan and Guiguet (1978), Guiguet (1971), and Carl (1971), Hart (1973), and Hoos and Packman (1974). The taxonomic names of the species are those used by

Banfield (1974) for mammals; Godfrey (1976) for birds; and Hart (1973) for fish.

Mammals

Twelve mammal species are present within the Fraser Delta area and in the Locarno Beach culture faunal remains. Appendix, Table A.1 lists their common and taxonomic names. Nine species are land mammals, and three species are marine mammals. All are classified according to four habitat categories (Table 2.1): Open/Littoral Water (1); Riverine (2); Estuarine/Forest Edge (3); and Forest (4).

Seasonal availability for the twelve species is classified into three categories (Table 2.2): Year Round (1); Winter to Spring (2); Fall to Spring (3).

A summary of the natural history and ethnographic use by Coast Salish of these twelve mammals follows.

Although harbour seal prefer the offshore waters of the foreslope, they have been observed in the riverine waters along with river otter and beaver. Smith (1907:266) and Suttles (1952:10) report an annual clubbing or harpooning of seal at Harrison Lake and Pitt Lake, respectively, in the summer, while the seals whelped. A resident group of harbour seal (200-250) dwell in Boundary Bay today.

River otter are mustelids associated with waterways, beaches, and adjacent land areas of the delta. They forage

Table 2.1: Preferred Habitat Categories of Mammals in the Fraser Delta Area.

Species	Category			
	1	2	3	4
Harbour Seal	X			
River Otter		X		
Beaver		X		
Muskrat			X	
Mink			X	
Peromyscus			X	
Striped Skunk			X	
Raccoon			X	
Canis			X	
Black Bear				X
Deer				X
Elk				X
Total	1	2	6	3

Habitat Categories

1. Open Littoral Water: the open waters of the delta foreslope (200m-100m) to the estuarine areas, including the deeper waters of bays, inlets, and estuaries.

2. Riverine: the waters immediately influenced by the Fraser, Serpentine, and Nickomekl Rivers and their tributaries, including the estuaries, marshlands, floodplains, streams.

3. Littoral/Forest Edge: the intertidal areas and bogs immediately adjacent to and including the fringes of the forests.

4. Forest: the deciduous and coniferous forests and adjacent areas of open meadow.

Table 2.2: Seasonal Availability of Mammal Fauna in the Fraser Delta Area.

Category	Species	Season J F M A M J J A S O N D
1	Deer	▁▁▁▁▁▁▁▁▁▁▁▁
	Black Bear	- - - - - - - - - - - -
	Canis	- - - - - - - - - - - -
	Raccoon	- - - - - - - - - - - -
	Striped Skunk	- - - - - - - - - - - -
	Peromyscus	▁▁▁▁▁▁▁▁▁▁▁▁
	Mink	- - - - - - - - - - - -
	Muskrat	- - - - - - - - - - - -
	Beaver	▁▁▁▁▁▁▁▁▁▁▁▁
	River otter	- - - - - - - - - - - -
2	Harbour Seal	========================
3	Elk	▁▁▁▁▁ ▁▁▁▁▁

Key: ==== Very Common ____ Common - - - Frequent . . . Rare

Seasonal Availability Categories

Year round	1. Year round in roughly equal abundance.
Winter-Spring	2. Present year round but more common in the winter-spring months (December through May).
Late Fall-Winter	3. Only present in late fall-spring months (October through May).

daily on shellfish, but mainly feed on fish. Young river otters are born in early to mid-spring (March to April)(Cowan and Guiguet 1978:331). Like the seal, the river otter was clubbed, netted, or harpooned as it sought its preferred fish prey, salmon, trout, and herring.

Beaver were abundant in the Fraser waterways preferring alder and bracken resources over hemlock and western cedar. Ham (1982:267) hypothesizes that they were also abundant in the Nicomekl-Serpentine Valleys. The young are born between April and July (Cowan 1978:170). Straits Salish hunted beaver with the bow and arrow and occasionally with a composite harpoon. Saanich hunters also trapped beaver (Suttles 1951:96).

Although not found in Locarno Beach culture samples in this study, Boehm (1973b:2-4) and Barnett (1955) state that northern sea lion (Eumetopias jubata) are known to follow the salmon runs through the Straits and up the Fraser River during the spring and summer. In preparation for this event, beginning in March, Penelekut Salish stationed a 24 hour watch to signal for the presence of sea lion herds that would traverse Porlier Pass (Suttles 1952:11-12). Using composite harpoons, canoe parties hunted sea lion in the saltwater of the Straits and sometimes at the mouth of the Fraser (Suttles 1952:12). In contrast, harbour seal, river otter, and beaver were exploited in the freshwater of the

Fraser River or other streams and creeks in the lower Fraser's drainage area.

With the exception of Peromyscus, small land mammals (e.g. muskrat, striped skunk, raccoon, and mink) are omnivorous animals that dwell in the Littoral/Forest edge habitat. They subsist on a variety of plants, seeds, crustaceans, shellfish, fish, birds, and bird eggs. Muskrat, striped skunk, and raccoon have multiple births each year, whereas the mink births in May through June (Cowan and Guiguet 1978:321). All were trapped for their pelts, although raccoon was also eaten (Suttles 1951:96-97).

Dogs were not eaten historically, but rather used as a source of wool for blankets. Owned by one man, dogs assisted in hunting activities by chasing large game and bear or retrieving waterfowl (Suttles 1951:102-105). There is no record of the procurement of other Canis, such as coyote or wolf in the Fraser Delta area. However, because of the difficulty in distinguishing between dog and coyote or wolf with this study's bone samples, all Canis is considered for its dietary value.

Deer are confined to the western slope of the coast range where they feed primarily on douglas fir, western cedar, Oregon yew, trailing blackberry, red huckleberry, and salal. Some herds migrate to mountain tops or high valleys in the summer and return to the lowlands in the winter.

However, they are present in roughly equal abundance year round in the Fraser Delta (Cowan and Guiguet 1978:366-369). Young are born between May and June. Ethnographically, deer were hunted by an individual or in groups using the bow and arrow, snare, or pitfall. Male deer were exploited in the spring and summer. Their meat was smoked for a winter food supply. Female deer were hunted in December for immediate use (Suttles 1951:82-83).

Elk, or wapiti, prefer parklands where "clumps of conifers provide shelter and where groves of deciduous trees interspersed with grassland provide food" (Cowan and Guiguet 1978:358). Most elk herds move to high altitudes in the summer and return to the lowlands of the Fraser Delta in the winter. Young are born in late May (Cowan and Guiguet 1978:358, 361-362). Elk hunting mainly occurred in the winter when the herds were present in the Fraser lowlands. Ethnographic procurement strategies paralleled those for deer (Suttles 1951:91-92).

On the coast, the omnivorous black bear prefers wooded areas with access to major berry patches. Bear eat a variety of resources including fish and marine invertebrates, as well as plants, berries, insects, grasses, and other small mammals. Young are born in the winter den and weaned in August. (Cowan 1978:195, 289-291). Although economic activity intensified after contact with the Hudson

Bay Company, the Saanich hunted bear, which sought the ripe crabapple, salmonberry, and huckleberry, between June and August. Bear were also ambushed on salmon-spawning streams in the autumn (Ham 1982:60).

Birds

Twenty-eight bird species are found within the Fraser Delta and in the Locarno Beach culture faunal remains. Appendix, Table A.2 lists their common and taxonomic names. Twenty-three species are waterfowl while only five are upland birds. Of the waterfowl, thirteen are diving birds that feed primarily on small fish, fish roe, and clams, and six species are surface feeders that subsist mainly on seeds and aquatic plants. Four species of waterfowl are scavengers (Table 2.3). All avifauna are classified into four habitat categories (see Table 2.4): Littoral/Riverine (1); Sheltered Estuarine Water (2); Strand/Littoral Interface (3); and Mixed Woodland (4).

Seasonal availability for the 28 species is classified into three major categories (Table 2.5): Year Round (1); Winter (2); Spring/Fall (3).

A brief natural history of the delta's avifauna follows. The arctic loon is one of two species of loon that dwell in the Fraser Delta during the fall and winter. From October through April, it dives for mainly perch and

Table 2.3: Types of Waterfowl in the Fraser Delta Area.

Diving Waterfowl
1. Common Loon
2. Artic Loon
3. Horned Grebe
4. Western Grebe
5. Double-crested Cormorant
6. Greater Scaup
7. Bufflehead
8. Oldsquaw
9. White-winged Scoter
10. Common Scoter
11. Common Merganser
12. Common Murre
13. Rhinocerous Auklet

Surface Feeding Waterfowl (Dabblers)
1. Canada Goose
2. Snow Goose
3. Mallard
4. Pintail
5. American Widgeon
6. American Coot

Scavengers
1. Great Blue Heron
2. Glaucous-winged Gull
3. Heerman's Gull
4. Black Oystercatcher

Table 2.4: Preferred Habitat Categories for Avifauna in the Fraser Delta.

	1	2	3	4
Common Loon	X			
Arctic Loon	X			
Horned Grebe	X			
Western Grebe	X			
Double-crested Cormorant	X			
Bufflehead	X			
Greater Scaup	X			
Oldsquaw	X			
White-winged Scoter	X			
Common Scoter	X			
Common Merganser	X			
Common Murre	X			
Rhinocerous Auklet	X			
Canada Goose		X		
Snow Goose		X		
Mallard		X		
Pintail		X		
American Widgeon		X		
American Coot		X		
Great Blue Heron			X	
Glaucous-winged Gull			X	
Heerman's Gull			X	
Black Oystercatcher			X	
Bald Eagle				X
Northwestern Crow				X
Raven				X
Great-horned Owl				X
Ruffed Grouse				X
TOTAL	13	6	4	5

Habitat Categories

1. Littoral/Riverine: the open waters of the delta foreslope, including the bays, inlets, rivers and sloughs.

2. Sheltered Estuarine Water: the estuarine areas of the delta, including the marshlands, tidal flats, sand and mud flats, and bogs.

3. Strand/Littoral Interface: the beaches and adjacent littoral waters.

4. Mixed Woodlands: the forest edge and forests of the uplands.

Table 2.5: Seasonal Availability Categories of Avifauna in the Fraser Delta Area.

Category	Type	J F M A M J J A S O N D
1	Common Merganser	- - - - - - - - - - - -
	Canada Goose	- - - - - - - - - - - -
	Snow Goose	- - - - - - - - - - - -
	Glaucous-winged Gull	————————————
	Heerman's Gull	————————————
	Great Blue Heron	————————————
	Bald Eagle	- - - - - - - - - - - -
	Northwestern Crow	. . . . .
	Raven	- - - - - - - - - - - -
	Great-horned Owl	. . . . .
	Ruffed Grouse	- - - - - - - - - - - -
2	Common Scoter	——— . . . . . ———
	American Coot	——— . . . . . ———
	Western Grebe	——— . . . . ———
	Oldsquaw	- - - . . . . . - - -
	White-winged Scoter	——— . . . . . ———
	Common Loon	——— . . . . ———
	Horned Grebe	——— . . . . ———
	Mallard	===== ————— =====
	Pintail	===== . . . . . =====
	American Widgeon	——— . . . ———
3	Arctic Loon	——— ———
	Greater Scaup	——— - - - - - ———
4	Double-crested Cormorant	. ======= . . .
	Bufflehead	——— . . ———
5	Common Murre	. . - - - - - - - . .
	Rhinocerous Auklet	. . - - - - - - - . .
	Black Oystercatcher	. - - ——— - - - .

KEY: ==== Very Common ——— Common - - - Frequent . . . Rare

Seasonal Avalability

Year round	1.	Present year round in roughly equal abundance
Winter-Spring	2.	Present year round but less common in the summer months.
	3.	Not present (for varying lengths of time) in the summer months.
	4.	Only present in late fall to very early spring.
Spring/Fall	5.	Present year round but more abundant in the fall and spring.

herring. The arctic loon occasionally shares feeding grounds with the common loon, however, the arctic loon prefers offshore reefs and channels (Angell and Balcomb 1982:16).

The common loon arrives in September and remains through May. Although occasionally summering in the delta, too, the common loon is most abundant in the spring. It dives for flounder, herring, sculpin, perch, shrimp, and crab in both open and estuarine waters (Angell and Balcomb 1982:20).

A winter resident of the delta, the western grebe prefers bays and inlets in the delta area. It moves nearshore to mudflats, bays, estuaries, and shallow sloughs when feeding on herring, sculpin, perch, and smelt, as well as some shrimp and crab (Angell and Balcomb 1982:22).

As a September to May resident, the horned grebe dives for its food in open waters, sheltered bays and estuaries. It eats sculpins, sticklebacks, perch, and crustaceans (Angell and Balcomb 1982:20).

The double-crested cormorant nests on both salt and fresh water bays, as does the heron. As a year round resident, the double-crested cormorant predominately dives for its food that includes sculpin, perch, carp, and stickleback (Angell and Balcomb 1982:33-34).

The greater scaup's migration route along the eastern Pacific rim brings it to the Fraser Delta between October and March. Here, it builds nests on the ground and prefers deep saltwater bays and estuaries. The scaup diet is a mixture of plant and animal food including eelgrass and herring roe for which it dives (Guiguet 1972:55-56; Angell and Balcomb 1982:45).

Bufflehead is a small waterfowl that nests in hollowed trees or ground burrows. It winters in the Fraser Delta feeding upon primarily crustaceans, mussel, and remains of spawning salmon (Guiguet 1971:59-61).

Oldsquaw is a diving duck that summers in the subarctic tundra. It arrives in the Fraser Delta in October and departs in late March or early April. Oldsquaw's main delta prey are shellfish, crustaceans, and some fish for which it dives (Guiguet 1971:63).

The white-winged scoter migrates to the area in the winter and feeds in sheltered locations. Crabs, clams, mussels, and herring roe form a major part of its diet while in the delta (Angell and Balcomb 1982:48).

Variously referred to as the black or American scoter, the common scoter is a diving duck that prefers feeding near offshore coastal reefs during its winter migration to the area. It feeds on shellfish and crabs, favoring the blue mussel (Pough 1951:114).

Largely a fish-eating bird, the common merganser dwells in the delta throughout the year. Winter populations increase in size due to the migration of interior groups to the coast. The merganser primarily dives for its food that includes small fish, fish roe, and crustaceans (Guiguet 1971:77-79).

The common murre is a permanent resident along the coast. Preferring the open waters of bays and reef habitats, it dives for herring, smelt, and some bottomfish (Angell and Balcomb 1982:94).

The rhinoceros auklet is common in the delta during late spring, summer, and fall. It eats anchovy, herring, and smelt in a variety of habitats including bays, estuaries, and reefs (Angell and Balcomb 1982:96).

The Canada goose winters at the mouth of the Fraser River from October to April or May. It is a surface feeding bird that primarily eats marsh and marine plants of the Fraser's foreshore area (Guiguet 1978a:15). Although there always seem to be non-breeding populations in the area, snow geese winter in the Fraser Delta from October into April (Angell and Balcomb 1982:39). There principal food resources aggregate in the saltmarsh, especially in the eelgrass community.

The mallard is a surface feeding duck that dwells in the delta throughout the year, although summer populations

are smaller that those of the winter. It prefers protected habitats such as lakes and ponds where it primarily eats aquatic plants (Campbell et. al 1972:144).

As a surface feeding bird, the pintail eats mainly aquatic plants. It frequents the Fraser Delta's protected bays, mudflats, and beaches on its way to and from winter and summer residences, from January through April and August through October (Guiguet 1971:34).

The American widgeon summers in the B.C. interior and spends the fall and winter on the coast. Being a surface feeder, the American widgeon mainly eats vegetal matter, including pond weeds, grasses, and sedges. While in the delta, it frequently feeds on marine algae, eelgrass and occasionally shellfish (Guiguet 1971:143-144).

The American coot is a winter migrant to the delta that prefers gathering in estuaries and mudflats to feed on aquatic plants (Angell and Balcomb 1982:60).

The great blue heron is a year round resident of the delta. The heron is "commonly seen fishing in tidal pools and along the shallow tidal margins" (Ham 1982:32). Hoos and Packman (1974:66) report the heron nests in densely wooded areas adjacent to Crescent Beach and Beach Grove. It feeds on perch, sculpin, starry flounder, and scavenges fish stranded on the beach after low tide (Angell and Balcomb 1982:33).

The glaucous-winged gull is a permanent resident of the delta and surrounding uplands. Minnows, herrings and crabs are its major food resources, as well as snatching the prey of diving birds such as cormorants, grebes and murres (Guiguet 1978b:6-8).

Heerman's gull frequents the delta in the spring and summer. It largely feeds on schools of herring and is sympatric with salmon and diving birds that feed on the herring (Guiguet 1978b:24-25).

An uncommon year round resident of the area is the black oystercatcher. It prefers rocky shore habitats and eats primarily mussels, chitons, and limpets from intertidal areas.

The bald eagle is permanent resident which eats fresh and carrion animals. It frequents the air currents of the uplands from where it spies prospective prey (Guiguet 1978d, Angell and Balcomb 1982:54-55).

Additional year round residents of the area are the raven and the northwestern crow. Both frequent the uplands but scavenge the beaches and shores for a variety of plant and animal resources (Guiguet 1978c, Angell and Balcomb 1982:102).

Great horned owl is a migrant fall and winter resident of the delta's timbered areas. Small mammals such as Peromyscus and squirrel make up a good part of its diet

(Jewett 1953:350-351).

Ruffed grouse is available year round in the upland areas. It feeds primarily on mixed and deciduous growth (Guiguet 1971:14-15).

Due to the temperate climate of the Fraser Delta, many non-breeding waterfowl remain in the study area throughout the year (i.e., they do not migrate with the breeding flocks). Table 2.5 takes this into consideration by noting when the largest concentration of species reside in the delta. Thus, seasonality categories of avifauna are based on when the largest groups are most likely to occur in the study area and not solely based on the presence or absence of specific species of birds.

Ethnographic bird procurement strategies and utilization are reported by Suttles (1951) and Barnett (1955). Waterfowl were taken in a variety of ways. Diving birds were obtained by submerged nets with anchors and hand netted from canoes (Suttles 1951:72-74,78). The Samish, Lummi, and Saanich also speared sleeping ducks at night, using controlled fires in canoes to frighten sleeping ducks (Suttles 1951:75, Barnett 1955:95-96). Snares and rock throwing were not common (Suttles 1951:93). Bows and arrows occasionally used in the hunting of upland avifauna (Suttles 1951:81). The abundance of ducks and duck hunting in the winter resulted in down being given as gifts (Suttles

1951:80).

Ham (1982:261) hypothesizes that the ethnographic technologies of bird procurement may be represented in archaeological faunal assemblages by two patterns in the data: (1) a high frequency of diving waterfowl indicates the use of submerged nets, and (2) a roughly equal frequency of diving and surface feeding waterfowl indicates the use of raised pole nets.

Fish

Twenty-eight fish species are found within the Fraser Delta and are identified in the three Locarno Beach assemblages. Appendix, Table A.3 lists their common and taxonomic names. Despite some vertical fluctuations, these fauna are grouped into three preferred habitat categories (Table 2.6): Littoral Water (1); Tidal Flats (2); and Riverine (3).

Four species change their preferred or optimal habitat location within the Fraser Delta area at different times of the year: (1) plainfin midshipman, (2) salmon, (3) sturgeon, and (4) trout. Four species—anchovy, eulachon, pacific herring and minnow—are within the study area for short periods to spawn. With these exceptions, most of the fish are in the region throughout the year in roughly equal abundance. Table 2.7 describes the seasonal availability

Table 2.6: Preferred Habitat Categories for Fish in the Fraser Delta Area.

Species	Category 1	2	3
Spiny Dogfish	X(F)		
Ratfish	X		
Northern Anchovy	X(S)		
Pacific Hake	X(W)		
Petrale Sole	X		
Pacific Halibut	X		
English Sole	X(W)		
Rockfish	X		
Lingcod	X(SP)		
Pacific Cod	X(SP)		
Walleye Pollack	X(W, SP)		
Big Skate	X		
Plainfin Midshipman	X(W)	X(SP)	
Pile Perch		X	
Great Sculpin		X(W)	
Buffalo Sculpin		X(W)	
Staghorn Sculpin		X(W)	
Sculpin		X(W)	
Rock Sole		X(W)	
Starry Flounder		X(W)	
Flatfish		X(W)	
Pacific Herring		X(W)	
Surf Smelt		X(SP)	
Salmon		X(S)	X(F)
Sturgeon		X(W)	X(SP)
Steelhead Trout		X(S)	X(W)
Eulachon			X(SP)
Minnow			X(SP)
TOTAL	13	14	5

KEY: (W) = Winter; (SP) = Spring; (S) = Summer; (F) = Fall

Habitat Categories

1. Littoral Water: the littoral waters of bays, inlets, and the mouth of the Fraser River, extending from low tide to offshore waters that have fine sandy and sandy to clayey silt.

2. Tidal Flats: the estuarine mud and intertidal flats of fine to medium grain sand and mud including the saltmarshes and bogs.

3. Riverine: the river floodplains and freshwater-brackish areas, including sloughs.

Table 2.7: Seasonal Availability for Fish in the Fraser Delta Area.

Category	Type	Season J F M A M J J A S O N D
1	Ratfish	————————————
	Rockfish	————————————
	Lingcod	- - - - - - - - - - - -
	Big Skate	————————————
	Sculpin	————————————
	Rock Sole	————————————
	Minnow	- - - - - - - - - - - -
	Sturgeon	- - - - - - - - - - - -
2	Staghorn Sculpin	==== ————————
	Dogfish	==== ————————
	Pacific Hake	==== ————————
	Walleye Pollack	==== ————————
	Pacific Cod	==== ————————
	Starry Flounder	==== ————————
	Flatfish	==== ————————
	Stickleback	. ====== .
3	Petrale Sole	———
	Pacific Halibut	———
	English Sole	———
	Eulachon	===== - - .
	Surf Smelt	=====
4	Northern Anchovy	- - - - - ——— - - - -
5	Trout	. . . . .======= . . .
6	Salmon	. . . . . .-=======-. .
7	Pacific Herring	———
	Plainfin Midshipman	——— - - - -
	Pile Perch	——— ———
	Great Sculpin	- - - -
	Buffalo Sculpin	- - - -

KEY: ==== Very Common ——— Common - - - Frequent . . . Rare

Seasonal Availability Categories

Year Round	1. Present year round in roughly equal abundance.
Spring/Early Summer	2. Present year round but more abundant in the spring and early summer.
	3. Only present in the spring and early summer.
Summer	4. Present year round but more common in the summer months.
	5. Only present in the summer.
Late Winter-Early Spring	6. Present year round but more common in the summer through early fall.
	7. Only present from winter to very early spring.

categories for fish.

The following is a summary of the natural history for the twenty-eight species of fish that are found in the delta.

The spiny dogfish is a shark (cartilagenous) that prefers the deep offshore waters of the delta's foreslope. It moves to the mouth of the Fraser River to prey on concentrations of eulachon in the summer and herring fry in the autumn (Hart 1973:45-46).

Another deep offshore water dweller and cartilagenous fish is the ratfish. Its food consists of crab, mussel, and other shellfish for which it will migrate to the inshore waters at night (Carl 1971:19-20).

The northern anchovy is the only anchovy that lives in the delta's waters. It prefers to spawn in the deep saltwater of inlets or off the coast (Hart 1973:103).

As a deep offshore dweller, the pacific hake eats anchovy, smelt, and herring. It is a nocturnal feeder (Hart 1973:226).

The petrale sole is common in offshore waters during the winter and moves closer to shore in the summer. They prey on a variety of resources depending on their abundance, including herring, shrimp, and bottom fishes, as well as some crustaceans (Hart 1973:608).

Feeding on fish, crab, clam, and crustaceans, the Pacific halibut is a bottom dweller preferring the deep offshore water of the delta (Hart 1973:615). Suttles (1951:114-115) reports that halibut was sought during the late spring and early summer when salmon was trolled and that the Semiahmoo, Samish, and Saanich used baited hook and line to catch halibut.

English sole frequents the intertidal zone early in its life cycle during the summer. It gradually moves to deeper waters as it matures (Hart 1973:629). This sole eats clams, small molluscs, marine worms, and shrimp (Hart 1973:630).

Rockfish are found in a variety of habitats from the intertidal zone to deep offshore waters. It prefers littoral water habitation and eats small fish such as anchovy and young hake (Hart 1973:421).

Lingcod spawn in shallow water from December to March. It is a common bottom fish that feeds on herring, flounder, hake, walleye pollack, cod, and rockfish. It can grow to five feet in length (Hart 1973:468-469). Strait Salish used lures and spears to obtain lingcod (Suttles 1951:124-125).

The Pacific cod is a large fish that is found in the delta area throughout the year. It frequents deep water during the fall and winter, then moving to shallow inshore waters to spawn in the spring (Carl 1971:39-40).

A common bottom dwelling fish in the deep rocky waters off the delta is the walleye pollack. It eats a variety of fish including herring, shrimp, and sand lance.

Dwelling at moderate depths, the big skate is a cartilagenous fish that eats crustaceans, and great sculpins (Hart 1973:57).

The plainfin midshipman spawns in the spring in shallow water or in the intertidal zone. Often "singing" and occasionally irredescent at night, the midshipman feeds on herring, herring roe, and crustaceans in Boundary Bay (personal communication, Ham July 1981).

The pile perch and three species of sculpin frequent the shallow inshore waters of the delta. The pile perch's pharyngeal teeth are large and adapted to crushing mollusc shells (Hart 1973:312). Similarly, sculpins have also developed large pharyngeal teeth to eat molluscs and crustaceans. The pile perch and sculpins are prey to waterfowl (Hart 1973:518, 499, 521).

Both the rock sole and starry flounder spawn in shallow water from February through April. They prefer low salinity waters with varied to soft bottoms, respectively (Hart 1973:622, 632). Food includes crab, small fish, and the roe of small fish. One of the favorite foods of the rock sole and starry flounder is herring roe (Carl 1971:43-44).

The pacific herring are seasonally present in the delta when they spawn from February through April. It prefers intertidal zones with rocky bottoms. Herring roe frequently adhere to intertidal grasses where it is the prey of flounder, waterfowl, and small mammals (Hart 1973:97-99). Straits Salish procured herring with a rake, "made of hemlock or white fir limbs or possibly of bone" (Suttles 1951:126).

The surf smelt is a small fish related to the eulachon. Both spawn in the spring and early summer, although smelt spawn in the intertidal areas off the sheltered bays, and eulachon spawn in the Fraser and its major streams. Eulachon concentrations during the spawning season attract many predatory fish, including dogfish, sturgeon, halibut, pacific cod, as well as gulls and sea lions (Hart 1973:148-150). Procurement technologies for these species varied from herring rakes to netting and scooping by Lummi, Samish, and Semiahmoo groups (Suttles 1951:128). Surf smelt were obtained by Musqueam and Squamish at Spanish Banks and Locarno Beach (Matthews 1955:395).

Five varieties of salmon frequent the Fraser watershed during the spring, summer, and fall. Their ascent of the river begins in June and can continue as late as December. The order of ascent is chinook, sockeye and pink, coho, and chum. Strait Salish used toggling harpoons to procure

individual chinook at the mouth of the Fraser River early in the year (March-April) (Berringer 1982:172). Sockeye and pinks were trawled along the mudflats and lower reaches of the Fraser later in the summer (August to September) (Hill-Tout 1907:90). Here, the Indians could take advantage of the sand bars and shoals that restrict the area through which the salmon runs would pass (Berringer 1982:53).

Reef netting was used by Strait Salish to intercept the Fraser-bound sockeye and pinks at saltwater approaches of Point Roberts (Berringer 1982:129). Suttles (1951:175) also observed reef netting at over 15 Point Roberts localities. Gill nets were used by Salish along sheltered shores and coves where runs were heavy or where salmon come inshore to feed on herring (Berringer 1982:60).

Chum and coho salmon have a similar life history in the Fraser Delta area. Both species enter the area to spawn in the late summer and early fall (Ham 1982:25-26). At the turn of the century, chum and coho salmon were gaffed by Indians in streams near Jericho and Locarno Beaches.

Sturgeon is a large anadromous fish that enters freshwater to spawn in the spring and early summer (Hart 1973:83). Sturgeon was harpooned and netted along the Fraser River as it sought spawning eulachon and salmon during the spring and summer (Suttles 1952:16-17).

The minnow generally spawns in freshwater in June and July. It feeds on aquatic plants and occasionally swims in brackish water (Hart 1973:203-205).

Like the salmon, steelhead trout is an anadromous fish that frequents freshwater to spawn, but spends most of its life in deep salt waters (Hart 1973:128-129). It eats small fish and crustaceans.

Site Reconstructions

The previous sections presented a literature review of the physical environment and fauna in the Fraser Delta area. This information can be used to suggest possible environment reconstructions for each site in the sample during the Locarno Beach culture.

Locarno Beach Site (DhRt 6)

This site is located on the north shore of the Burrard Peninsula. During the time of the Locarno Beach culture, the Point Grey Uplands probably protruded farther west into the Gulf than today (Clague et. al 1983:1324). Years of wave action, winds, and water drainage from storms have led to the erosion of the headlands to its present topography. As today, the current from the Fraser River may have carried silts from freshets and decomposing hills to English Bay's

southern shore during Locarno Beach times.

Today, two streams flow near DhRt 6. One empties into the developing Spanish Bank, west of the site; the other empties at Jericho Beach, east of the site. The latter stream was canoe-able in the 1940's and may have been a larger stream or slough in the past (Harris 1978:5). Due to silt transportation and sedimentation, the Jericho Beach area may have been a salt marsh estuary during the Locarno Beach culture.

In historic times, DhRt 6 was called "EYALMO" and "KO-KOH-PAI" by Musqueam Indians (Matthews 1955:395). In interviews with J.S. Matthews, Khahtsahlano Indians referred to DhRt 6 as "a good camping ground," a bay nicknamed "crabtree," and a place for catching smelts (Matthews 1955:395). Today, wild crabapples along N.W. Marine Drive ripen during July and August, and smelts are handnetted and dip-netted at Spanish Banks by non-Native Americans from May to late July. Since the climate has remained unchanged, these conditions may have existed in prehistoric times.

Whalen Farm Site (DfRs 3)

This site is located on the Point Roberts Peninsula, a long, narrow north-south trending strip of land. During the period of the Locarno Beach culture, the Whalen Farm site was probably located on the eastern shore of a small island.

It is probable that DfRs 3 was protected from northwesterly and westerly winds by the Roberts headland. Hebda (1977:188) suggests that salt marshes and an estuary were developed in the Fraser Delta to the north and northeast of the site by 4000 B.P. These would have attracted a large number of migratory waterfowl, spawning fish, molluscs, and crustaceans. Evidence from Burns Bog suggests that the marsh may have prevented spawning salmon from entering the Fraser River from Boundary Bay (Hebda 1977:170, 172) by 5000 B.P., although Ham (1982:260) believes that between 5000 B.P. and 2500 B.P. the bay was connected to the Fraser on some occasions. The Serpentine and Nicomekl Rivers across the bay and near the Crescent Beach site (DgRr 1) may have been access routes to the adjacent river valleys (Ham 1982:260), as well as riparian resources.

The eastern shore of Roberts Island changed dimensions with the changing cycle of tides and currents. Streams from the uplands may have been present and emptied into the eastern shoreline, perhaps near DfRs 3 or DgRs 1 (Beach

Grove site), although there are no geological reports to substantiate this.

Musqueam NE (DhRt 4)

Ham (1973:3) suggests that the slope of the Musqueam area during the Locarno Beach culture times varied from a flat floodplain south of the site to near vertical cliffs along the western border of the Burrard Peninsula. The site rested on flat alluvial deposits.

Relying on evidence from Lulu Island and Burns Bogs (Clague et. al 1983:1325), it is probable that the sand bar and North Arm of the Fraser River were developed by 5000 B.P.

Surrounding vegetation probably included forests in the uplands; intertidal species on tidal flats and shoals in the delta across from the site to the south; and a riparian environment to the east along the North Arm (Ham 1973:4-5). The nature and extent of freshwater-brackish or saltmarshes in the area can not be determined at this time. The Iona Sand Bar and Lulu Island probably maintained grasslands that attracted deer and elk (Ham 1973).

The present-day Musqueam Creek could have been a slough located west of the site.

Summary

The results of the present review of Fraser Delta paleoecological and faunal studies have a number of implications for archaeological research in the study area during the period of the Locarno Beach culture (3300-2400 B.P.). As usual, there are more questions than answers.

1. Paleoecological research by Hebda (1977:170,172), Clague et. al (1983:1320), and North and Teversham (n.d.) strongly suggest that plant types present in the Fraser Delta have not changed for about 7000 years. However, the location of specific plant communities has changed with respect to the delta's westward progradation. Until more evidence is available, the actual location of the Fraser Estuary's freshwater-brackish marshes and saltmarshes during the Locarno Beach culture cannot be determined. This situation has major implications for locating where in the delta particular migratory waterfowl and fish would have aggregated.

2. Archaeological evidence from the Glenrose Cannery site (DgRs 6) suggests that mammals, birds, and fish of the Fraser Delta have not changed in 5000 to 7000 years (Matson 1976a, Ham 1976, Imamoto 1976). This hypothesis is in agreement with evidence from other archaeological sites in the Gulf of Georgia region for the St. Mungo (4300-3300 B.P.) and Marpole (2400-1200 B.P.) cultures (King 1950,

Carlson 1954, 1960, 1970, Calvert 1970, Boehm 1973a, Mitchell 1971ab, 1979). This suggests that fauna present during the Locarno Beach culture should be part of the same continuum observed in archaeological evidence for the St. Mungo and Marpole cultures.

3. The ability to reconstruct geological, palynological, and hydrological events at three Locarno Beach culture localities is impeded by lack of research. Although more studies are necessary, recent land development (i.e. water and power lines for housing) at each locality complicates extracting undisturbed samples for analysis. To locate undisturbed deposits, researchers should consult City of Vancouver Department of Engineering maps for the exact location of gas and water pipes.

4. Although recent work has clarified the types of delta formation processes in the Fraser River system (Hebda 1977, Clague et. al 1983), there is no model of how and when areas of the Fraser Delta formed. Palynological evidence from Burns Bog suggests that Boundary Bay was either cut off from the Fraser River by 5000 B.P. (Hebda 1977:170) or that only the eastern portion of Boundary Bay was not influenced by freshwater after 5000 B.P. (Clague et. al 1983:1325). In contrast, archaeological evidence from Crescent Beach (Ham 1982:17-18) and Beach Grove (Ball 1979) indicates that freshwater continued to flow into Boundary Bay until 2500

B.P. Evidence for the development of Boundary Bay directly affects any discussion about the development of the Fraser Estuary's freshwater-brackish marshes and saltmarshes and, in turn, where and when particular animal communities aggregated for people to procure during Locarno Beach culture times. Until a model is developed and tested, it is assumed in this thesis that the Fraser River may have flowed into Boundary Bay between 5000 B.P. and 2500 B.P. However, because of its southern location, freshwater from the Fraser River probably did not influence the environment of DfRs 3.

5. What are the similarities and differences of each Locarno Beach culture locality under investigation here? DhRt 6 is located on the shore of a large saltwater bay. DfRs 3 is also situated in a saline bay-like environment. It is possible that Spanish Banks, Jericho Beach, and the Burrard Uplands near DhRt 6 provided an ecological setting that was very similar to the DfRs 3 locality (Ham 1982:357), which may have had counterparts at Beach Grove, Crescent Beach, and the Roberts Uplands. But, the DhRt 4 locality may have been gulf front property. An analysis of faunal remains from each site's Locarno Beach culture component may have important implications on the extent of delta progradation in the Musqueam area.

Chapter 3

THE SAMPLE: BORDEN'S ARCHAEOLOGY OF THE LOCARNO BEACH CULTURE

Introduction

This chapter reviews C.E. Borden's investigations of the three sites analysed in order to determine the provenience of the Locarno component at each site. These sites, DhRt 6, DhRt 4, and DfRs 3, are described in terms of: (1) location in the study area, (2) Borden's excavation methodology, (3) available stratigraphic information, and (4) the extent of cultural zones defined and described by Borden. The sampling of archaeological data from these records and available material stored at the U.B.C. Laboratory of Archaeology is described. Sampled provenience units are verified as Locarno Beach units by the correlation of artifact distributions with Mitchell's (1971b:52-53, 57) "diagnostic archaeological features" of Marpole and Locarno Beach culture types and Calvert's (1970:74) work for the St. Mungo culture.

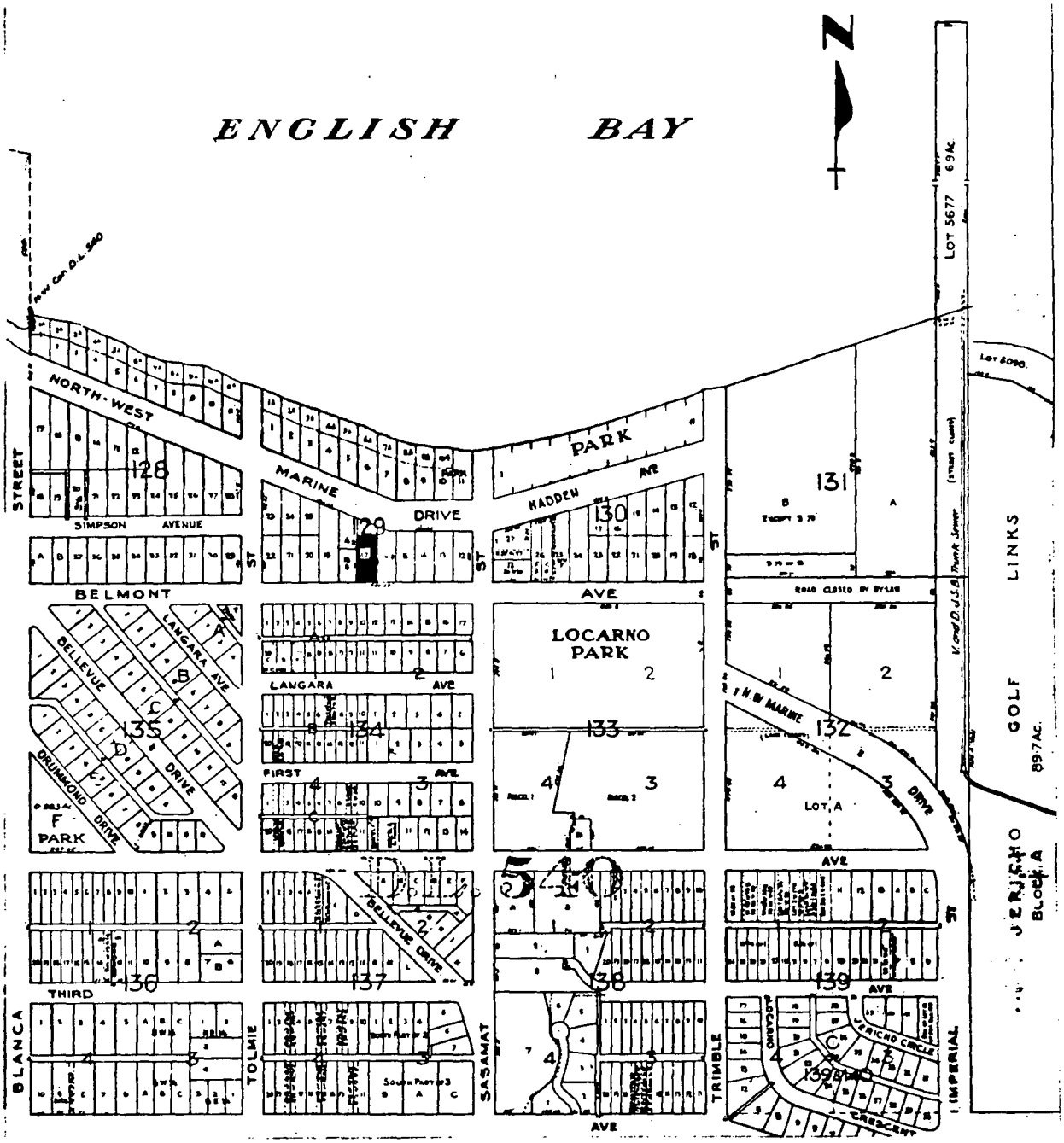
Locarno Beach Site, DhRt 6

Location

DhRt 6 is the type site for the Locarno Beach culture (Borden 1970:97). It is located between Tolmie and Sasamat Streets on the north shore of the Burrard Peninsula (Figure 3.1). Ham (1979:4) reports that the excavation was located on city lot 17, block 129 of city chart 159. Situated east of Point Grey and Spanish Banks and west of Jericho Beach, DhRt 6 extends to the beach and is bordered by streams. One stream originates in the uplands and empties into English Bay near Spanish Banks Beach, while the other flows through the relatively flat area of Jericho Beach. The source of the latter stream was a lake between McDonald and Alma Streets prior to the laying of drainage pipes in 1920 (Harris 1978; personal communication, Kew, February 1982).

To salvage an undisturbed section of the large shell midden that was to be destroyed and replaced by a residential development, Borden excavated at DhRt 6 from January 6 to June 21, 1948. He was assisted by University of British Columbia English professor P. A. Akrigg. The two trenches that constitute the 1948 excavation at DhRt 6 were situated perpendicular to the English Bay shoreline. This orientation produced a long cross- section through the midden.

Figure 3.1: Location of Locarno Beach site, DhRt 6, (shaded area) according to Ham (1979:3) and Borden (1948).



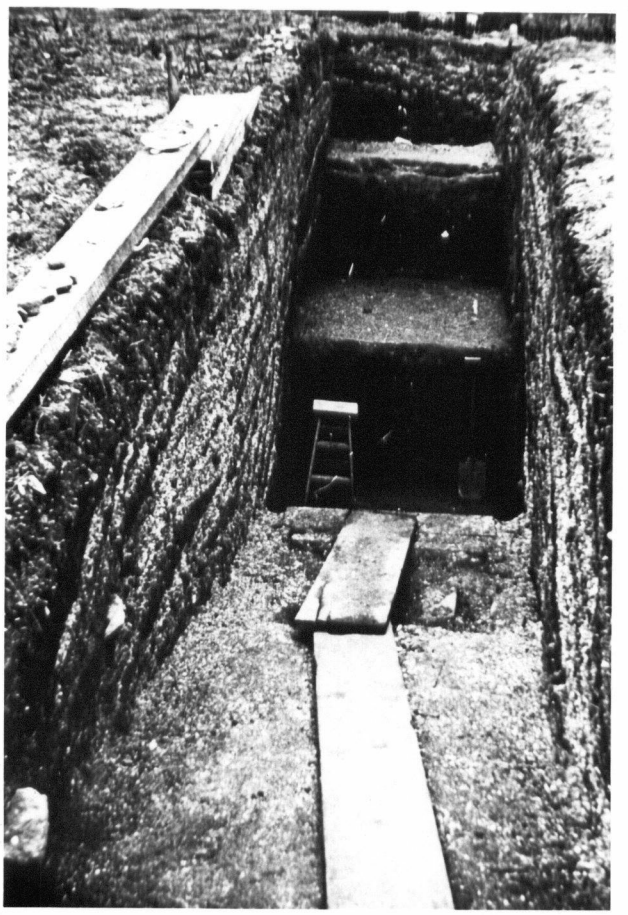
Excavation Methodology

Two trenches were excavated. Trench 1 was principally excavated by Borden with some assistance from Akrigg. Borden's fieldnotes for Trench 1 summarized daily procedures and described some details of stratigraphy. Akrigg either did not record the details of what was encountered during the excavation of Trench 4 or the records have been lost.

Both Trench 1 and Trench 4 were staked-out in 5' x 5' intervals from a fixed datum located on the northeast corner of city lot 18. With a north to south orientation, Trench 1 extended 40 feet in length from N40'-80' and E15'-20'. However, during the course of excavation, winter and spring rainfall and snow frequently eroded deposits of midden and caused sidewalls to collapse in Trench 1. Thus, at the conclusion of the excavation, the dimensions of Trench 1 were N40'-50' and E15'-20', N50'-76' and E13'-22', and N76'-80' and E15'-20'. Trench 4 was also oriented in a north to south direction and extended 25 feet in length from N35'-60.5' and E30'-35' (Figure 3.2)

Neither excavator employed a standardized vertical unit of excavation. Rather, a unit of excavation was determined by the progress of one day. The dimensions of each vertical unit varied inconsistently for the convenience of wheelbarrow mobility in removing excavated matrix from the trenches (Borden 1948: February 3 entry in fieldnotes).

Figure 3.2: View of Trench 1 at DhRt 6, Looking north, both the wheelbarrow ramp (foreground) and the principal tool for excavating, a shovel, can be seen.



However, one 10 foot horizontal section of Trench 1 at N50'-60' was maintained throughout the excavation. Depth of the excavation varied between 8 and 12 feet.

The photographic record indicates that shovels were the principal tool used for removing matrix (Figure 3.2). Fieldnotes report the use of trowels only for straightening sidewalls prior to drawing trench wall profiles of stratigraphy. Matrix was screened, although the mesh size is not reported. In this study it is assumed that 1/4" mesh or larger was used to screen matrix.

Thomas (1969) reports different sizes of mesh affect the retrieval of small faunal remains. Thus, the size of the mesh employed at DhRt 6 is one variable that may have influenced the recovery rate of small faunal remains such as smelt, eulachon, anchovy, and herring vertebrae or fish otoliths.

Both the provenience (by three-dimensional location measurements) and stratigraphic context of each artifact are recorded for Trench 1 material. The equivalent information is not available for Trench 4, thus reducing the potential research value of the Trench 4 collection in this study.

The excavators paid little attention to recording the location of faunal remains. While Borden recorded stratigraphic changes in shell matrix composition, the archaeological context of all faunal remains can only be

reduced to the provenience listed on each level bag or bone material bag found in archaeological storage at the U.B.C. Museum of Anthropology.

Stratigraphy

A stratigraphic profile was drawn for the west face of Trench 1. Figure 3.3 is the N50'-60' section of this profile.

The method of recording wall stratigraphy was a "stratasquare." This instrument was suspended from the surface of the trench and juxtaposed against the sidewall of the trench. It acted as a reference from which stratigraphic layers were drawn for Trench 1.

From the examination of the Trench 1 profile during the excavation, Borden (1950a) originally separated midden deposits into two stratigraphic units. These, the lower and upper horizons, were distinguished by Borden on the basis of the relative thickness of the shell lensing and the degree of disintegration of shell remains.

> "In the lower horizon, the culture bearing strata are thin and alternate with thick layers of discolored beach sand. In the upper horizon, the shell strata are thick. Numerous dark sandy strata containing heavy concentrations of fish and other organic remains also occur here. A considerable time lapse between the two occupation periods is suggested by the fact that in the lower deposits, the shell remains have been reduced to a fine powder, whereas in the upper

Figure 3.3: West face wall profile, Trench 1 at DhRt 6.

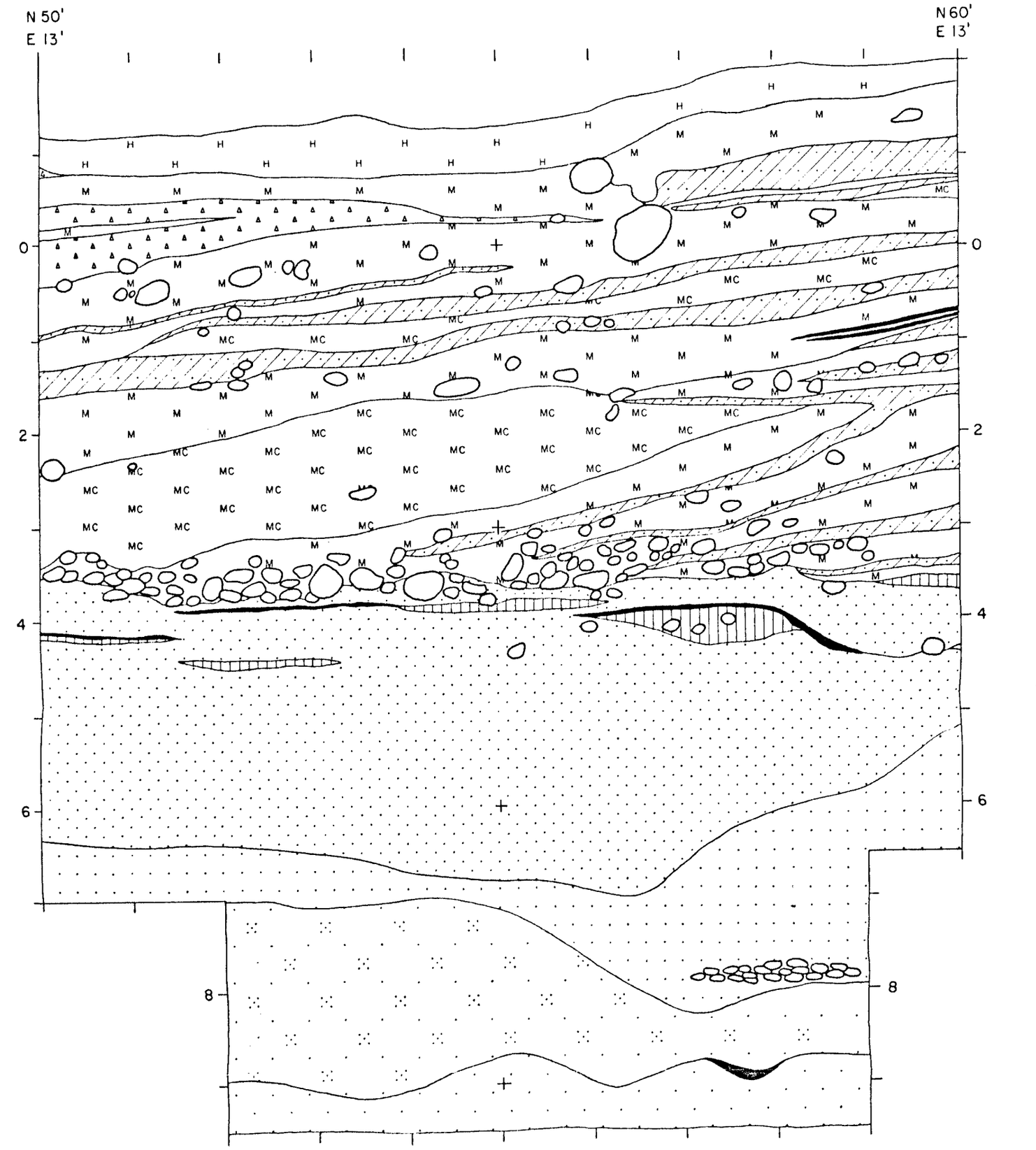

N 50'
E 13'
N 60'
E 13'
0
2
4
6
8
HUMUS
MUSSEL SHELL
SAND & ORGANIC MATTER
MUSSEL SHELL & CHARCOAL
YELLOW ASH
LOAM & GRAVEL
CHARCOAL
ROCK
BLACK SAND, CHARCOAL, ASH, & MINUTE SHELL FRAGS
DARK SAND
MOTTLED SAND
CLEAN SAND

Figure 3.3

> horizon, disintegrated shell, while advanced, has not proceeded that far" (Borden 1950a:15).

The boundary between these units was not described, nor was it noted on the wall profile.

In a later publication, stratigraphy at DhRt 6 is not discussed (Borden 1970), giving the impression that Borden re-thought his position about the presence of two distinct stratigraphic units.

Cultural Zones

Two cultural zones were originally distinguished by Borden (1950a). These were defined by artifactual and stratigraphic evidence. (Radio-carbon dating was not performed on DhRt 6 samples until the mid-1950's.) However, Borden (1950a) did not state if artifactual and stratigraphic changes coincided.

Borden re-thought the two-zone scheme as early as 1962. In a letter to Fredrica de Laguna, Borden (1962:2) commented:

> "Rightly or wrongly, the others [all sites but Whalen Farm in Borden (1950a)], have been treated as single component sites, although I am aware that the case could be made for the division of Locarno Beach into two components (as I did in 1950). Some traits like labrets, small adzes, medium size wedges are limited to Locarno Beach I (the lower horizon) and completely absent from Locarno Beach II (the upper horizon), even though we have a large sample of the latter. Other traits like facetted ground slate points and

> heavy slate knives link the 2 horizons. If we had a larger sample of both horizons, the present differences might tend to disappear" (Borden 11/26/62 in response to de Laguna 10/26/62) [author's addition].

After the publication of Borden's preliminary evaluation of DhRt 6 (1950a, 1951) and the development of radiocarbon dating in archaeology, Borden sent at least two samples of DhRt 6 archaeological remains to the Sasketchewan dating lab in the mid-1950's. Composition of the radiocarbon dated material is unknown. The two radiocarbon dates published for DhRt 6 (Borden 1970:76) are:

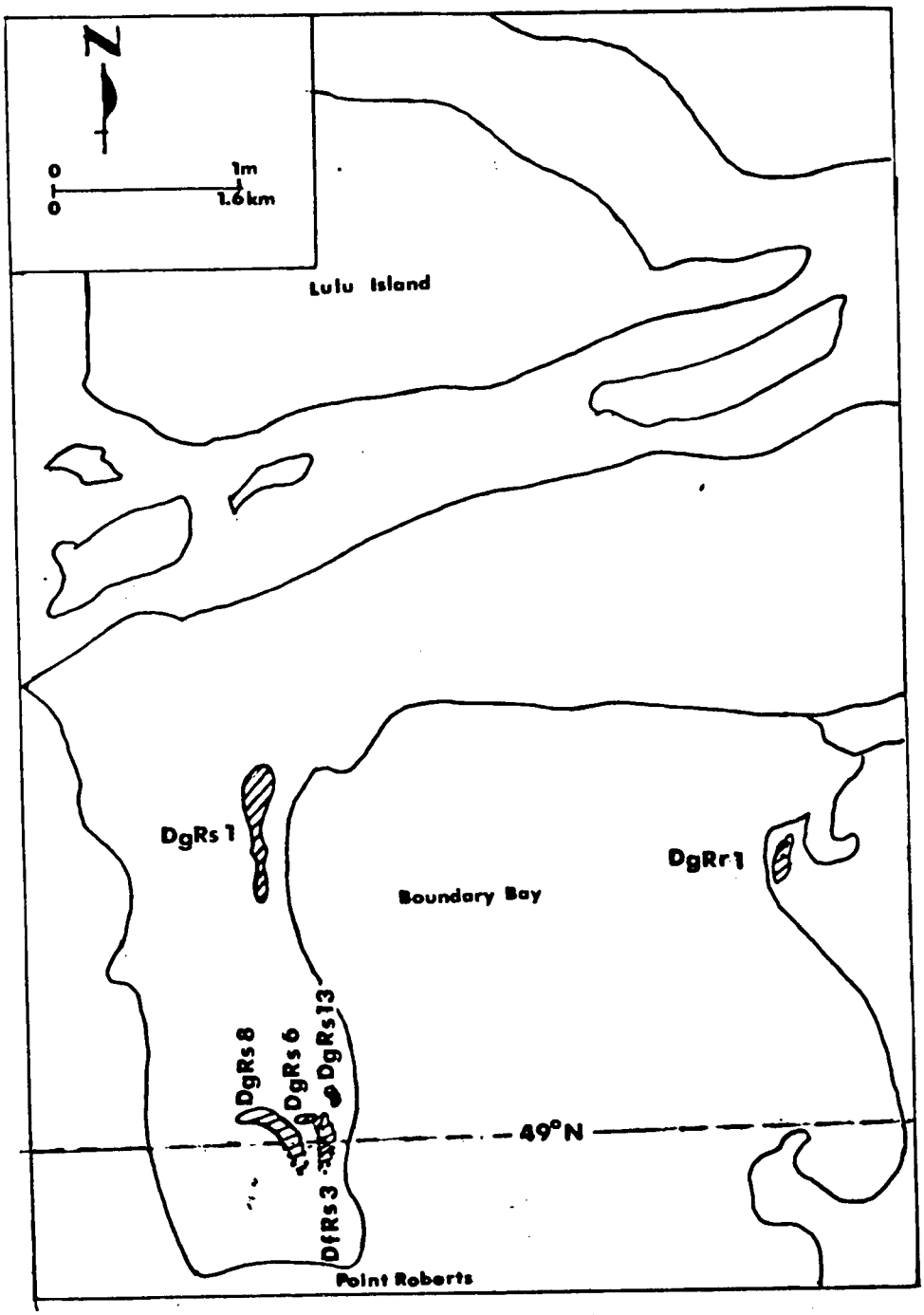
> 2270 ± 100 years B.P. or 320 B.C. (I-7791)
> 2450 ± 100 years B.P. or 500 B.C. (I-7790)

Whalen Farm Site, DfRs 3

Location

DfRs 3 is a shell midden site located at the southwest corner of the Fraser Delta area, on the western shore of Boundary Bay (Figure 3.4). Similar to DhRt 6, DfRs 3 is situated on the knoll of an ancient lagoon spit that is protected from winds by the Point Roberts Upland, just southwest of the site (Kenny 1975). Borden (1949) observed several archaeological shell middens within walking distance to DfRs 3. Although the location of these middens was not described, it is probable that Borden located sites now

Figure 3.4: Location of the Whalen Farm Site, DfRs 3, and Other Boundary Bay sites.



designated DgRs 8, 16, and 13. The Beach Grove site (DgRs 1), a large Marpole culture village site (Matson et. al 1981) with some Locarno affinities at the north end of the site (Ball 1979), is also located in the same vicinity, suggesting that the western shore of Boundary Bay was densely populated in the past. Another nearby site is Crescent Beach site (DgRr 1), a multicomponent site with a 3000 year chronology located on the eastern shore of Boundary Bay near the Nicomekl and Serpentine Rivers. At the Whalen Farm site, a single trench was situated perpendicular to the Boundary Bay shoreline for the 1949-1950 excavation (Figure 3.5). This orientation produced a long cross section through the midden, similar to that at DhRt 6 (Figure 3.6). The distance between DfRs 3 and the present-day shoreline could not be determined from the records.

Excavation Methodology

As part of a joint field school between the University of Washington and U.B.C., Borden directed a 5 student salvage crew on Michael Whalen's property in Boundary Bay, Washington in 1949 and 1950. The same methods of excavation were employed during both field seasons.

Unlike DhRt 6, Borden (1950b) described procedures involved in determining site location and in excavating the

Figure 3.5: Whalen Farm, DfRs 3 Boundary Bay, Wash. 1949 (after Archaeology Lab Map, U.B.C.).

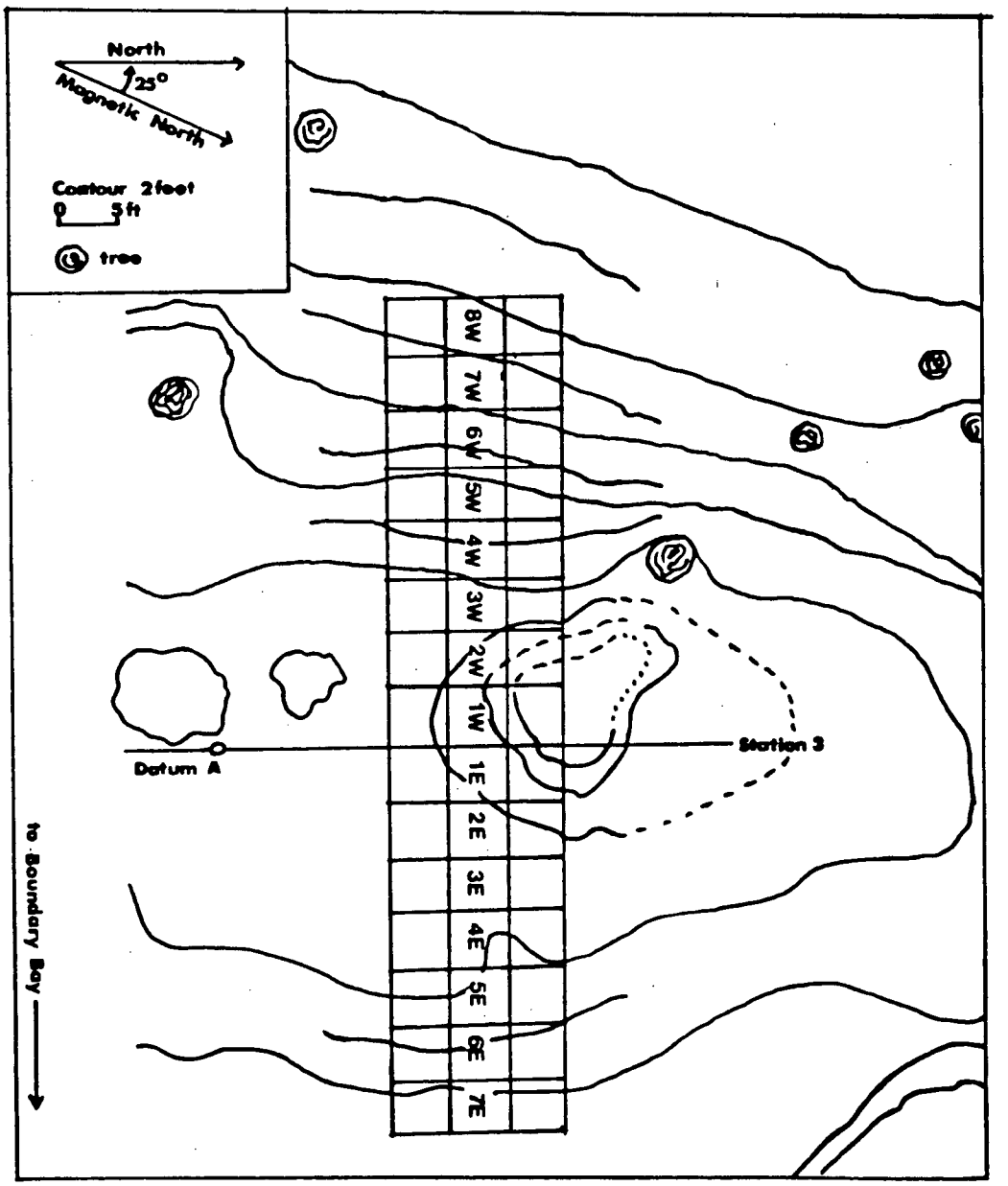


Figure 3.6: View West to East of Large Midden at Whalen Farm Site (DfRs 3).

95 foot trench at DfRs 3.

> "...Before the excavation proper began, the students were busy with alidad, plane-table, and stadia rod, surveying, fixing datum points and bench marks, and preparing contour maps of the site. There upon, the area was staked-out and its location recorded on the contour map. In excavating, only small implements were used—pointed mason trowels and dirt pans, and even finer work, grapefruit knives, spoons, dentist's tools, whisk brooms, and soft hair brushes. Shovels came into play during clean-up operations. All excavated material was screened and closely scrutinized. Every find, upon discovery, immediately received an identification number and its location measured three-dimensionally with reference to datum point and bench mark... Associated material, such as food remains, detritus of manufacture, charcoal, samples of ash, and other midden material from various strata were collected in special bags and its origin recorded. After the excavation of every four foot level was completed, scale drawings of stratification as it appeared on the trench faces were made on graph paper. In addition, to copious fieldnotes, nearly 350 photographs were taken of work in progress of special features, and so forth. In this fashion, a trench of 80 feet long, five feet wide and 12 feet deep was excavated during nine weeks of the field trip" (Borden 1950b:242).

> "Using station 3 as datum point and bench mark, the Whalen Farm crew staked out 19 adjacent 5' x 5' units. Twelve units were west of the line running north through station 3 and 7 units were east of the line (Figure 3.5; Borden 1949, June 22 entry in fieldnotes).

Although a 95 foot trench was staked-out in 19 5' x 5' units only an 80 foot trench was excavated from W60' to E35'. Most of Trench 1 was completed during the first field season

in 1949.

Excavation units of 5' x 5' x 4' were consistently removed in blocks of 5' x 2.5' x 2'. Some excavated units, then could contain more than one stratum. Nevertheless, the methodical removal of dirt during Borden's excavation at DfRs 3 was consistent. This situation contrasts with Borden's excavation methodology at DhRt 6, just one year before. These differences in excavation methodology may have created differences in the sample recovered.

The archaeological context of artifactual remains was preserved clearly in the DfRs 3 site records. The artifact catalogues record the same information as the DhRt 6 fieldnotes for Trench 1. In addition to recording 3-dimensional locations for each artifact, Borden also described the stratigraphic context in which each artifact was found. Superior and inferior strata are noted as well as the stratum in which the artifact was found. This situation yields more information to the researcher and was used by the author in delineating the Locarno Beach culture component at DfRs 3 (see discussion later in this chapter).

Fieldnotes also frequently referred to faunal resources found within excavation units. For example, student R. Heglar (1949) and Borden's (1950a, 1950b:242-3) reports indicated the presence of relatively few land and sea mammals compared to bird, fish, and shellfish remains. In a

recent personal communication with the author, A.L. Bryan (January 1982), who was a student participating in the 1949-1950 field school, substantiated the aforementioned facts regarding excavation methodology. In addition, Bryan discussed the collection of faunal remains.

> "Carl (Borden) paid meticulous attention to collecting faunal remains (at least everything except the common shellfish) and recording stratigraphy, as well as collecting artifacts." (personal communication, Bryan January 1982).

Stratigraphy

The record of stratigraphy at DfRs 3 is more complete than at DhRt 6. Borden kept daily records of stratigraphic relationships for each excavation unit, and he was assisted by field school participant Wilson Duff who used a stratasquare to draw the north wall profile of the trench (Figure 3.7).

Borden paid close attention to stratigraphic changes, even though he excavated in sublevels of 24" (personal communication, Bryan, January 1982) within the larger 4 foot arbitrary levels. However, unlike those of DhRt 6, the DfRs 3 fieldnotes note when more than one stratum comprise a single excavation unit.

Two stratigraphic units were defined at DfRs 3 (Borden 1950a) (Figure 3.8). The north face profile delineates the

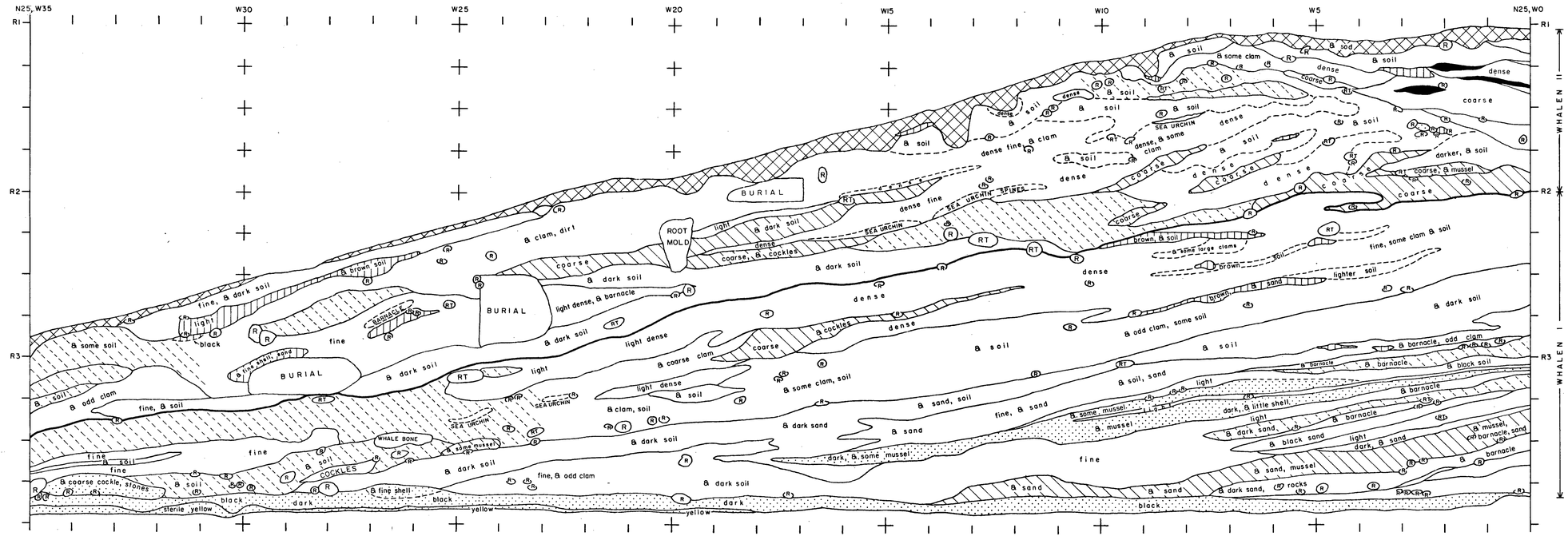
Figure 3.7: Wilson Duff and stratasquare.

Figure 3.8: West Wall Profile at DfRs 3.

74a

TOPSOIL | MUSSEL (details on profile) | CLAM (details on profile) | CLAM & MUSSEL (details on profile) | SAND (details on profile) | ASH (yellow unless otherwise indicated) | CHARCOAL | UPPER CASE indicates only named item present | R = rock | RT = root | 0 1 FOOT

Figure 3.8



boundary between the upper (Whalen II) and lower (Whalen I) stratigraphic units. These units were distinguished by Borden based on the relative quantities and type of shell present and the degree of disintegration.

> "In the lower horizon the strata consist chiefly of mussels with occasional lenses of cockles. Larger species of clam are rare. [This is very similar to the shell deposits at DhRt 6.] In this mound, however, the mussel deposit is suddenly overlaid by thick layers of large clams, such as Schizothairus nuttalli and Saxidomus nuttalli, although mussel do not disappear entirely" (Borden's 1950a:19; parenthetical phrase is the author's addition).

Isolated deposits of sea urchin spines are located throughout the lower horizon. A whale bone fragment was also described in the profile, however, it was not mentioned in the fieldnotes nor was it found in the Laboratory of Archaeology's DfRs 3 collection.

Measured by mid-1950 techniques, the radiocarbon date for the lower horizon is 2450 ± 160 years B.P., S-18 (Borden 1970:96; McCallum and Dyck 1960:77). This date places the horizon in the Locarno Beach culture time slot propounded by Borden (1970) and Mitchell (1971b).

A variety of shell species comprise the upper horizon at DfRs 3. However, horse clam (Schizothairus or Tresus nuttalli) and Washington butter clam (Saxidomus nuttalli) dominate the unit. Mussel is present in small quantities relative to the lower horizon. Radiocarbon dating yielded a

date of 1580 ± 140, S-19 (Daugherty 1958:454; Borden 1970: 96). Mitchell (1971b:62) places this unit in the "late Marpole (?)-Gulf of Georgia culture type." The hiatus between the two units is not as enigmatic as Borden (1970) thought. With so many midden sites in the area, it is probable that some locations, such as DfRs 3, may have been abandoned for the use of a neighboring site a few yards away. Seymour (1976) reports a Marpole unit at DfRs 3 during a 1972 excavation, which may substantiate this hypothesis.

The 2-unit distinction observed by Borden at DfRs 3 was never reformulated. Unlike the 2-unit distinction at DhRt 6, the existence of 2 units at DfRs 3 persists in Borden's later writings and thoughts (Borden 1970). This distinction was based on both stratigraphic and carbon dating evidence, which have been accepted and used by the archeological community (Mitchell 1971b; Matson 1974).

Cultural Zones

Two archaeological cultures were distinguished at DfRs 3 by Borden. These, Whalen I and Whalen II, have been defined by abrupt changes in the artifact assemblages which coincide with the differences in stratigraphy and radio carbon dates.

The Whalen I assemblage resembles material from DhRt 6, thus further supporting its affinity to the Locarno Beach culture. Borden (1950a) lists artifacts that are present in this assemblage. Although he did not describe the artifacts, hand-drawn diagrams of each artifact were catalogued along with information on their provenience and stratigraphic location in the site records.

The Whalen II assemblage, the upper cultural unit, is attributed to the Gulf of Georgia culture type (Mitchell 1971b).

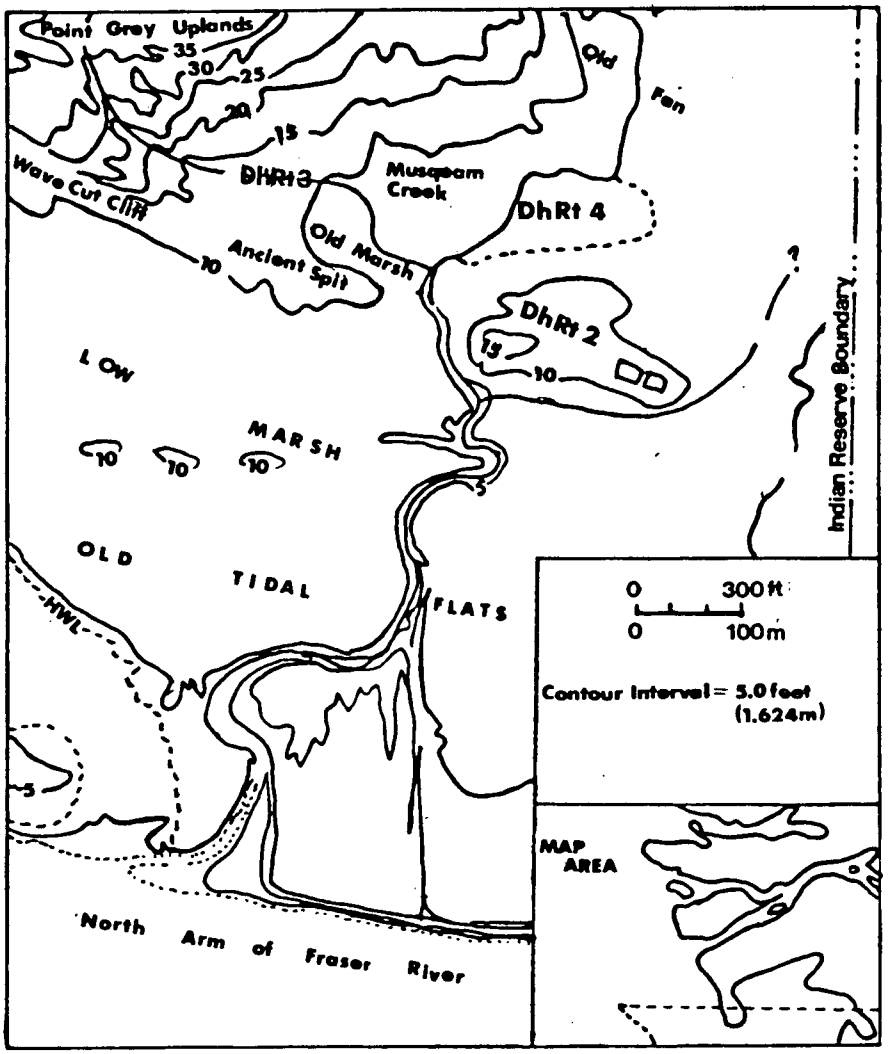
A 35 foot section of the north face wall profile (W35'-0', N20'-25') exists in the DfRs 3 records (Figure 3.8). An labelled line on the profile delineates the location of the Whalen I-II interface.

Musqueam NE Site, DhRt 4

Location

DhRt 4 is located in the Musqueam Creek area of the Musqueam Indian Reserve (Figure 3.9). Situated on a "broad flat expanse of deltaic deposits" (Archer 1972:2), the site is sandwiched between the Point Grey Uplands and the floodplain and delta front on the north shore of the Fraser River's North Arm. A stream originating in the Point Grey

Figure 3.9: Location of Musqueam NE, DhRt 4 (after Borden 1976:236).



Uplands passes near the western edge of the site.

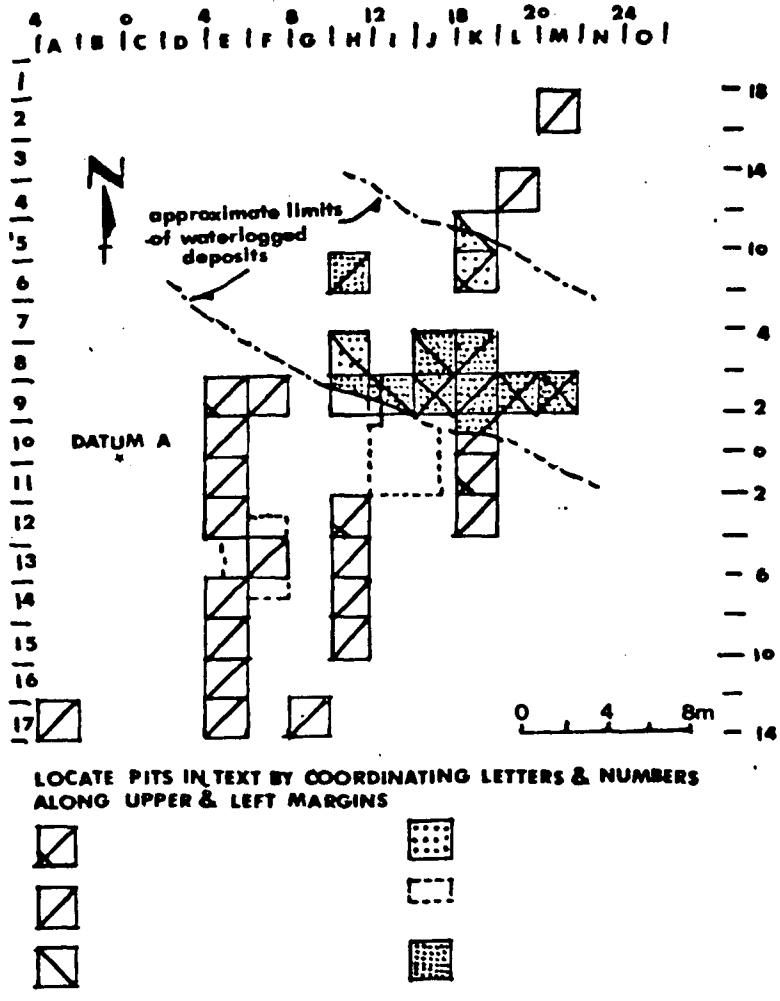
The excavation of DhRt 4 was part of a three year (1972-1974) salvage project involving Musqueam Band members Indian volunteers. Borden supervised the excavation with the assistance of David Archer and Kathryn Bernick as in-field directors. The location of the excavation units was situated on north to south transacts (Figure 3.10). This orientation produced complex stratigraphic profiles of the lensing.

Excavation Methodology

In general, the same methods of excavation were employed during all three field seasons at DhRt 4. However, greater care was employed in waterlogged regions of the site.

Along three north to south lines and one intersecting east to west line, Borden laid out a grid of 2m x 2m units. These units were excavated in 10cm arbitrary levels that disregarded natural layers. After loosening matrix with trowels and small utensils, the excavators screened soil through a 1/4 inch mesh. Both dry and water sieving techniques were used during the three season project. Special care was used in removing perishable remains from waterlogged units. Figure 3.10 summarizes the progress of work for each field season.

Figure 3.10: Distribution of excavated pits at DhRt 4 (Borden and Archer 1975:62).



Stratigraphy

Sketches of excavation unit wall profiles were made by volunteers during the excavation (Figures 3.11a and 3.11b). After the 1974 field season, Bernick combined information from fieldnotes and sketches to produce stratigraphic profiles for three of the four trenches. Together, these profiles delineate eight major stratigraphic zones and the three cultural zones described by Archer (1972:6-8).

Unlike DhRt 6, a rolling mound of midden is absent from DhRt 4's landscape and excavation. Fieldnotes indicate that some clam and relatively large quantities of bay mussel shell were encountered, however, "the stratigraphy does not have abundant mollusc remains"(Croes 1975:38).

Cultural Zones

Based on a preliminary analysis of artifactual and stratigraphic information, Borden (1976) described three distinct cultural zones at DhRt 4. These zones, A1, A2, and B, were differentiated in the field by the presence-absence or distribution of key artifact types (Archer 1972:2; Borden 1976). According to Archer and Bernick (independent personal communication, October 1981), the in-field test was the presence of microblades that suggested a Marpole culture component; their absence indicated a Locarno Beach culture component. While this procedure negates any argument about

Figure 3.11a: Musqueam NE (DhRt 4) Stratigraphy.

Figure 3.11a

RECENT OVERBURDEN (loosely compacted dark brown loam with roots & rocks)

LOAM (details on profile)

CRUSHED SHELL (details on profile)

SEE PROFILE

0 0.5 m

ASH (details on profile)

CHARCOAL

R = rock

Elevations are in metres below arbitrary datum of 100 metres.

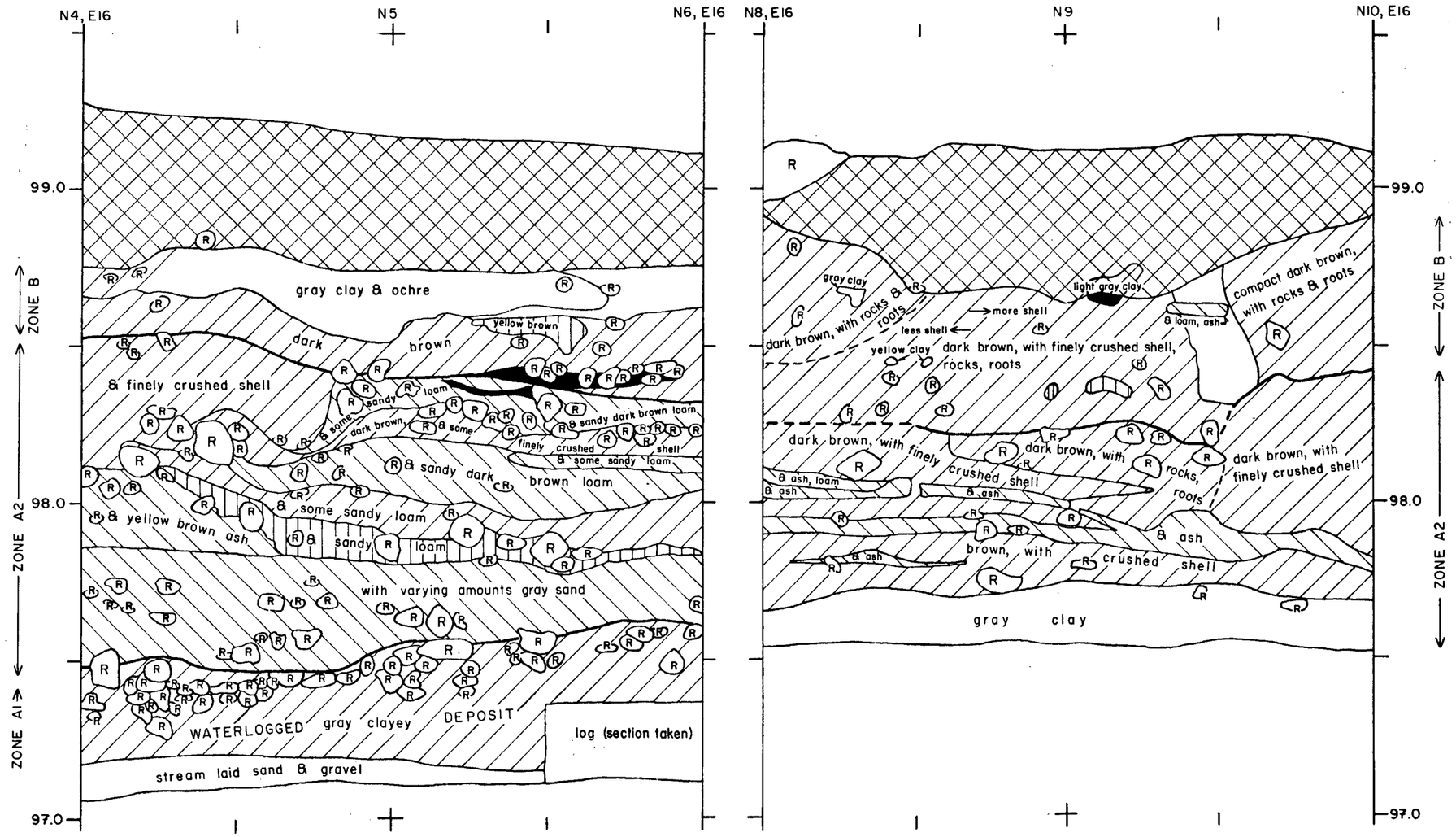


Figure 3.11b: Musqueam NE (DhRt 4) Stratigraphy.

RECENT OVERBURDEN (loosely compacted dark brown loam with roots & rocks)

LOAM (details on profile)

CRUSHED SHELL (details on profile)

SEE PROFILE

SAND (details on profile)

ASH (details on profile)

CHARCOAL

R = rock
RT = root
RH = rodent hole

0 0.5 m

Elevations are in metres below arbitrary datum of 100 metres

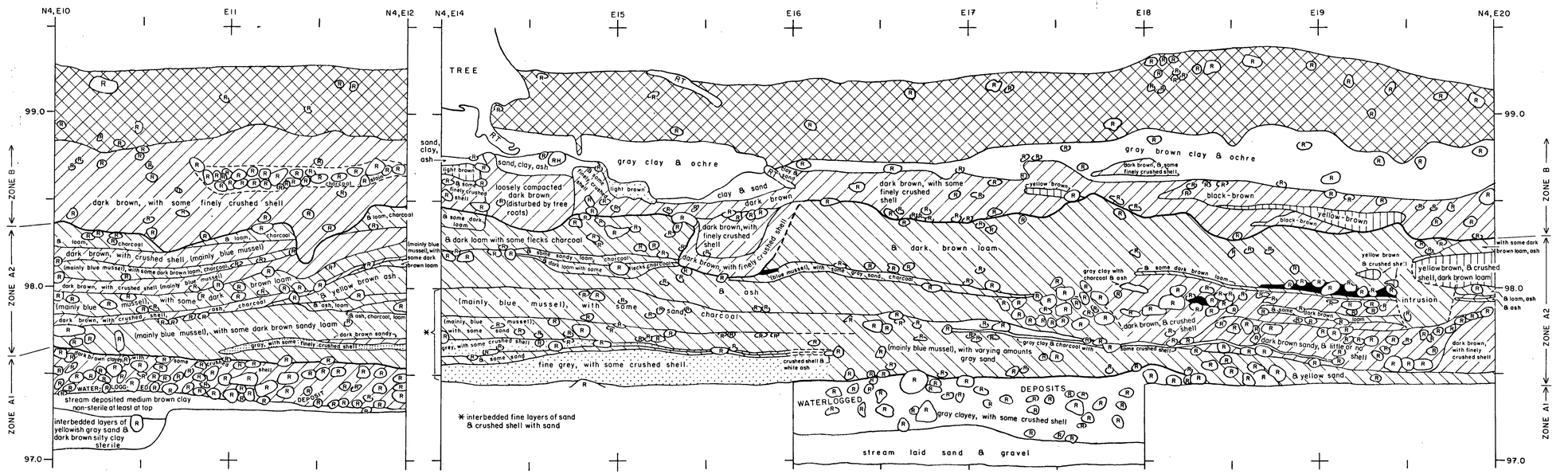


Figure 3.11b

microblades being used for specific activities that might have occurred during both coastal phases, it is the criterion used by Borden to distinguish two cultural units at DhRt 4. Thus, although it can be argued that the basis of Borden's 2-unit distinction between Locarno Beach and Marpole is precarious, the distinction is maintained in the present study so that site records will be consistent with Borden's definition.

The provenience of Zone A and Zone B are delineated on Bernick's profiles. Matson's (1974) analysis also showed this distinction was valid.

Zone A, the Locarno Beach component, has two subdivisions. Zone A1 includes the waterlogged deposits of perishable remains (e.g. basketry, wood chips, nuts, mats, etc.) and some other artifactual remains. Zone A2 lacks perishable material but contains the same distribution of other artifacts as Zone A1. Radiocarbon dates are available for both divisions of Zone A. A wood sample from Zone A1 (the waterlogged component) was radiocarbon dated at 2970 ± 90 B.P. or 1020 B.C. (I-7791), and a charcoal sample from Zone A2 yielded a C_{14} date of 2550 ± 85 B.P. or 600 B.C. (I-7790) (Borden and Archer 1975:59). Because of these close dates Borden and Archer (1975:2) lumped Zones A1 and A2 and associated it with the chronology for the Locarno Beach culture, as described by Borden (1970) and Mitchell

(1971b). Aside from probable perishable remains from a Locarno Beach associated waterlogged region of the Pitt River site (personal communication, Valerie Patenaude, February 1982), the oldest perishable remains of rope, cordage, net, and basketry on the Northwest Coast are from the Locarno Beach component at DhRt 4. Perishable remains of similar antiquity are present at the Hoko site (45 Ca 213) on the Olympic Peninsula in Washington (Croes 1975).

Zone B yielded artifact classes characteristic of the Marpole phase in the Gulf of Georgia chronological scheme (see Mitchell 1971b, Burley 1980). This Marpole component is relatively small compared to the Locarno one. Radiocarbon dates are not available for this unit.

Although described as "Disturbed material," remains from some areas of the site reflect historic occupation. A number of broken glass bottles, china plates, iron nails, etc. have been catalogued, in addition to the excavation of three late mortuary houses.

In general, the chronology of human occupation at DhRt 4 spans at least 3000 years but is incomplete.

Verification of an Association with the Locarno Beach Culture

The sampling of faunal remains within the excavated Locarno Beach components of each site under investigation is limited by the available information from the records of each site. Since Borden was principal investigator for the excavations at DhRt 6, DfRs 3, and DhRt 4, his excavation methodologies have been reviewed for information describing and delineating the vertical and horizontal location of the Locarno Beach components for each site. Borden's publications and his correspondence have also been consulted.

Although it is not the purpose of this investigation to do both a faunal and artifactual study, there are several reasons why it is necessary to tabulate artifact classes from the Locarno Beach components under investigation. In addition to radiocarbon dates, artifact tabulations from sampled areas of each site's Locarno Beach component are compared to Mitchell's (1971b:52-3, 57) diagnostic archaeological features of the Marpole and Locarno Beach culture type and Calvert (1970:74) and Matson's (1976a) work on the St. Mungo phase. This comparison insures that samples are associated with the Locarno Beach culture, as defined by Borden (1970) and Mitchell (1971b:57). Second, variability in artifact assemblages (although small in size) may be helpful in suggesting hypotheses for the patterns of

faunal utilization observed at each site. Finally, the three sites under investigation have never been fully described in the literature. Thus, artifact tabulations provided in this study are made available for future Northwest Coast prehistoric research.

Locarno Beach Site, DhRt 6

The sampled area is restricted to Trench 1 at N50'-60', E13'-22', surface to 10'. The factors that influenced this selection are: (1) The incomplete record of excavation of Trench 4 diminishes the research value of the collection; (2) the majority of material from this block of the site was located in assorted materials and faunal bags in the storage area of Archaeology Research Lab at the U.B.C. Museum of Anthropology; (3) a sidewall profile of stratigraphic relationships in this area was available; and (4) unlike the rest of Trench 1, horizontal dimensions were maintained distinct throughout the excavation of N50'-60'.

A sample of 84 artifacts were catalogued for the sampled area of the site. Appendix, Table B.1 lists the distribution of artifact classes. Awls and points manufactured primarily from bird bone are the most frequently occurring artifactual remains. Nine items of Mitchell's 19 diagnostic features of the Locarno Beach culture type are found among this collection of artifacts

Table 3.1: Distribution of Mitchell's (1971:57) Locarno Beach diagnostic archaeological features for sampled areas of three Locarno Beach Culture components.

			DhRt 6	DfRs 3 (Whalen I)	DhRt 4
1.	Medium-sized chipped basalt points	+	+	+	
2.	Microblades & cores	-	-	+	
3.	Chipped slate or sandstone knives	+	+	+	
4.	Crude cobble, split-cobble & boulder spall implements	-	-	-	
5.	Bone & ground slate points with facets	+	+	+	
6.	Thick ground slate knives	+	+	+	
7.	Celts	-	-	-	
8.	Gulf Island complex artifacts	-	-	-	
9.	Labrets	+	-	+	
10.	Earspools	-	-	-	
11.	Grooved or notched sinkers	-	-	?	
12.	Handstones and grinding slabs (abrasive)	+	+	+	
13.	Heavy bone wedges	+	-	+	
14.	Bilaterally barbed antler points	-	-	-	
15.	Toggling or composite harpoons	-	-	-	
16.	Antler foreshafts for harpoons (#15)	+	+	+	
17.	Sea mussel shell celts	-	-	-	
18.	Clay-lined depressions & rock slab alignments	-	-	-	
19.	Heavy decomposition of shell matrix & now "inland" location of site	+	+	+	
	TOTAL	9	7	10	

Table 3.2: Distribution of Mitchell's (1971:52-53) Marpole diagnostic archaeological features for sampled areas of three Locarno Beach units.

		DhRt 6	DfRs 3 (Whalen I)	DhRt 4
1.	Varieties of chipped stone points	+	+	+
2.	Microblades	-	-	+
3.	Large ground slate points	-	-	-
4.	Thin ground slate knives	-	-	-
5.	Celts	-	-	-
6.	Disc boads	-	-	-
7.	Labrets or earspools	+	-	+
8.	Stone hand mauls with decorated handles	-	-	-
9.	Perforated stones	-	-	-
10.	Stone sculpture	-	-	-
11.	Large needles	-	-	-
12.	Sectioned or split awls	-	-	-
13.	Barbed, non toggling harpoons	-	-	-
14.	Unilaterally barbed antler points	-	-	-
15.	Antler wedges	-	-	-
16.	Antler sculpture	+	-	-
17.	Native copper ornaments	-	-	-
18.	Midden burial	-	-	-
19.	Skull deformation	-	-	-
20.	Large post mould & house outlines	-	-	-
	TOTAL	3	1	3

Table 3.3: Distribution of Calvert's (1970:74) St. Mungo diagnostic archaeological features for sampled areas of three Locarno Beach Culture components.

		DhRt 6	DfRs 3 (Whalen I)	DhRt 4
1.	Stemmed or single shouldered points	+	+	+
2.	Bilaterally barbed harpoon	-	+	-
3.	Boulder spall tools	-	-	-
4.	Bone rings	-	-	+
5.	Brow bands	-	-	-
6.	Varieties of tooth & bone pendants	-	-	-
7.	Bone "charms"	-	-	-
8.	Large cores	-	-	-
	TOTAL	1	2	2

(Table 3.1). This contrasts with only 3 of 20 matches for Marpole diagnostic features (Table 3.2) and 1 of 8 for the St. Mungo culture (Table 3.3). Thus, the artifact distribution from the sampled area of DhRt 6 substantiates radiocarbon dates, suggesting that the sampled area is a valid Locarno Beach culture component.

Whalen Farm Site, DfRs 3

The sampled area is restricted to the only area of the site with a stratigraphic profile delineating the two culture zones, N20'-25', W0'-35' (Figure 3.7). Depth of the deposit in the sample varies with the number of excavated units that fall completely within the Whalen I unit.

A sample of 84 artifacts has been catalogued for the sampled area. Appendix, Table B.1 lists the distribution of artifact classes. Pecked and ground stone, bone, and shell industries are important in the assemblage. A large number of abrasive stones were found in the collection, as well as a variety of bone tools (points, bipoints, scrapers, needles and miscellaneous bone objects). Shell artifacts and barbed harpoons are major attributes differentiating the DfRs 3 assemblage from DfRt 6 and DhRt 4. As with DhRt 6, wood artifacts are absent from DfRs 3. One antler wedge was recovered, suggesting the presence of some woodworking activities.

DfRs 3 has 7 of 19 diagnostic (37%) features of the Locarno Beach culture (Table 3.1) in contrast to 1 (5%) of 20 for Marpole (Table 3.2) and 2 (25%) of 8 for St. Mungo (Table 3.3) phases. This data supports radiocarbon dates suggesting that the sampled area represents a valid Locarno Beach component.

Musqueam NE Site, DhRt 4

Excavation units for sampling were limited to those having stratigraphic profiles with Locarno Beach culture delineations made by Bernick. Units near the edge of the Locarno Beach deposit were excluded from the sample. Only 12 of the 33 excavation units had profiles that clearly distinguished between Zones A and B. 33% of these 12 units were random sampled with the assistance of D.L. Pokotylo (January 1982). These units are:

N2m-4m E10m-12m
N2m-4m E18m-20m
N4m-6m E14m-16m
N8m-10m E16m-18m

Fieldnotes by Archer and profile drawings by Bernick were invaluable in determining vertical location (i.e. levels) of the Locarno Beach component excavation unit.

The distribution of artifacts from these four excavation units is listed by Zone A1 and A2 in Appendix Table, B.1. A total of 428 artifacts is catalogued. A

total of 190 artifacts is found in Zone A2. The wood industry is the largest industry of the assemblage. Of the 238 artifacts of Zone A1 (waterlogged), 187 are perishable remains, including cordage, netting, wood chips, and basketry fragments. Retouched and utilized flakes constitute the largest artifact classes from the area sampled. Evidence of a woodworking industry suggests that ethnographic activities have considerable antiquity (Borden 1976).

A total of 10 (53%) of the 19 potential Locarno Beach culture diagnostics were recovered from the sampled area (Table 3.1). Only 3 (15%) of 20 Marpole diagnostics (Table 3.2) and 2 (25%) of 8 St. Mungo diagnostics (Table 3.3) were catalogued from areas in the sample. This situation confirms that material sampled is from a Locarno Beach component as suggested by radiocarbon dates.

Conclusions

This chapter has reviewed the three Fraser Delta area sites excavated by C.E. Borden. Although two of the sites, DhRt 6 and DfRs 3, were excavated over 30 years ago, sufficient information is available from Borden's site records to determine the Locarno Beach culture component at each site.

Due to a combination of factors, only selected areas of each component from each site were suitable for sampling faunal remains for this study. A comparison of catalogued artifacts from sampled areas of each site with diagnostic archaeological features of Marpole, Locarno Beach, and St. Mungo cultures indicates that each sampled assemblage is definitely part of a Locarno Beach culture. This situation supports chronological and stratigraphic characteristics of the Locarno Beach culture, as described by Borden (1970) and Mitchell (1971b).

Chapter 4

METHODS AND RESULTS:
THE LOCARNO BEACH CULTURE SUBSISTENCE PATTERN

Introduction

This chapter describes the methods and results of an analysis of Locarno vertebrate faunal remains from DhRt 6, DfRs 3, and DhRt 4. Each assemblage includes mammal, bird, and fish remains. Non-vertebrate faunal remains including shellfish, crab, barnacles, and both land and marine snails were collected at DhRt 6 and DfRs 3. However, non-vertebrate faunal remains are not analysed here.

From the three assemblages, a total of 6826 skeletal elements were identified to the level of Family or a more specific taxonomic unit. Of these, 204 elements are mammal (including humman remains), 1042 elements are bird, and 5580 elements are fish.

Methods of Identification

All faunal remains were identified by the author at the U.B.C. Museum of Anthropology between January and March 1982. Identifications were made by comparing archaeological remains with skeletal elements from comparative vertebrate faunal collections at: (1) the Laboratory of Archaeology U.B.C., (2) the U.B.C. Zoology Museum, and (3) the Archaeology Division of the British Columbia Provincial Museum at Victoria, B.C. Dr. N.J. Wilimovsky of the Institute of Animal Resource Ecology at U.B.C. also made available his descriptive illustrated key of fish remains developed for the Yuquot excavations on the west coast of Vancouver Island. However, this key was not useful to the author until she had learned to identify fish remains from comparative faunal material. Similar problems with keys for fauna have been reported elsewhere (Chaplin 1971). Detailed identification procedures are described and illustrated below.

Faunal remains sampled from each site's Locarno Beach culture component were separated from three sources (unsorted material bags, previously sorted faunal bags, and museum exhibits) into four general categories: (1) mammal, (2) bird, (3) fish, and (4) unidentifiable remains (Figure 4.1). The sample size of the latter category was very small, probably due to the method of collecting faunal

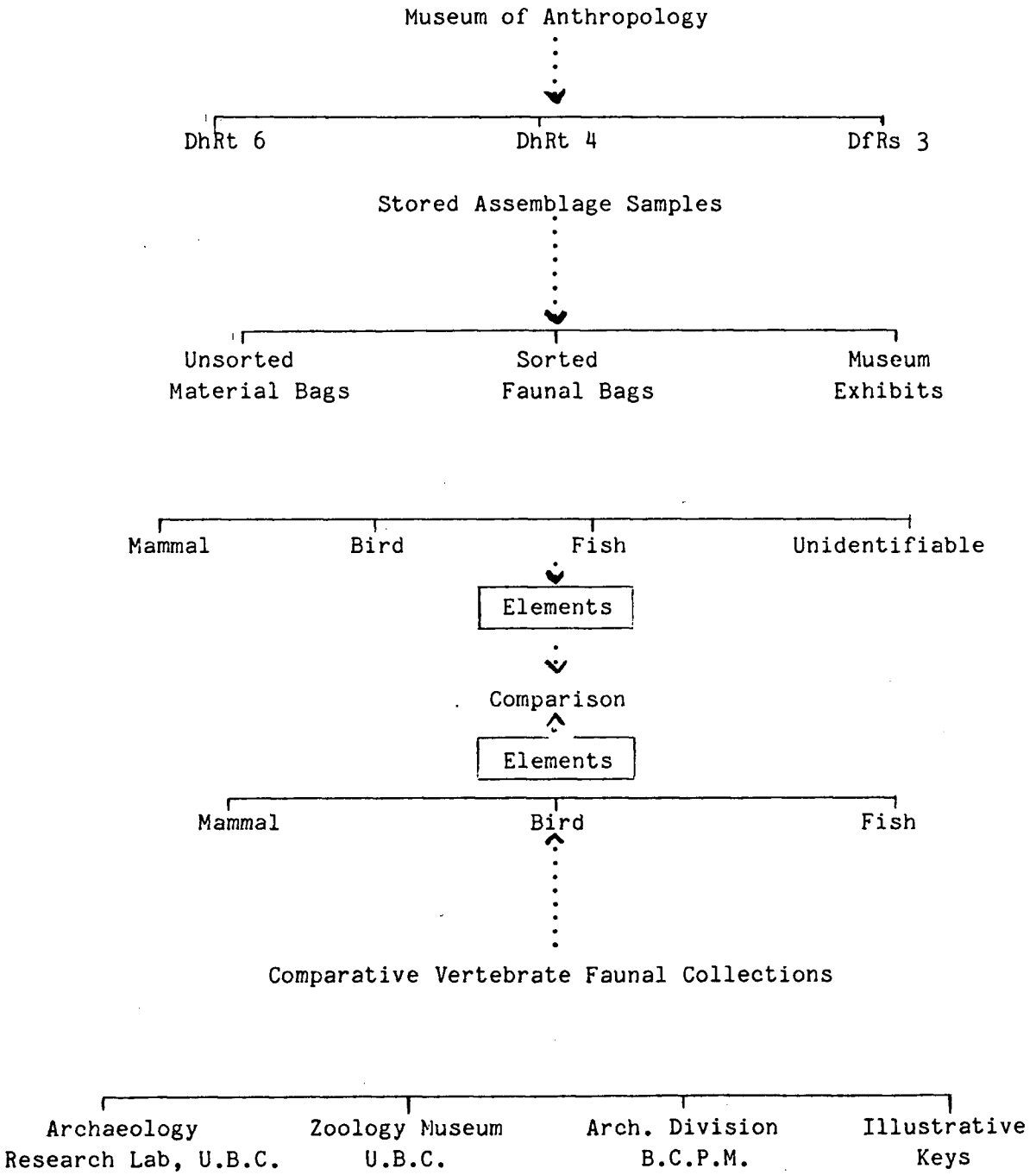
material during each excavation. Varied retrieval techniques at the three excavations may account for the small sample size of mammal remains (n = 204). After initial separation, mammal, bird, and fish bones were further classified by skeletal element and side of the body. Comparative collections of each skeletal element were prepared using available osteological materials and then compared to corresponding archaeological remains of that element. This procedure is similar to that used and described by Sutton (1979:338).

Mammal and bird remains were identified if they retained diagnostic morphological features, such as articular surfaces, femora, and muscle scars. No attempt was made to identify bird toe bones, ribs, scapulae or clavicla, some of which are difficult to distinguish at the level of Family.

Fish were identified to the species level, where possible. The majority of identifiable fish remains were vertebrae or bones of the head. Except for the first interhymal and interneural spines, and the dorsal spine of the dogfish, no attempt was made to identify the spines, rays, and ribs of fish, which lack salient distinguishable diagnostic morphological features for easy indentification.

Relative ages of mammal and bird remains were recorded. Calvert's (1980:143) age categories are used for mammals

Figure 4.1: Flowchart of Laboratory Procedures for Faunal Identification.



(Figure 4.2). Sutton's (1979:337) "degree of osteological maturity" is used for birds (Figure 4.3). Both sets of criteria have been reliably used in the identification of archaeological fauna from coastal and island environmental settings. Size distinctions are taken into account, wherever possible. No attempt was made to age classify fish, nor to sex faunal remains. Only Casteel (1976a) has age classified fish through x-ray photography.

Rick (1975, 1979) has offered precedents for the use of bird medullary bone as a seasonal dating technique in archaeological faunal analysis. "Medullary bone develops in female (birds) during the breeding period, when it serves as a calcium source for the developing eggshell" (Rick 1975:1). Thus, the presence of medullary bone was noted from only the broken bird bones in each assemblage. No attempt was made to cross-section whole bird bone in each assemblage.

Figure 4.2: Age Categories for Classifying Mammal Remains (after Calvert 1980:143).

1. Adult: element is full size, with epiphyses fully fused and articular facets and muscle ridges developed.

2. Sub-Adult: element is full size or nearly so, but epiphyses are not fully joined, articular facets and muscle ridges developed. With sea mammals, the criterion of epiphyseal union is less useful than for land mammals, as they retain unfused epiphyses of many elements well into adulthood. Thus, many sea mammal elements have had to be classified as either adult or sub-adult. The sub-adult category is not used for rodents, raccoons or the small mustelids, as it is roughly equivalent to the juvenile category for these animals.

3. Juvenile: element is less than adult size, still retains the juvenile cortex, epiphyses are unfused, and muscle attachments are still developing. The category roughly corresponds to animals in their first year of life.

4. New Born/Foetal: element is of very small size, morphological features and articular surfaces still forming, juvenile cortex evident and epiphyses absent. The lack of comparative material, particularly for sea mammals, of definitely new born or definitely foetal ages has necessitated combining these age groupings. This is especially so for sea mammals, as unlike most land mammals, they are precocious. The northern fur seal, for example, sheds its deciduous teeth <u>in utero</u>.

Figure 4.3: Age Categories for Classifying Bird Remains (after Sutton 1979:337).

1. Adult: fully matured bone.
2. Sub-Adult: bone is at or near full adult length.
3. Immature: articular ends are unformed, highly grandular.

Methods of Quantification

The sampled Locarno Beach culture component of each site is the basic unit of quantification for the faunal remains. Due to excavation methodology, subunits of quantification based on natural layers or arbitrary levels within layers of the Locarno Beach culture components at DhRt 6, DfRs 3, and DhRt 4 are impossible. Evaluating mammal and bird data by subunits of arbitrary levels would result in an inflated value of minimum number of individuals (Grayson 1973, 1974). Therefore, both excavation methodology and faunal assemblage size preclude the use of any subunits of quantification.

While quantitative methods are helpful in detecting patterns in archaeofaunal data, the methods are not without faults. Faunal analysts should be aware of the shortcomings of each method employed.

In this study, two units of measurement are used for analysing both mammal and bird data. The skeletal element count (E) is the number of identifiable bone elements per taxon. A major problem with E and its use in statistical calculations is the unknown degree of interdependence of the counted skeletal elements (Grayson 1979). As Lyman (1982:359) explains, "there is no known technique to determine if two deer bones or bone fragments are from one or two individual deer." Although age and sex data (Chaplin

1971) would eliminate potential interdependence, there are still questions of how cultural (e.g. butchery, "schlepp") and preservation factors affect the number of bone elements or fragments that survive in a site.

The E calculation here is considered conservative even though no attempt was made to match unpaired identifiable fragments of the same skeletal element from the same species from different levels of one pit at DfRs 3 or DhRt 4. The reasons for this are twofold: (1) most identified mammal and bird bone elements were whole, thus minimizing the amount of fragmented identifiable bone from any level and (2) identifiable fragmented bones broken as a result of storage from one level were paired in most cases. This procedure permits consistent treatment of remains in each assemblage, although it undermines strong interpretations of butchery and disposal patterns during the Locarno Beach culture.

The minimum number of individuals (MNI) is the second unit of measurement employed to quantify mammal and bird data. This technique provides independent variables (Grayson 1979) that in turn can be used to calculate values for estimated usable meat. However, caution must be exercised in using MNI, whose values vary with different methods of calculation (Grayson 1973). MNI values are also interdependent with sample size, so that a small sample size

inflates MNI values (Grayson 1978).

Imamoto (1976:25) and Matson (1976b:88) note that where percentages of E and MNI are similar for the same faunal assemblage, the MNI value probably best represents the data in tests of significance. MNI values avoid skewing sample size and overemphasizing the number of identifiable skeletal elements per species that is evident in the E and weight methods (Casteel 1978).

The low frequency of paired-elements of fish remains in these samples (especially of salmon skull bones) prevents the calculation of MNI for fish by conventional methods. Minimum numbers for fish can also be estimated by dividing the average number of vertebrae per species (found in Hart 1973) by the total vertebrae remains of this species present in the sample. However, this method produced fractions under 1% of MNI for many fish species represented by a small number of identifiable bone elements. Because these results were difficult to interpret when compared across each Locarno Beach culture assemblage in this study and to previous archaeological fish analyses on the Northwest Coast, only E is presented for fish remains.

The estimated usable meat (EUM) is the MNI value per taxon multiplied by its dressed meat value (see Imamoto 1976:29 or White 1953:397-398). EUM values provide a check against some of the aforementioned shortcomings of E and MNI

values. For example, 25 raccoon bone elements and 10 deer bone fragments do not indicate a major dietary trend toward raccoon with a little deer to supplement it. By employing EUM, differences between the relative contribution of big and small mammals are taken into account. In this study, EUM is calculated only for mammals (see Appendix, Table D.1). It is not intended to be an absolute or actual meat value per taxon. Rather, EUM is used strictly as in indicator of the relative dietary importance of mammals. That is why usable meat values based on Imamoto's work (1976:29) in the delta are significant to only three digits in this study. Using greater accuracy would only give the impression that EUM is being used as an absolute value for usable meat, and this is not the case.

As already noted, unidentifiable remains were small in terms of both size of fragments and proportions of each vertebrate type for each assemblage. Due to their paucity, unidentifiable fragments of mammal, bird, and fish remains were not tabulated, although total weight of mammal and fish remains was obtained.

Weight data are not available for bird remains because only a few wing tip and toe bones (or less than 5% of each sample) make-up the unidentifiable portion of each of the three Locarno Beach culture assemblages. Therefore, most of the bird assemblage was identifiable bone elements or

fragments. Human remains are excluded from the following summary.

DhRt 6 Assemblage

A total of 886 bone remains were identified from a 10' x 5' x 12' block of Trench 1. Of the 758g of mammal remains, 68% (by weight) was identified, represented by 48 bone elements. Fish remains weighed 209g of which 87% (by weight) was identified. There were 680 fish bone elements. A total of 158 bird bones were identified.

DfRs 3 Assemblage

A total of 1206 identifiable elements are in the Locarno Beach culture sample. Non-human mammal remains weighed 101g of which 47% (by weight) were identified, and these were represented by 48 bone elements. Of the 459g of fish remains, 83% (by weight) was identified, representing 679 bone elements. A total of 479 bird bone elements or fragments were identified.

DhRt 4 Assemblage

A total of 4721 bone remains were identified from this assemblage. The 95 identifiable non-human mammal bones weighed 1142g or 53% of the total mammal remains that were collected. Of the 280g of fish remains, 235g or 84% (by weight) accounted for the 4221 identifiable fish bone elements. 405 bird bone elements were also identified.

Results

The Vertebrate Fauna Sample

In all assemblages, fish remains are the most abundant vertebrate remains, varying from 56% to 89% by bone count. Birds are the second most common vertebrate remains, comprising 9% to 40% by bone count of the assemblages. The least frequently occurring identifiable skeletal elements are mammal remains, representing 5% by bone count of the assemblage or less. Table 4.1 presents these relative frequencies. A X^2 test value of 785.52 (Table 4.1) indicates that the contribution of different vertebrate classes (e.g. mammals, birds, and fish) to the faunal assemblages of the three Locarno Beach components differs significantly at the .001 level. The relationship within each vertebrate class is discussed below by Locarno Beach

Table 4.1: Distribution of Vertebrate Remains by Vertebrate Class, All Assemblages, E.

Taxa/Site	DhRt 6		DfRs 3		DhRt 4	
Mammal[1]	5	(48)	4	(48)	2	(95)
Bird	18	(158)	40	(479)	9	(405)
Fish	77	(680)	56	(679)	89	(4221)
TOTAL		886		1207		4721

H_o : Equal proportions of mammals, birds, and fish

Reject H_o at .001, $X^2 \geq 16.268$ at 3 degrees of freedom

For E -
$X^2 = 785.52$
significant at
$p = .001$
reject H_o

[1] The mammal category excludes human remains from DfRs 3 (n=7) and DhRt 4 (n=6).

culture component.

Mammal remains

Based on presence-absence, there is minor variation in mammal types across each assemblage (Table 4.2). Of the three water focused mammals (i.e. harbour seal, river otter, and beaver), harbour seal and river otter are found in all three assemblages. Beaver is found at DfRs 3 and DhRt 4, but not at DhRt 6. Deer is the only large land mammal that is present in each assemblage. Elk and bear are present in the DhRt 6 and DhRt 4 assemblages, but absent from the DfRs 3 assemblage. Muskrat is only present in the DfRs 3 assemblage. An increasing number of mammal types occur in samples from DhRt 6 (n=7), DfRs 3 (n=8), and DhRt 4 (n=10), respectively. However, the incease is relatively small and is probably directly related to the small sample size of mammal remains (Table 4.1).

Locarno Beach site, DhRt 6

A total of 48 identifiable bone elements and fragments represents seven species in the mammal assemblage (Table 4.3). Elk, deer, and black bear collectively account for 60.5% of the sample by bone count, 45% by MNI and 78.6% by EUM. Harbour seal is a fourth major mammal resource with 8.3% by E, 15% by MNI, and 17% by EUM. River otter is only a small portion of the sample with 12.5% by E, 15% by MNI,

Table 4.2: Presence-Absence Data For Mammal Remains, All Assemblages.

Taxa/Site	DhRt 6	DfRs 3	DhRt 4
Harbour Seal	+	+	+
River Otter	+	+	+
Beaver	-	+	+
Muskrat	-	+	-
Mink	-	-	+
Peromyscus	-	-	+
Striped Skunk	-	+	-
Raccoon	+	+	+
Canis	+	+	+
Black Bear	+	-	+
Deer	+	+	+
Elk	+	-	+
TOTAL	7	8	10

Table 4.3: Identified Mammal Remains from Locarno Beach Site, DhRt 6.

Taxa	%(E)	%(MNI)	%(EUM in kg)
Harbour Seal	8.3(4)	15(2)	17.0(118.0)
River Otter	12.5(6)	15(2)	2.0(14.0)
Beaver	-	-	-
Muskrat	-	-	-
Mink	-	-	-
Peromyscus	-	-	-
Striped Skunk	-	-	-
Raccoon	14.6(7)	15(2)	1.6(11.4)
Canis	4.1(2)	10(1)	0.8(5.7)
Black Bear	23.0(11)	15(2)	27.3(190.0)
Deer	25.0(12)	15(2)	9.3(64.8)
Elk	12.5(6)	15(2)	42.0(292.0)
TOTAL	48	13	695.9

and only 2% by EUM. A similar relationship exists for Canis, which is 4.1% by E, 10% by MNI, and 0.8% EUM.

The elk remains represent two adults. Of the two deer, one is adult and the incompletely fused cervical vertebra is of a juvenile individual, indicating a summer-to-fall season of death. One adult and one juvenile comprise both the bear and raccoon remains, which respectively represent summer-to-fall and spring seasons of death. In addition, six bone elements represent two new born river otters, indicating a spring season of death.

Major mammal resources are elk, black bear, deer, and harbour seal by EUM.

Whalen Farm site, DfRs 3

The 48 identifiable bone elements represent eight mammal species (Table 4.4). Elk and black bear, two of the large land mammal resources, are absent from the sample. The two identified bone elements of deer make up a small percentage of E (2%) and MNI (8.5%), but its EUM value is 26.7%. Of the smaller land mammal resources, muskrat (10.5%, E; 16.5%, MNI; negligible EUM) is more frequent than beaver (2%, E; 8.5%, MNI; 4.6%, EUM). Striped skunk is strongly represented by bone count (29.1%) and MNI (16.5%), but EUM is negligible. Harbour seal constitutes the most frequently occurring resource by bone count (25%) and EUM

Table 4.4: Identified Mammal Remains from Whalen Farm Site, DfRs 3.

Taxa	%(E)	%(MNI)	%(EUM in kg)
Harbour Seal	25. (12)	8.5(1)	47.9(59.0)
River Otter	4.2(2)	8.5(1)	5.7(7.0)
Beaver	2 (1)	8.5(1)	4.6(5.7)
Muskrat	10.5(5)	16.5(2)	*
Mink	-	-	-
Peromyscus	-	-	-
Striped Skunk	29.1(14)	16.5(2)	*
Raccoon	21.0(10)	16.5(2)	6.2(7.6)
Canis	6.2(3)	16.5(2)	9.3(11.4)
Black Bear	-	-	-
Deer	2.0(1)	8.5(1)	26.3(32.4)
Elk	-	-	-
TOTAL	48	12	123.1

*Negligable estimated usable meat value

(47.9%), but not by MNI (8.5%) in the sample. This is not a surprise, as today, there is a resident group of approximately 250-275 harbour seals (Phoca vitulina) in Boundary Bay (Ham 1982:25).

Ten of the identified mammals are adult individuals. One of two Canis remains is a sub-adult, and one of two raccoon individuals is juvenile (spring season of death). Of the three muskrat individuals, one is juvenile. It is not possible to indicate a season of death for muskrat, as they have up to three litters in one year.

Deer and harbour seal constitute the major mammal resources by E, MNI, and EUM.

Musqueam NE site, DhRt 4

There are 95 skeletal elements in the Locarno Beach component (Table 4.5). Ten mammal species are present in the sample.

Canis dominates the land mammal category of the sample by E (32.6%) and MNI (27.9%), but EUM is only 7.0% of the sample. The three large land mammal resources (i.e. elk, deer, and black bear) collectively represent 37% of the sample by bone count and 22.6% of the sample by MNI. Their EUM value is 65.0%. By themselves, elk and deer contribute 34.9% by bone count and 18.1% by MNI, and 47.0% by EUM. Raccoon is the most frequently occurring small land mammal,

Table 4.5: Identified Mammal Remains from Musqueam NE Site, DhRt 4.

Taxa	%(E)	%(MNI)	%(EUM in kg)
Harbour Seal	9.5(9)	9.0(2)	23.0(118.0)
River Otter	1.0(1)	4.5(1)	1.0(7.0)
Beaver	2.1(2)	4.5(1)	1.0(5.7)
Muskrat	-	-	-
Mink	2.1(2)	4.5(1)	*
Peromyscus	4.2(4)	9.0(2)	*
Striped Skunk	-	-	*
Raccoon	11.5(11)	18.0(4)	3.0(15.2)
Canis	32.6(31)	27.9(6)	7.0(34.2)
Black Bear	2.1(2)	4.5(1)	18.0(95.0)
Deer	22.1(21)	13.6(3)	19.0(97.2)
Elk	12.8(12)	4.5(1)	28.0(146.0)
TOTAL	95	22	664.3

*Negligable estimated usable meat value

contributing 11.5% to the sample by bone count and 18% by MNI. Harbour seal dominates the water-focused mammal resources in the assemblage, (9.5%, E; 9%, MNI; and 23.0%, EUM).

Most mammal remains represent adult individuals. Of the three deer, one is a juvenile individual (summer-fall season of death). There are also two juvenile raccoons (spring season of death).

The major mammal resources are elk, deer, and harbour seal by EUM.

Summary of mammal remains

At each site, only a small portion of the Locarno Beach culture component was sampled, which probably affected the sample size of mammal remains for each assemblage. Excavation methodology or butchery patterns (i.e. "schlepp") may also be factors. However, this cannot be verified because in most cases, only one or two specimens of a bone type is present per species (see Appendix, Tables C.1, C.2, and C.3).

The mammal sample is small for the Locarno Beach culture. In 75% of the cases, each species is represented by less than 10 bone specimens. The small number of identifiable bone specimens seems to affect percentages of E and MNI for the same species in the DhRt 6 and DfRs 3

assemblages, whereas percentages of E and MNI do not vary as much at DhRt 4 (Tables 4.4, 4.5, and 4.6). Thus, caution should be used in using MNI values in tests of significance for mammals (Imamoto 1976:25, Matson 1976:288).

Emphasis in mammal hunting is examined by a breakdown of mammal remains into aquatic and land mammal categories at all sites (Tables 4.6 and 4.7). Aquatic mammals include harbour seal, river otter, and beaver; the whale bone drawn in the stratigraphic profile of the Locarno Beach component at DfRs 3 is excluded. By both percentages of E and MNI, land mammals predominate the mammal remains (Tables 4.6 and 4.7). A X^2 test for equal proportions of land and aquatic mammals is not significant at the .001 level (X^2 = 9.778 for E; X^2 = .759 for MNI). The interpretation is that a high ratio of land mammals to aquatic mammals prevails in all three Locarno Beach culture assemblages.

A review of Tables 4.3, 4.4, and 4.5 suggests that the major mammal resources are:

DhRt 6: elk, deer, black bear, harbour seal
DfRs 3: deer, harbour seal
DhRt 4: elk, deer, harbour seal.

This is not a surprise since three of the four species are land mammals, and all four species provide the largest contribution of EUM for mammals in the three Locarno Beach culture components.

Table 4.6: Bone Frequencies E of Aquatic and Land Mammal Remains, All Assemblages.

Taxa/Site	DhRt 6	DfRs 3	DhRt 4
Aquatic Mammal	21 (10)	27 (14)	11 (11)
Land Mammal	79 (38)	73 (34)	89 (84)
TOTAL	48	48	95

Table 4.7: MNI Values of Aquatic and Land Mammal Remains, All Assemblages.

Taxa/Site	DhRt 6	DfRs 3	DhRt 4
Aquatic Mammal	30 (4)	15 (3)	14 (4)
Land Mammal	70 (9)	85 (12)	86 (18)
TOTAL	13	12	22

H_o = Equal proportions of aquatic and land mammals.
Reject H_o at .001, $X^2 \geq 13.815$ at 2 degrees of freedom

For E -
X^2 = 9.778
not significant at
p=.001
do not reject H_o

For MNI -
X^2 = .759
not significant at
p = .001
do not reject H_o

Given the high meat value of deer, elk, and harbour seal (i.e. the major mammals exploited during the Locarno Beach culture), it is possible that mammal hunting played a more important role in vertebrate subsistence activities than the small frequency of identifiable remains in each assemblage indicates. I suggest that mammal hunting occurred mainly in the Forest and Estuarine/Forest Edge areas of the delta. It was here that butchering and dressing of the animals took place, and only the high meat value bones were "schlepped" to the locations of the three assemblages where the bones were eventually discarded. "Schlepping" is a term used to describe transporting only a portion of an animal from the kill site to a home base (Perkins and Daly 1968:104).

Bird remains

Bird remains are the second most common vertebrate remains in all three assemblages (n=1042; Table 4.1).

Table 4.8 tabulates the presence-absence of bird species in all assemblages. The number of bird species represented at DhRt 6, DfRs 3, and DhRt 4 is 17, 23, and 20, respectively. This suggests little variation between avian assemblages.

Table 4.8: Presence-Absence of Identified Bird Species, All Assemblages.

Taxa/Site	DhRt 6	DfRs 3	DhRt 4
Common Loon	+	+	+
Arctic Loon	+	+	+
Horned Grebe	+	-	+
Western Grebe	+	+	+
Double-crested Cormorant	-	+	-
Greater Scaup	+	+	+
Bufflehead	-	+	-
Oldsquaw	+	+	+
White-winged Scoter	+	+	+
Commom Scoter	+	+	+
Common Merganser	-	+	-
Common Murre	+	-	-
Rhinocerous Auklet	-	+	-
Canada Goose	+	+	+
Snow Goose	-	+	+
Mallard	+	+	+
Pintail	+	+	+
American Widgeon	+	+	+
American Coot	-	-	+
Great Blue Heron	-	+	-
Glaucous-winged Gull	+	+	+
Heerman's Gull	+	+	-
Black Oystercatcher	-	+	-
Bald Eagle	+	+	+
Northwestern Crow	+	+	+
Raven	-	+	+
Great Horned Owl	-	-	+
Ruffed Grouse	-	-	+
TOTAL	17	23	20

Locarno Beach site, DhRt 6

Seventeen bird species represent the 126 bird bone remains in the DhRt 6 assemblage (Table 4.9). In addition, there are 32 radii of unspecified duck. Fifteen species of waterfowl and two species of upland fowl are present. The waterfowl include nine diving duck species, four surface-feeding (or dabbling) duck species, and two scavenging species. In total waterfowl account for 90% of the assemblage by E and 95% by MNI. Diving ducks collectively dominate waterfowl species (66%, E; 67%, MNI) followed by surface-feeders (14%, E; 17%, MNI), a distant second. In contrast to waterfowl, the two species of upland fowl are only 12% of the assemblage by bone count and 7% by MNI.

Including the unspecified duck faunal type, the most frequently occurring skeletal elements are the three bone types of the wing: the ulna (n=51 or 32%), radius (n=37 or 23%), and carpometacarpus (n=32 or 20%) (see Appendix, Table C.4). Wing bones account for 91.5% (n=143) of the bone elements in the bird assemblage (Table 4.10). Absent from the assemblage are bird bones with immature, burnt, and medullary bone indicators. The most frequently occurring species are common scoter (44%, E; 41% MNI), northwestern crow (10%, E; 4% MNI), and greater scaup (8%, E; 9%, MNI) (Table 4.9). Both common scoter and greater scaup are present year round in the Fraser Delta, but tend to be less

Table 4.9: Identified Bird Remains, Locarno Beach Site (DhRt 6).

Taxa	% (E)	% (MNI)
Divers		
Common Loon	2	2
Arctic Loon	4	1
Horned Grebe	2	1
Western Grebe	5	1
Double-crested Cormorant	-	-
Greater Scaup	10	4
Bufflehead	-	-
Oldsquaw	2	1
White-winged Scoter	3	1
Common Scoter	55	19
Common Merganser	-	-
Common Murre	1	1
Rhinocerous Auklet	-	-
	66(84)	67(31)
Dabblers		
Canada Goose	1	1
Snow Goose	-	-
Mallard	4	2
Pintail	7	2
American Widgeon	5	3
American Coot	-	-
	14(17)	17(8)
Scavengers		
Great Blue Heron	-	-
Glaucous-winged Gull	2	2
Heerman's Gull	8	2
Black Oystercatcher	-	-
	8(10)	1(4)
Upland		
Bald Eagle	3	1
Northwestern Crow	12	2
Raven	-	-
Great-horned Owl	-	-
Ruffed Grouse	-	-
	12(15)	7(3)
Unspecified Duck[1]	32	19
TOTAL	126	46

[1] Unspecified duck is excluded from calculations of percentages and total.

Table 4.10: Distribution of Bird Bone Types, Locarno Beach Site (DhRt 6).

	Wing Bones[1] (+/-)	Leg Bones[2] (+/-)	Wing Bones[1] (n)	Leg Bones[2] (n)
Divers				
Common Loon	+	-	2	0
Arctic Loon	+	+	2	2
Horned Grebe	+	-	2	0
Western Grebe	+	+	4	1
Greater Scaup	+	-	10	0
Oldsquaw	+	-	2	0
White-winged Scoter	+	+	2	1
Common Scoter	+	+	53	2
Common Murre	+	+	1	0
Dabblers				
Canada Goose	+	-	1	0
Mallard	+	+	2	2
Pintail	+	-	7	0
American Widgeon	+	-	5	0
Scavengers				
Glaucous-winged Gull	+	-	2	0
Heerman's Gull	+	+	5	3
Upland				
Bald Eagle	+	+	2	1
Northwestern Crow	+	+	9	3
Unspecified Duck[3]	+	-	32	0
TOTAL	17	9	91.5(143)	9.5(15)

KEY: + = present - = absent n = number of identifiable skeletal elements

[1] Wing bones include the coracoid, radius, ulna, carpometacarpus, and humerus.
[2] Leg bones include the femur, tibiatarsus, and tarsametatarsus.
[3] Unspecified duck is a faunal type based totally on the radii of ducks.

common inhabitants during the summer months (May to September).

The sample of bird remains suggests limited use of upland fowl and selected use of the waterfowl. The major bird resource is diving birds. Their presence may indicate a concurrence of inshore water resources such as pacific herring or surf smelt roe, which would be abundant during spawning in late winter (February to April) and late spring to summer, respectively.

Whalen Farm site, DfRs 3

Twenty-three bird species represent the 435 bird bone remains in the DfRs 3 assemblage (Table 4.11). Twenty species of waterfowl and three species of upland fowl are present in the sample. The twenty waterfowl represent 11 divers, five dabblers, and four scavengers. The waterfowl collectively account for 90% of assemblage by E and 95% by MNI. Diving duck species dominate the avifauna assemblage (59%, E; 60%, MNI), followed by surface-feeders (28%, E; 30%, MNI) (Table 4.11). There are three species of upland fowl, which account for 10% of the assemblage by bone count and 5% by MNI.

Including unspecified duck remains, the most frequently occurring bone type is the carpometacarpus (n=209 or 43%) and the ulna (n=92 or 19%) (see Appendix, Table C.5). Wing

Table 4.11: Identified Bird Remains, Whalen Farm Site (DfRs 3).

	% (E)	% (MNI)
Divers		
Common Loon	7	3
Arctic Loon	22	9
Horned Grebe	-	-
Western Grebe	5	1
Double-crested Cormorant	2	1
Greater Scaup	36	15
Bufflehead	5	3
Oldsquaw	9	2
White-winged Scoter	11	2
Common Scoter	156	53
Common Merganser	1	1
Common Murre	-	-
Rhinocerous Auklet	1	1
	59(255)	60(91)
Dabblers		
Canada Goose	1	1
Snow Goose	5	3
Mallard	43	17
Pintail	59	17
American Widgeon	14	7
American Coot	-	-
	28(122)	30(45)
Scavengers		
Great Blue Heron	1	1
Glaucous-winged Gull	6	4
Heerman's Gull	5	2
Black Oystercatcher	1	1
	3(13)	5(8)
Upland		
Bald Eagle	1	1
Northwestern Crow	42	5
Raven	2	1
Great-horned Owl	-	-
Ruffed Grouse	-	-
	10(45)	5(7)
Unspecified Duck[1]	44	23
TOTAL	436	151

[1] Unspecified duck is excluded from calculations of percentages and total.

bones account for 82% (n=395) of the bird assemblages (Table 4.12). The most frequently occurring species is the common scoter (36%, E; 35%, MNI) (Table 4.12). Common scoter inhabitats the Fraser Delta from September to the end of April.

Medullary bone is present in two bone elements from unspecified duck. Burnt bird bone is absent from the sample. Two matching radii of unspecified duck are immature.

The sample of bird remains suggests limited use of upland fowl and selected use of waterfowl. The major bird resource is diving birds, which tend to be more common in the Fraser Delta during the winter months.

Musqueam NE site, DhRt 4

Twenty species of bird represent the 405 identifiable bird bones in the DhRt 4 assemblage (Table 4.13). Fifteen species of waterfowl and five species of upland fowl occur in the sample. The fifteen species include eight diving duck types, six dabblers, and one scavenger. The majority of waterfowl are diving ducks (68%, E; 61%, MNI) (Table 4.13). Surface feeding ducks are considerably less frequent than divers (25.8%, E; 29%, MNI) (Table 4.13). The five species of upland fowl comprise 6% of the assemblage by bone count and 9% by MNI.

Table 4.12: Distribution of Bird Bone Types, Whalen Farm Site (DfRs 3).

Taxa / Bone Type	Wing Bones[1] (+/-)	Leg Bones[2] (+/-)	Wing Bones[1] (n)	Leg Bones[2] (n)
Divers				
Common Loon	+	+	4	3
Arctic Loon	+	+	21	1
Western Grebe	+	+	4	1
Double-crested Cormorant	+	+	1	1
Greater Scaup	+	+	30	6
Bufflehead	+	-	5	0
Oldsquaw	+	+	7	2
White-winged Scoter	+	+	7	4
Common Scoter	+	+	139	17
Common Merganser	+	-	1	0
Rhinocerous Auklet	+	-	1	0
Dabblers				
Canada Goose	+	-	1	0
Snow Goose	+	-	5	0
Mallard	+	+	32	11
Pintail	+	+	47	12
American Widgeon	+	-	14	0
Scavengers				
Great Blue Heron	-	+	0	1
Glaucous-winged Gull	+	+	5	1
Heerman's Gull	+	+	1	4
Black Oystercatcher	+	-	1	0
Upland				
Bald Eagle	+	-	1	0
Northwestern Crow	+	+	24	18
Raven	-	+	0	2
Unspecified Duck[3]	+	-	44	0
TOTAL	21	15	82(395)	18(84)

KEY: + = present - = absent n = number of identifiable skeletal elements

[1] Wing bones include the coracoid, radius, ulna, carpometacarpus, and humerus.
[2] Leg bones include the femur, tibiatarsus, and tarsametatarsus.
[3] Unspecified duck is a faunal type based totally on the radii of ducks.

Table 4.13: Identified Bird Remains, Musqueam NE Site (DhRt 4).

Taxa	% (E)	% (MNI)
Divers		
Common Loon	4	2
Arctic Loon	5	3
Horned Grebe	3	2
Western Grebe	1	1
Double-crested Cormorant	-	-
Greater Scaup	46	15
Bufflehead	-	-
Oldsquaw	37	8
White-winged Scoter	38	8
Common Scoter	115	26
Common Merganser	-	-
Common Murre	-	-
Rhinocerous Auklet	-	1
	68(249)	61(65)
Dabblers		
Canada Goose	2	1
Snow Goose	8	2
Mallard	47	17
Pintail	36	9
American Widgeon	1	1
American Coot	1	1
	25.8(95)	29(31)
Scavengers		
Great Blue Heron	-	-
Glaucous-winged Gull	1	1
Heerman's Gull	-	-
Black Oystercatcher	-	-
	0.2(1)	1(1)
Upland		
Bald Eagle	4	1
Northwestern Crow	16	5
Raven	1	1
Great-horned Owl	1	1
Ruffed Grouse	1	1
	6(23)	9(9)
Unspecified Duck[1]	37	28
TOTAL	368	106

[1] Unspecified duck is excluded from calculations of percentages and total.

Including unspecified duck remains, the most frequently occurring bone types are ulna (n=79 or 20%), carpometacarpus (n=68 or 17%) and humerus (n=64 or 16%) (Appendix, Table C.6). Wing bones are the dominate bone types in the bird assemblage (n=293, 72%; Table 4.14). Common scoter remains are the most frequently occurring avifauna in the sample (31%, E; 25%, MNI) (Table 4.13). Common scoter is more common during the winter months in the Fraser Delta.

Medullary bone is absent from the broken bone specimens. Four bone elements from three species of waterfowl and one bone element from one species of land fowl are burnt. Two matching humerii of northwestern crow are immature, from which no definite season of death can be suggested.

The sample of bird remains suggests limited use of upland fowl and selected use of waterfowl. Major bird resources are diving birds, which tend to be less common in the Fraser Delta from May to September.

Summary of the bird remains

The number of identifiable bird remains from the Locarno Beach culture components (n=1042) is much larger than the non-human mammal sample (n=191). Because of the sample size, percentages of E and MNI are very similar for each bird species and for each class of birds (e.g. diving

Table 4.14: Distribution of Bird Bone Types, Musqueam NE Site (DhRt 4).

Taxa / Bone Type	Wing Bones[1] (+/-)	Leg Bones[2] (+/-)	Wing Bones[1] (n)	Leg Bones[2] (n)
Divers				
Common Loon	+	+	1	3
Arctic Loon	-	+	0	5
Horned Grebe	+	-	3	0
Western Grebe	+	-	1	0
Greater Scaup	+	+	31	15
Oldsquaw	+	+	33	4
White-winged Scoter	+	+	21	17
Common Scoter	+	+	102	13
Dabblers				
Canada Goose	+	-	2	0
Snow Goose	+	+	5	3
Mallard	+	+	8	39
Pintail	+	-	25	11
American Widgeon	+	-	1	0
American Coot	+	-	1	0
Scavengers				
Glaucous-winged Gull	+	-	1	0
Upland				
Bald Eagle	+	-	4	0
Northwestern Crow	+	+	14	2
Raven	+	-	1	0
Great-horned Owl	+	-	1	0
Ruffed Grouse	+	-	1	0
Unspecified Duck[3]	+	-	37	0
TOTAL	14	10	72(293)	28(112)

KEY: + = present - = absent n = number of identifiable skeletal elements

[1] Wing bones include the coracoid, radius, ulna, carpometucarpus, and humerus.
[2] Leg bones include the femur, tibiatarsus, and tarsametatarsus.
[3] Unspecified duck is a faunal type based totally on the radii of ducks.

waterfowl, etc.) (Tables 4.9, 4.11, and 4.13). Thus, MNI is a better value to use in tests of significance.

Emphasis in bird utilization is examined by a breakdown of bird remains into upland fowl and waterfowl (Tables 4.15 and 4.16). Upland fowl include bald eagle, northwestern crow, raven, great-horned owl, and ruffed grouse. By both percentages of E and MNI, waterfowl dominate the bird remains in all assemblages. A X^2 test for constant proportions of upland fowl and waterfowl is not significant at the .001 level (Table 4.16). The interpretation is that the three Locarno Beach culture bird assemblages have a similar pattern of relatively high proportions of waterfowl compared to upland fowl.

Three types of waterfowl are present in each assemblage: diving species, surface-feeding (or dabbling species), and scavenging species (e.g. gulls, etc.). A comparison of waterfowl remains by diving and surface-feeding waterfowl categories (Tables 4.17 and 4.18; Appendix, Table D.2) reveals an emphasis in diving birds in all three assemblages. Using MNI data, a chi square test for equal contribution of diving and surface-feeding waterfowl is not significant at the .001 level (Table 4.18). The interpretation is that a high ratio of diving to surface-feeding birds prevails in all three Locarno Beach culture assemblages. That diving bird species make up a

Table 4.15: Frequency Data for Waterfowl and Upland Fowl, All Assemblages*.

Taxa/Site	DhRt 6 %(E)	DfRs 3 %(E)	DhRt 4 %(E)
Waterfowl	91 (143)	90 (433)	94 (382)
Upland Fowl	9 (15)	10 (47)	6 (23)
TOTAL	158	480	405

Table 4.16: MNI Data for Waterfowl and Upland Fowl All Assemblages*.

Taxa/Site	DhRt 6 %(MNI)	DfRs 3 %(MNI)	DhRt 4 %(MNI)
Waterfowl	95 (62)	96 (167)	93 (125)
Upland Fowl	5 (3)	4 (7)	7 (9)
TOTAL	65	174	134

H_o : Equal proportions of upland fowl and waterfowl.
Reject H_o at .001, $X^2 \geq 13.815$ at 2 degrees of freedom

For MNI -
$X^2 = 1.19$
not significant at
$p = .001$
do not reject H_o

*Includes unspecified duck remains.

Table 4.17: Frequency Data For Diving Bird and Surface-Feeding Bird Remains, All Assemblages*.

Taxa/Site	DhRt 6 %(n)	DfRs 3 %(n)	DhRt 4 %(n)
Diving Waterfowl	83 (84)	68 (255)	72 (249)
Surface-Feeding Waterfowl	17 (17)	32 (122)	28 (95)
TOTAL	111	377	344

Table 4.18: MNI Data for of Diving Bird and Surface-Feeding Bird Remains, All Assemblages*.

Taxa/Site	DhRt 6 %(n)	DfRs 3 %(n)	DhRt 4 %(n)
Diving Waterfowl	79 (31)	67 (91)	68 (65)
Surface-Feeding Waterfowl	21 (8)	33 (45)	32 (31)
TOTAL	39	136	96

H_o : Equal contribution of diving and surface feeding waterfowl
Reject at .001, $X^2 \geq 13.815$ at 2 degrees of freedom.

For MNI -
$X^2 = 1.188$
not significant at
$p = .001$
do not reject H_o

* Unspecified duck and scavaging waterfowl are not included (see Appendix, Table D.2).

large part of the avifauna in all three assemblages may indicate selective hunting, possibly with submerged nets similar to those observed by Suttles (1951:73). The presence of diving birds may also be related to the concurrence of pacific herring and their roe in inshore waters during their spawning seasons (late winter to spring). The timely convergence of bird hunting activities with large aggregations of spawning fish has been suggested at Deep Bay, DfRu 7 (Monks 1977) and on Boundary Bay at Crescent Beach, DgRr 1 (Ham 1982).

Table 4.19 compares the number of bird wing and leg bones for each assemblage. Wing bones include the coracoid, radius, ulna, carpometacarpus, and humerus. A X^2 test for equal proportion of wing and leg bones for all bird remains in each assemblage is significant at the .001 level. (X^2 = 21.04). The interpretation of the X^2 test is that the three sites do not have a similar pattern of identifiable wing and leg bone types. The pattern prevails in a test of significance that compares only diving and surface-feeding waterfowl for all assemblages (Table 4.20). It may be the result of a relatively lower percentage of wing bones (70%) at DhRt 4 than at DhRt 6 (88%) and DfRs 3 (81%). However, there is a not significant difference at the .001 level in the distribution of wing and leg bones for a sample of all birds at only DhRt 6 and DfRs 3 (Table 4.21). This pattern

Table 4.19: Distribution of Bone Type for All Bird Remains, All Assemblages.

Bone Type / Site	DhRt 6 %(n)	DfRs 3 %(n)	DhRt 4 %(n)
Wings	88(111)	81(351)	70(256)
Legs	12 (15)	19 (84)	30(112)
TOTAL	126	435	368

H_o : Equal proportions of bird wing and leg bones.
Reject at .001, $X^2 \geq 13.815$ at 2 degrees of freedom.

For E -
$X^2 = 21.04$
significant at
$p = .001$
reject H_o

Table 4.20: Distribution of Bone Types for Diving and Surface-feeding Waterfowl, All Assemblages.

Bone Type / Site	DhRt 6 %(n)	DfRs 3 %(n)	DhRt 4 %(n)
Wings	92(93)	85(319)	68(234)
Legs	8(8)	15(58)	32(110)
TOTAL	101	377	344

H_o = Equal proportion of wing and leg bones for diving and surface-feeding waterfowl.

Reject at .001, $X^2 \geq 13.815$ at 2 degrees of freedom.

For E -
$X^2 = 42.56$
significant at
$p = .001$
reject H_o

Table 4.21: Distribution of Bone Types for All Birds at DhRt 6 and DfRs 3.

Bone Type / Site	DhRt 6 %(n)	DfRs 3 %(n)
Wings	88(111)	81(315)
Legs	12(15)	19(84)
TOTAL	126	435

H_o : Equal proportion of wing and leg bones for all birds.

Reject at .001, $X^2 \geq 10.827$ at 1 degree of freedom.

For E -
$X^2 = 3.68$
not significant at
$p = .001$
do not reject H_o

suggests that although there is a relatively high proportion of wing bones in each assemblage, the distribution of bird bone types is different at DhRt 4 than DhRt 6 and DfRs 3. This is probably related to better excavation methodology at DhRt 4 than at DhRt 6 and DfRs 3.

Fish remains

Fish remains are the most frequently occurring vertebrate remains in all three assemblages (n = 5580) (Table 4.1). Table 4.22 compares the presence-absence of fish species in all three Locarno Beach culture fish assemblages. The number of fish species present at DhRt 6, DfRs 3, and DhRt 4 is 17, 14, and 22, respectively (Table 4.22).

In this study, the relative frequency of small fish remains is affected by excavation methods (Table 4.23). 1/4 inch mesh or larger was used during the excavations to screen the matrix. As Thomas (1969) has noted, 1/4 inch mesh fails to recover small bone elements. Matson et. al (1981) and Calvert (1980:173, Table 17) have noted that 1/4 inch mesh prevents retrieval of many southwestern B.C. fish remains in archaeological middens, especially the vertebrae of pacific herring, eulachon, northern anchovy, and surf smelt. Since the assorted materials bags of the DhRt 6 assemblage still contained matrix, 2mm mesh was used to

Table 4.22: Presence of Fish Remains, All Assemblages.

Taxa/Site	DhRt 6	DfRs 3	DhRt 4
Dogfish	+	+	+
Ratfish	+	-	+
Northern Anchovy	+	-	-
Pacific Hake	+	-	+
Petrale Sole	-	+	+
Pacific Halibut	+	+	-
English Sole	-	+	-
Rockfish	-	-	+
Lingcod	-	-	+
Pacific Cod	+	+	+
Walleye Pollack	-	-	+
Big Skate	-	+	+
Plainfin Midshipman	+	-	-
Pile Perch	+	-	+
Great Sculpin	-	-	+
Buffalo Sculpin	+	-	-
Staghorn Sculpin	-	+	+
Sculpin	-	+	+
Rock Sole	+	+	+
Starry Flounder	+	+	+
Flatfish	+	+	+
Pacific Herring	+	+	+
Surf Smelt	+	-	-
Eulachon	+	-	+
Minnow	-	-	+
Salmon	+	+	+
Trout	-	-	+
Sturgeon	+	+	+
TOTAL	17	14	22

Table 4.23: Frequency of Salmon with and without Small Fish[1].

	DhRt 6 with small fish % (E)	DhRt 6 without small fish % (E)
Salmon	40 (281)	78 (281)
Other fish	60 (399)	22 (77)
TOTAL	680	358

[1] Small fish include pacific herring, surf smelt, northern anchovy, and eulachon.

rescreen the DhRt 6 material prior to the identification of all faunal remains. This procedure could not be duplicated for the DfRs 3 and DhRt 4 samples, which were screened exclusively with 1/4 inch or larger mesh during each excavation. The disparity in recovery techniques affected the composition of fish remains in the Locarno Beach culture samples. Consequently, the smaller bone elements of fish such as northern anchovy, eulachon, surf smelt, and pacific herring would be under-represented in the samples from DfRs 3 and DhRt 4.

Locarno Beach site, DhRt 6

Seventeen taxa of fish are present in the DhRt 6 assemblage (Table 4.22). Of the 680 identifiable fish remains by bone count, 281 bone elements (or 40% of the assemblage) are salmon (Table 4.24). Surf smelt and pacific herring represent 46% by bone count, with the majority being smelt remains (n=233, 35%). Flatfish account for 7% (n=46) of the sample while midshipmen, present only in this assemblage, are 2% (n=11) of the sample. Sturgeon, sculpins, codfish, ratfish, spiny dogfish, eulachon, and pile perch occur less than 1% each by E.

Pile perch and buffalo sculpin are represented by skull remains (Table 4.25). Pacific herring and halibut were identified by skull and vertebrae remains. Eleven fish

Table 4.24: Identified Fish Remains, Locarno Beach Site (DhRt 6).

Taxa	%	(E)
Class Chondrichthyes (Cartilaginous Fish)		
Spiny Dogfish		1
Ratfish		6
	1	(7)
Class Osteichthyes (Bony Fish)		
Sturgeon		6
Pacific Herring		79
Northern Anchovy		8
Salmon		281
Surf Smelt		233
Eulachon		2
Plainfin Midshipman		11
	91	(620)
Pacific Cod		1
Pacific Hake		3
	.5	(4)
Pile Perch		1
Buffalo Sculpin		2
	.5	(3)
Pacific Halibut		9
Rock Sole		4
Starry Flounder		5
Flatfish		28
	7	(46)
TOTAL		680

Table 4.25: Distribution of Fish Bone Types, Locarno Beach Site (DhRt 6)[1].

Taxa / Bone Type	Only Vertebrae[2] (+/-)	Only Skull (+/-)	Skull & Vertebrae (+/-)	Misc. Bones (+/-)
Sturgeon	-	-	-	+
Pacific Herring	-	-	+	-
Northern Anchovy	+	-	-	-
Salmon	+	-	-	-
Surf Smelt	+	-	-	-
Eulachon	+	-	-	-
Plainfin Midshipman	+	-	-	-
Pacific Cod	+	-	-	-
Pacific Hake	+	-	-	-
Pile Perch	-	+	-	-
Buffalo Sculpin	-	+	-	-
Pacific Halibut	-	-	+	-
Rock Sole	+	-	-	-
Starry Flounder	+	-	-	-
Flatfish	+	-	-	-
TOTAL	10	2	2	1

[1] The cartilaginous fish in the sample (e.g. spiny dogfish and ratfish) are excluded from this table.

[2] Atlases and spines are included in the "Only Vertebrae" category

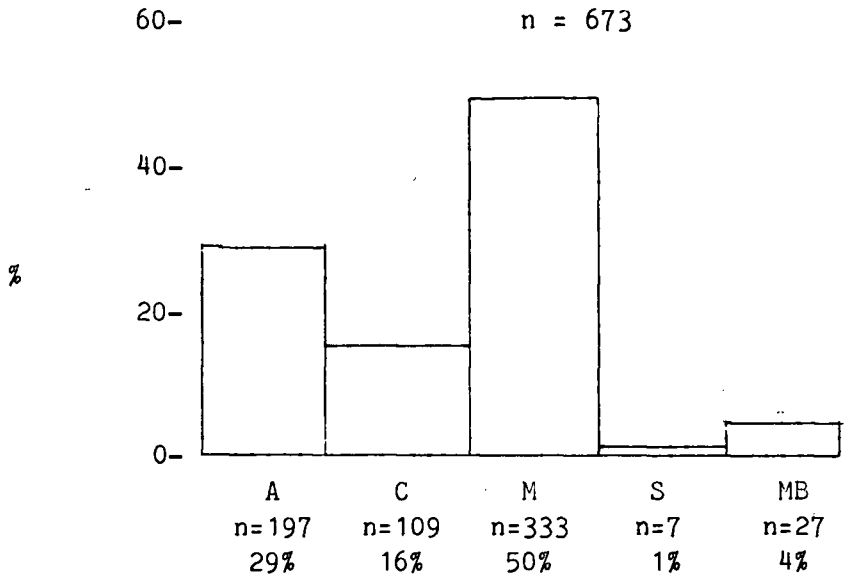
species are represented by only vertebral skeletal elements. The most frequently occurring skeletal element is vertebrae (n=640, 94%). (Figure 4.4) Of this, 29% are abdominal vertebrae, 16% are caudal vertebrae. Fifty percent could not be identified as either caudal or abdominal vertebrae. Skull (1%) and miscellaneous bone elements (4%) make up the smallest percentage of identified bone elements.

In a personal communication with the author, salmon expert Howard Raymond (January, 1985) of the Coastal Zone Estuarine studies group of the Northwest and Alaska Fisheries Center (Seattle, Washington) stated that the diameter of salmon vertebrae may be an indicator of fish species. Although scientific verification is required, this relationship has also been observed by Northwest Coast archaeologists working with fish fauna (Casteel 1976:85, personal communication, Ham, July 1981, personal communication, Matson, January 1983, personal communication, Wigeon, July 1984). The diameter of 75% (n=210) of the salmon vertebrae in the sample were measured. The sizes of abdominal and caudal vertebrae breakdown into two distinct ranges or categories:

11mm-12mm	48% (n=101)
8mm- 9mm	52% (n=109)

Relatively similar percentages of vertebrae occur in the 11mm-12mm (48%) and 8mm-9mm (52%) categories. Raymond

Figure 4.4: Most Frequently Occurring Fish Bone Elements, Locarno Beach Site (DhRt 6)[1].



Key:
A = Abdominal vertebrae
C = Caudal vertebrae
M = Miscellaneous vertebrae[2]
S = Skull
MB = Miscellaneous bones

[1] The cartilaginous fish in the sample (e.g. spiny dogfish and ratfish) are excluded from this figure.

[2] Miscellaneous vertebrae include herring (n=79) and surf smelt (n=233). Raw data are listed in Appendix, Table C.7.

(personal communication, January, 1985) suggested that the 8mm-9mm vertebrae are characteristic of sockeye salmon.

Smelt and herring are abundant seasonal intertidal resources at the Locarno Beach site locality. The sum total of smelt and herring remains (n=312) is greater than the frequency of salmon (n=281). The poor recovery rate of 1/4 inch or larger mesh indicates that smelt and herring may have been important resources at this locality, despite the relatively larger size of salmon. The Locarno Beach site locality was used for smelt procurement by Musqueam and Squamish Indians in historic times (Matthews 1955:395, 397).

Whalen Farm site, DfRs 3

Fourteen species of fish are present in the DfRs 3 assemblage (Table 4.22). Of the three Locarno Beach culture components, this assemblage has the second largest diversity of fish. Six-hundred seventy-nine fish remains were identified to the level of species, genus, or family. Salmon are the largest category of fish remains with 446 (67%) identified bone elements (Table 4.26).

In addition to the unspecified flatfish category, there are five species of flatfish, which collectively represent 31% of the assemblage. Two bones of sculpin and one bone of big skate occur, each less than 1% of the fish sample. Only one species of cod—pacific cod—is present in the

Table 4.26: Identified Fish Remains, Whalen Farm Site (DfRs 3).

Taxa	%	(E)
Class Chondrichthyes (Cartilaginous Fish)		
Spiny Dogfish		8
Big Skate		1
	1.3	(9)
Class Osteichthyes (Bony Fish)		
Sturgeon		6
Pacific Herring		1
Salmon		446
	67.0	(453)
Pacific Cod		4
	0.5	(4)
Staghorn Sculpin		1
Sculpin		1
	0.2	(2)
Petrale Sole		15
Pacific Halibut		12
Rock Sole		9
English Sole		8
Starry Flounder		36
Flatfish		131
	31.0	(211)
TOTAL		679

assemblage. Its four identifiable bone elements account for .5% of the sample. Sturgeon and spiny dogfish also occur infrequently by bone count, with 1% each. Rockfish, surf smelt, and eulachon are absent, while 1 identifiable bone of pacific herring was recovered, representing only .1% of the fish remains.

Four of 15 fish species present in the assemblage are represented by non-vertebral skeletal elements (Table 4.27). However, ninety-nine percent of the identifiable fish remains are vertebrae (Figure 4.5). Skull and miscellaneous bone elements collectively represent 1% of the sample.

The diameter of 15% (n=68) of the salmon vertebrae in the sample were measured. Only abdominal vertebrae were identified in this sample. The sizes of the vertebrae breakdown into three distinct categories:

13mm-15mm	10% (n=7)
11mm-12mm	49% (n=33)
8mm- 9mm	41% (n=28)

The highest percentages of vertebrae occur in the 11mm-12mm (49%) and the 8mm-9mm (41%) categories. Very large sized vertebrae (13mm-15mm) represented 10% of the sample. The 13mm-15mm vertebrae stand out in size and may represent the large chinook salmon(personal communication, Raymond, January 1985). Chinook would be available in the delta

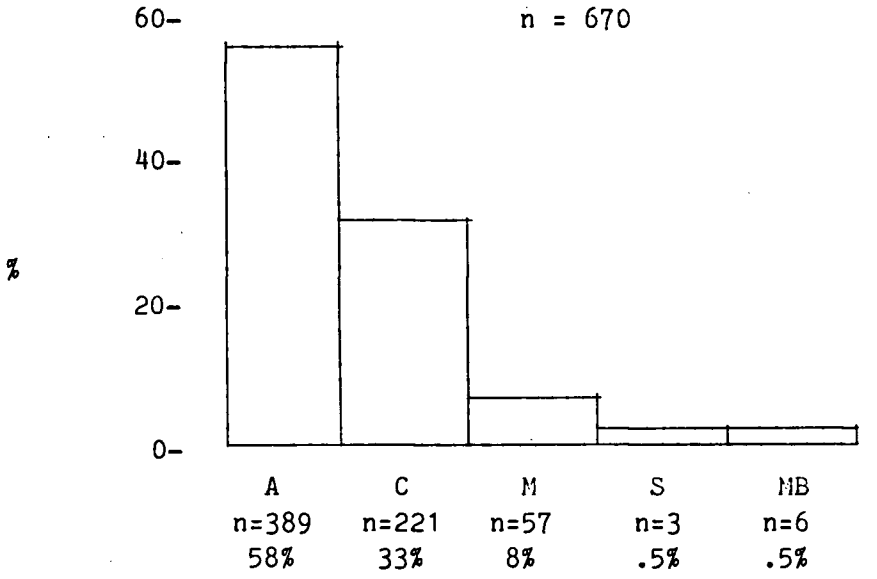
Table 4.27: Distribution of Fish Bone Types, Whalen Farm Site (DfRs 3)[1].

Taxa / Bone Type	Only Vertebrae[2] (+/-)	Only Skull (+/-)	Skull & Vertebrae (+/-)	Misc. Bones (+/-)
Sturgeon	-	-	-	+
Pacific Herring	+	-	-	-
Salmon	+	-	-	-
Pacific Cod	+	-	-	-
Staghorn Sculpin	-	+	-	-
Sculpin	-	+	-	-
Petrale Sole	+	-	-	-
Pacific Halibut	+	-	-	-
Rock Sole	+	-	-	-
English Sole	+	-	-	-
Starry Flounder	+	-	-	-
Flatfish	+	-	-	-
TOTAL	9	3	0	1

[1] The cartilaginous fish in the sample (e.g. spiny dogfish and ratfish) are excluded from this table.

[2] Atlases and spines are included in the "Only Vertebrae" category

Figure 4.5: Most Frequently Occurring Fish Bone Elements, Whalen Farm Site (DfRs 3)[1].



Key:
A = Abdominal vertebrae
C = Caudal vertebrae
M = Miscellaneous vertebrae
S = Skull
MB = Miscellaneous bones

[1] The cartilaginous fish in the assemblage (e.g. spiny dogfish and big skate) are excluded from this figure.

during the early spring months when they fed on spawning herring (Berringer 1982:43,151). After perusing the salmon remains from all fish assemblages in this study, it was determined that DfRs 3 has the only sample of salmon vertebrae in the 13mm-15mm size range.

As noted, salmon are the principal fish resource by bone count (n=446, 60%). Flatfish are the next major fish resource (n=211, 31%). The use of screens with 1/4 inch or larger mesh probably affected the recovery rate of remains of small boned fish. There is one identifiable bone element of pacific herring in the DfRs 3 sample, which may be a sign of abundance considering screening techniques. Thus, although herring has a very low frequency, it may have been another important fish resource at this locality.

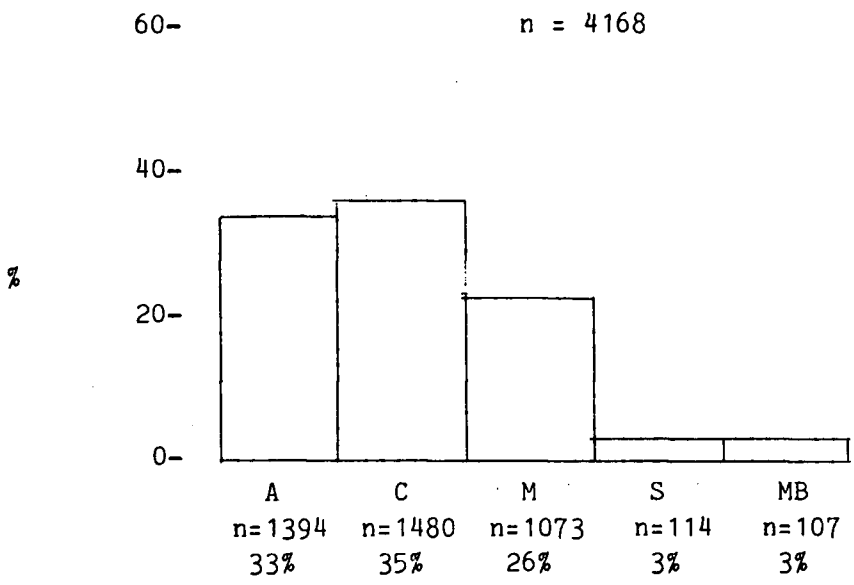
Musqueam NE site, DhRt 4

DhRt 4 has the largest diversity and sample size of fish (Tables 4.1 and 4.28). Twenty-two fish species account for 4221 identifiable fish bone elements or fragments. Fifty-eight percent of the assemblage, or 2470 identifiable bone elements are of Salmonidae, including two vertebrae of steelhead trout. There are three codfishes present in the assemblage: pacific hake, pacific cod, and walleye pollack, which collectively account for less than 1% of the assemblage by E. Flatfish are the second largest category of

Table 4.28: Identified Fish Remains, Musqueam NE Site (DhRt 4).

	%	(E)
Class Chondrichthyes (Cartilaginous Fish)		
Spiny Dogfish		13
Big Skate		35
Ratfish		5
	1.5	(53)
Class Osteichthyes (Bony Fish)		
Sturgeon		108
Pacific Herring		2
Salmon		2470
Steelhead Trout		2
Eulachon		1
	61.0	(2583)
Pacific Cod		15
Pacific Hake		9
Walleye Pollack		3
	0.6	(27)
Pile Perch		2
Rockfish		36
Lingcod		37
	1.7	(75)
Great Sculpin		4
Staghorn Sculpin		15
Sculpin		9
	0.6	(28)
Pacific Halibut		70
Rock Sole		75
Starry Flounder		184
Flatfish		1119
	34.5	(1448)
Minnow		7
	0.1	(7)
TOTAL		4221

Figure 4.6: Most Frequently Occurring Fish Bone Elements, Musqueam NE Site (DhRt 4)[1].



Key:
A = Abdominal vertebrae
C = Caudal vertebrae
M = Miscellaneous vertebrae
S = Skull
MB = Miscellaneous bones

[1] The cartilaginous fish in the assemblage (e.g. spiny dogfish, ratfish, and big skate) are excluded from this figure.

fish remains in the assemblage, with four species identified representing 34.5% (n=1448) of the assemblage. The 108 identifiable bone elements of sturgeon are the single largest sample of sturgeon in the three Locarno Beach culture fish assemblages. Sturgeon remains represent 2% of the DhRt 4 fish sample.

Eight fish species have been identified by both vertebral and skull skeletal elements. Five species have been identified by only vertebrae or only skull bone types (Table 4.29). Ninety-four percent of the identified fish remains are vertebrae (Figure 4.6). Skull and miscellaneous bone elements represent 3% each of the sample.

The diameter of 19% (n=459) of the salmon vertebrae were measured. The sizes of abdominal and caudal vertebrae breakdown into two distinct categories:

11mm-12mm	9%	(11)
8mm-9mm	91%	(448)

The sample is almost exclusively represented by the 8mm-9mm vertebrae, which may indicate a very high percentage of sockeye salmon (personal communication, Raymond, January 1985). This species is found in the Fraser Delta area in the late summer and fall (Hart 1973:119).

Salmon and flatfish are the major fish resources. Although sculpins are present in greatest number of species (n=3) and frequency of remains (n=19) at DhRt 4 of all three

Table 4.29: Distribution of Fish Bone Types, Musqueam NE Site (DhRt 4)[1].

Taxa / Bone Type	Only Vertebrae[2] (+/-)	Only Skull (+/-)	Skull & Vertebrae (+/-)	Misc. Bones (+/-)
Sturgeon	-	-	-	+
Pacific Herring	+	-	-	-
Salmon	+	-	-	-
Steelhead Trout	+	-	-	-
Eulachon	+	-	-	-
Pacific Cod	-	-	+	-
Pacific Hake	+	-	-	-
Walleye Pollack	-	+	-	-
Pile Perch	-	+	-	-
Rockfish	-	-	+	-
Lingcod	-	-	+	-
Great Sculpin	-	+	-	-
Staghorn Sculpin	-	-	+	-
Sculpin	-	-	+	-
Pacific Halibut	-	-	+	-
Rock Sole	+	-	-	-
Starry Flounder	-	+	-	-
Flatfish	-	-	+	-
Minnow	-	+	-	-
TOTAL	6	5	7	1

[1] The cartilaginous fish in the assemblage (e.g. spiny dogfish, ratfish, and big skate) are excluded from this table.

[2] Atlases and spines are included in the "Only Vertebrae" category.

Locarno Beach culture assemblages, sculpins do not contribute as much to the Locarno Beach culture diet as sturgeon, whose weight can reach 1 ton per individual (Hart 1973:84). Matson (1981a:73,75) suggests that sturgeon was an important fish resource in the Glenrose Marpole component, located upriver from DhRt 4.

Summary of fish remains

Of the three major taxonomic groups (mammal, bird, and fish), the recovery and consequently the sample size of fish remains in the three assemblages have been greatly affected by excavation methodology and museum curation. Nevertheless, the fish data described above permit the initial pattern detection of fish resource utilization for each assemblage.

The number of identifiable fish remains (n=5580) in the three Locarno Beach culture samples is greater than the sum total of non-human mammal (n=191) and bird (n=1042) remains. With respect to the total number of fish remains in each assemblage (DhRt 6, n=680; DfRs 3, n=679; DhRt 4, n=4221), there is little variation in the number of species present in each assemblage (DhRt 6, n=17; DfRs 3, n=14; DhRt 4, n=22).

Because of low frequency of paired skeletal elements for fish remains, MNI cannot be calculated for fish. As a

second choice, E is used cautiously in tests of significance because of the unknown degree of interdependence of skeletal elements.

The relationship between salmon and other fish is illustrated in Table 4.30, which excludes small fish data (e.g. pacific herring, eulachon, surf smelt, and northern anchovy). In each Locarno Beach culture assemblage, salmon are more abundant than the other fish. Salmon vary from 59% to 78% of the samples. A X^2 value of 63.09 indicates that the proportion of salmon and all other fish is significantly different at the .001 level. Thus, the contribution of salmon varies from site to site.

Salmon are represented by only vertebrae; cranial bones are absent from all assemblages. Similar patterning of salmon skeletal remains has occurred in all documented Fraser Delta sites, including Beach Grove, DgRs 1 (personal communication, Boyd, December 1980), St. Mungo, DgRr 2 (Calvert, personal communication, November 1981), Glenrose, DgRr 6 (Casteel 1976b), the Marpole component at Whalen Farm, DfRs 3 (Seymour 1976) and Crescent Beach, DgRr 1 (Ham, personal communication, July 1981). Ham (1982) argues that this patterning of salmon remains in the late prehistoric period represents the use of "preserved salmon backs" with intact vertebral columns, or a type of fish-jerky used by Northwest Coast hunters at seasonal, limited activity sites.

Table 4.30: Comparison of Salmon and Other Fish Remains (Excluding Small Fish Species), All Assemblages, E.

Taxa / Site	DhRt 6	DfRs 3	DhRt 4
Salmon	78 (281)	66 (446)	59 (2470)
Other Fish	22 (77)	34 (232)	41 (1748)
TOTAL	358	678	4218

H_o : Equal proportions of salmon and other fish.

Reject at .001, $X^2 \geq 13.815$ at 2 degrees of freedom.

For E -
$X^2 = 63.09$
significant at
$p = .001$
reject H_o

That only salmon vertebral elements occur in Locarno Beach culture components suggests this may have also occurred earlier on the delta. As in later prehistoric periods, this patterning may also be related to salmon procurement and preservation technology.

The diameter of salmon vertebrae may be useful in determining what species are present in the fish assemblages. Although there is no published documentation to support it, the following relationship is suggested for the sake of argument based on published living weights (Hart 1973:106-126) and communications with a salmon fishery expert (Raymond, January 1985) and archaeologists working in this area (Ham, July 1981, Matson, January 1983, Wigeon, July 1984):

Salmon Vertebrae Diameter	Species
13mm-15mm	Chinook
11mm-12mm	Chum or Coho
8mm-9mm	Sockeye

Based on this assumption, it appears that two species of salmon are represented in the DhRt 6 assemblage (sockeye and chum or coho), three species in the DfRs 3 assemblage (chinook, chum or coho, and sockeye), and at least 1 species in the DhRt 4 assemblage (sockeye). If the relationship between vertebrae diameter and species of salmon is upheld and if present seasonality of salmon in the Fraser Delta

area can be pushed back 3000 years as suggested by Fladmark (1975), it would seem that there is evidence to suggest that people during the Locarno Beach culture exploited salmon runs from early spring to late fall.

The high percentage (91%) of 8mm-9mm vertebrae in the DhRt 4 assemblage indicates that sockeye salmon might have been exploited in the nearby Fraser River. Croes (1975:57) suggests that nets and net anchors in the DhRt 4 waterlogged component (2450 B.P.) may have been used for salmon procurement. The co-occurence of large, durable baskets in the waterlogged component could also have been used to carry or store large quantities of fish (Croes 1975:38). Ethnographic evidence supports the hypothesis of sockeye salmon trawling off the Fraser Delta's sand bars and shoals during August and September (Berringer 1982:53). However, at this time, it cannot be determined if the sockeye vertebrae were a preserved resource used during the winter or whether they represent evidence of on-site salmon processing.

Regardless of the aforementioned attempt to identify what species of salmon are present in the three Locarno Beach culture assemblages, there appears to be enough evidence at DhRt 4 to indicate a 3000+ year chronology of intensive salmon fishing in the Fraser River.

Flatfish are also an abundant fish resource. They were probably attracted to the delta and estuary by spawning fish (e.g. herring, smelt, and others), as well as shellfish. Spiny dogfish, pacific halibut, and ratfish occur infrequently in the Fraser Delta's Locarno Beach culture assemblages. These fish usually dwell in the deep waters of the delta foreslope. However, their low frequency in each assemblage indicates that they may also have been attracted to the estuary or rivers to feed on spawning fish (e.g. salmon, pacific herring, surf smelt, etc.).

The low frequency of pacific halibut in the Fraser Delta during the Locarno Beach culture contrasts with contemporaneous evidence at the Hoko site (45 ca 213) on the Washington peninsula (Croes and Hackenberger 1984). At Hoko, deep-water fish explotation is inferred from the co-occurence of high percentages of halibut remains and halibut hooks. The Fraser Delta assemblages lack a deep water fishing tool kit (e.g. halibut hooks) (Appendix, Table B.1). The low frequency of deep water dwelling fish in the Locarno Beach culture Fraser Delta assemblages supports the lack of a deep water exploitative fishing strategy.

Season of Exploitation

Mammals

The small sample of mammal remains prevents using relative frequencies of bone skeletal elements as seasonality markers. As an alternative, presence-absence information is illustrated in Table 4.31. A problem arises in classifying harbour seal remains. It is difficult to distinguish adult seal and sub-adult individuals from the typically unfused remains of adult specimens. Since seals are present year round in the delta area (Table 2.2), they are classified as being present in each seasonality category (Table 4.31).

Juvenile deer indicates summer-to-fall occupation at DhRt 6 and DhRt 4. Juvenile bear further supports this seasonality at DhRt 6. The presence of immature raccoon in all assemblages may also indicate summer seasonality.

Birds

Using the seasonal categories based on Ham (1982) and Hoos and Packman (1974) for the Fraser Delta area (Table 2.5) the bird remains were grouped into three categories by MNI values: (1) year round; (2, 3, 4) winter (September to April) and; (5) Spring and/or fall. The presence of medullary or immature bone is taken into consideration in a fourth category, which suggests a summer season of death.

Table 4.31: Presence-Absence of Non-Adult Mammal Fauna, All Assemblages.

	Winter	Spring	Summer	Fall
DhRt 6				
Harbour Seal	+	+	+	+
River Otter	-	+	-	-
Deer	-	-	+	+
Black Bear	-	-	+	+
Raccoon	-	-	+	+
DfRs 3				
Harbour Seal	+	+	+	+
Raccoon	-	-	+	+
Muskrat	-	-	+	+
DhRt 4				
Harbour Seal	+	+	+	+
Deer	-	-	+	+
Raccoon	-	-	+	+

These broad groupings of seasonality categories were used to reflect the time of the year when the species in question were most likely to be present in their greatest abundance and hence, most likely to have been exploited. Calvert (1980:225) employs a similar methodology at Hesquait Harbour.

The results of classifying Locarno Beach culture bird data by seasonality categories is illustrated in Table 4.32. Year round and spring/fall seasonality are present in low percentages for each assemblage. Very high percentages of MNI occur in the winter/early spring category (i.e. September to April) in all assemblages. This contrasts with very low percentages for summer exploitation. At DfRs 3, unspecified duck remains include two matched immature bones and two radii with medullary bone. The suggested season of death is summer. One immature bone of northwestern crow at DhRt 4 could support this seasonality. Therefore, although evidence for bird exploitation exists at all sites for most of the seasons, there appears to be a major exploitation of avifauna (predominately diving waterfowl) from September to April. Summer exploitation of immature or nesting birds seems insignificant.

Table 4.32: Seasonality of Avifauna, All Assemblages, MNI[1].

Season / Site	DhRt 6 %	DhRt 6 (MNI)	DfRs 3 %	DfRs 3 (MNI)	DhRt 4 %	DhRt 4 (MNI)
Year Round (1)	17	(8)	12	(19)	12	(13)
Winter/ Early Spring (2, 3, 4)	81	(37)	85	(130)	87	(93)
Spring/Fall (5)	2	(1)	1.1	(2)	0	(0)
Summer (Medullary or immature bone)	0	(0)	1.9	(3)	1	(1)
TOTAL[2]		46		154		107

[1] Raw data for categories 1 - 5 in Table 4.32 are listed in Appendix, Table D.3.

[2] Unspecified duck remains are excluded.

Fish

Like mammals and birds, few fish species of the Fraser Delta area can be used as seasonality indicators based on only their presence or absence. Four exceptions are pacific herring, which run along shallow water beaches from late winter to early spring (or February through April); plainfin midshipmen and sole, which spawn in the intertidal zone during spring and early summer; and surf smelt, which also spawn in the intertidal zone during the summer. Salmon are available year round in the study area, although sockeye group and run in the summer and fall. In addition, salmon butchery, preservation, and storage techniques preclude their use in seasonality studies based on presence-absence data. Thus, the salmon sample (Category 6, Table 2.7) from each assemblage is excluded from the present discussion.

Using seasonality information defined by Ham (1982) (Table 2.7), the fish remains were grouped by bone element into four categories: (1) year round; (2, 3) spring and early summer; (4, 5) summer; and (7) winter and early spring. Since the frequency of the small-sized fishes (e.g. pacific herring, eulachon, surf smelt, and northern anchovy) was affected by differential recovery techniques (see Chapter 3), their bone elements are included cautiously in Table 4.33.

Table 4.33: Seasonality of Fish Fauna, All Assemblages, E[1].

Season / Site	DhRt 6 % (E)	DfRs 3 % (E)	DhRt 4 % (E)
Year Round (1)	4 (16)	7.6 (18)	17.8 (312)
Spring/Early Summer (2, 3)	71 (282)	92 (215)	81.7 (1429)
Summer (4, 5)	2 (8)	0 (0)	0.1 (2)
Late Winter/ Early Spring (7)	23 (93)	0.4 (1)	0.4 (8)
TOTAL	399	234	1751

[1] Raw data for Table 4.33 are listed in Appendix Table D.4.

The seasonality of fish exploitation at DfRs 3 and DhRt 4 appears to be similar. High percentages of E occur in the spring/early summer category with low percentages of E in the summer. A similar environmental setting for these sites may account for this relationship. A winter/early spring exploitation is confirmed for all assemblages because of the presence of pacific herring, even though low percentages of E occur in the DfRs 3 and DhRt 4 assemblages. As discussed earlier, the winter/early spring data may be skewed due to the possible poor recovery of pacific herring.

The highest percentage of E for DhRt 6 occurs in the spring/early summer category principally due to the high frequency of surf smelt (n=233). The interpretation is that this site might have been occupied during the summer smelt runs. Historic information supports this hypothesis so that DhRt 6 may have a 3000+ year chronology of smelt procurement. The fish seasonality data (excluding salmon) suggest that fish exploitation took place during the winter through early summer months at DhRt 6 and mainly during the winter and spring at DfRs 3 and DhRt 4.

Locarno Beach culture seasonality

During the Locarno Beach culture, there is exploitation of a wide variety of vertebrate resources, probably over a long term basis at each site. Based on faunal evidence presented in this thesis, each site's seasonality is strikingly similar (Table 4.34).

In all assemblages, evidence for bird exploitation in the Fraser Delta area occurs consistently from September through April.

Late winter/early spring is also represented in each assemblage by the presence of pacific herring. A winter/early spring occupation is suggested at DhRt 6 and DfRs 3 by the co-occurence of herring and flatfish. A spring/early summer occupation at DhRt 6 is substantiated by surf smelt, which is in only this assemblage.

Pacific halibut, ratfish, and spiny dogfish are usually deep water fish throughout the year. However, their low frequency may indicate that a small number followed spawning fish to the Fraser Estuary and River.

Salmon is the most abundant fish resource in all assemblages. In all probability, Locarno Beach culture populations of the Fraser Delta took advantage of the salmon runs in the Fraser River and local streams. Nets for fishing and baskets for carrying or storing heavy loads are found in the DhRt 4 waterlogged component. Their presence

Table 4.34: Presence-Absence of Seasons for Locarno Beach Culture Vertebrate Fauna, All Assemblages.

Site / Season		Winter	Spring	Summer	Fall	Year Round
DhRt 6	Mammals	-	+	+	+	+
	Birds	+	-	-	-	+
	Fish	+	+	-	-	+
DfRs 3	Mammals	-	-	+	+	+
	Birds	+	-	-	-	+
	Fish	+	+	-	-	+
DhRt 4	Mammals	-	-	+	+	+
	Birds	+	-	-	-	+
	Fish	+	+	-	-	+

suggests that DhRt 4 may have been occupied for prolonged periods during the winter or during the long spring-to-fall salmon runs in the Fraser River.

The seasonality of non-adult mammal remains is similar in each assemblage. However, the seasonality of harbour seal and non-adult raccoon and muskrat is precarious. By excluding them from the sample, the frequency of juvenile mammal remains is reduced to four occurrences (DhRt 6, n=3; DhRt 4, n=1) in the spring and summer-to-fall. A summer seasonality coincides with eulachon and salmon runs in local streams and rivers. Two new born river otters in the DhRt 6 assemblage probably died in the spring, which would coincide with herring or possibly early smelt fishing. Nevertheless, the low frequency of occurrence suggests that non-adult mammal hunting was not the main summertime vertebrate subsistence activity. The alternative summer vertebrate subsistence activity would be fishing, especially for salmon.

Locarno Beach culture site seasonality seems to reflect similarities in (1) local ecological settings, (2) resource availability, and (3) access to habitats in which aggregations of fauna occur on a seasonal basis. It is hypothesized that vertebrate fauna were hunted or fished as they aggregated in geographically restricted areas of the delta. Groups may have inhabited a site for short periods

of time (e.g. 6 to 8 weeks) to wait for, to exploit, and to process resources, and then they left the site.

Stratigraphic evidence from DhRt 6 and DfRs 3's Locarno Beach culture components supports a hypothesis that occupation was seasonal, not year round. According to Ham's (1982:182-184) model of shell midden lensing, diagnostics of long term winter village residence are the presence of post moulds for large, permanent dwellings and level or gradually sloping stratigraphy. All three Locarno Beach culture components lack post moulds (evidence for long houses), and with respect to a cross-section that is perpendicular to the shoreline, lensing at both DhRt 6 and DfRs 3 gains approximately 2 feet in vertical provenience for every 10 foot horizontal length. This steep sloping contrasts with a 0 foot gain at DhRt 4, which according to Ham's diagnostics is unlike a seasonally occupied site and more characteristic of stratigraphy found at a long-occupied site such as a winter village. Thus far then, stratigraphic evidence supports an argument for seasonal occupation at DhRt 6 and DfRs 3, while it may be for prolonged periods at DhRt 4.

At DhRt 6 and DhRt 4, the presence of ash, charcoal, and fire-cracked rock indicates on-site food processing by stone boiling or earth ovens. According to Ham's (1982) criteria, this may be indicative of either a limited activity site or a winter village site. However, major food

processing is inferred from abundant and widespread evidence of ash, charcoal, and fire-cracked rock at DhRt 6, which may be related to the steaming of shellfish resources (Ham 1982:183).

Compared to DhRt 6, the ash, charcoal, and fire-cracked rock at DhRt 4 is less abundant and widespread, suggesting less shellfish preparation. Croes (1975:38) supports this argument: "The gathering of molluscs is probably not significant (at DhRt 4) since the stratigraphy does not have abundant mollusc remains." This pattern would also characterize a winter village occupation in Ham's model.

Habitat Exploitation

Mammals

Emphasis in habitat selection for mammals is examined by a breakdown of MNI for each assemblage by four categories (Open Littoral Waters, Riverine, Estuarine/Forest Edge, and Forest) defined in Chapter 2. By MNI, mammal exploitation occurred in each category but focused in the Estuarine/Forest Edge and Forest habitats (Table 4.35). This does not support the early Borden (1951) and Drucker (1955) hypothesis of a marine mammal exploitative pattern characterizing the Locarno Beach vertebrate subsistence economy.

Table 4.35: Mammal Habitat Categories, All Assemblages, MNI[1].

Habitat / Site	DhRt 6 % (MNI)	DfRs 3 % (MNI)	DhRt 4 % (MNI)	Total % (MNI)	Combined % (MNI)
Open Littoral Water	15 (2)	8 (1)	9 (2)	10 (5)	23 (11)
Riverine	15 (2)	17 (2)	9 (2)	15 (6)	
Estuarine/Forest Edge	24 (3)	67 (8)	59(13)	50 (24)	77 (36)
Forest	46 (6)	8 (1)	23 (5)	25 (12)	
TOTAL	13	12	22	47	47

Table 4.36: Avifauna Habitat Categories, All Assemblages, MNI[2].

Habitat / Site	DhRt 6 % (MNI)	DfRs 3 % (MNI)	DhRt 4 % (MNI)	Total % (MNI)	Combined % (MNI)
Littoral / Riverine	67 (31)	60 (91)	62 (65)	62 (187)	62 (187)
Sheltered Estuarine Water	17 (8)	30 (45)	29 (31)	28 (84)	28 (84)
Strand/Littoral Interface	9 (4)	5 (8)	1 (1)	4 (13)	10 (32)
Mixed Woodlands	7 (3)	5 (7)	8 (8)	6 (18)	
TOTAL[3]	46	151	105	302	302

[1] Appendix, Table D.5 lists raw data for Table 4.35
[2] Appendix, Table D.6 lists raw data for Table 4.36.
[3] Unspecified and immature bird remains are excluded.

Locarno Beach site, DhRt 6

Of the seven species present, five species are in the Forest and Estuarine/Forest Edge categories while only two are found in the Riverine and Open Littoral Waters. Of the 48 mammal bones in the assemblage, 70% (MNI=9) are Forest and Estuarine/Forest Edge dwelling animals. Thirty percent (MNI=4) live in the Open Littoral Waters and Riverine habitat categories. However, two river otters in this assemblage were new borns and probably not associated with a riverine setting. This situation strengthens the argument that animals of principally the Estuarine/Forest Edge and Forest area were hunted during Locarno Beach times.

Whalen Farm site, DfRs 3

Of the three Locarno Beach culture assemblages, the smallest percentage of Forest and Estuarine/Forest Edge dwelling mammals occurs in this assemblage (5 species present). This is due to the small sample size (n=48) including the absence of two large land mammals, black bear and elk. DfRs 3 may not have been the location of intensive land mammal hunting because other subsistence activities occurred there. Nevertheless, the Forest and Estuarine/Forest Edge categories represent 75% (MNI=9) of the sample. Both Riverine and Open Littoral Water animals are present and occur in the sample, (25%, MNI=3).

Musqueam NE, DhRt 4

Eighty-three mammal bones in the assemblage are associated with 7 mammal species that live in the Forest and Estuarine/Forest Edge. Three species (beaver, river otter, and harbour seal) account for the Riverine and Open Littoral Water species. They account for 18% (MNI=4) of the mammal assemblage, while the Forest and Estuarine/Forest Edge dwelling fauna represent 82% (MNI=18) of the sample.

Birds

Four categories defined in Chapter 2 are used to examine bird habitat exploitation in the Fraser Delta area. Unspecified duck and immature bird have been excluded from the raw data by MNI. The data for each assemblage separate into three areas of habitat exploitation: (1) Littoral/Riverine Water; (2) Sheltered Estuarine Water; and (3) Strand/Littoral Interface and Mixed Woodlands (hereafter termed Strand-Uplands) (Table 4.36). Whereas mammal exploitation was restricted to the beaches and uplands associated with the Forest and Estuarine/Forest Edge zones, the focus of avifauna exploitation was the foreshore of bays and rivers. Avifauna exploitation in this region is no surprise since the majority of the birds in each assemblage is waterfowl.

Locarno Beach site, DhRt 6

Of the 17 bird species present, nine species are in the Littoral/Riverine Water category; four are in the Sheltered Estuarine Water category; and four are in the Strand-Uplands category. Of the 126 bone elements identified to the level of adult species, 67% (MNI=31) represent the Littoral/Riverine category. Seventeen percent (MNI=8) represent the Sheltered Estuarine Water category, and 16% (MNI=7) fall in the Strand-Uplands habitat category.

Whalen Farm site, DfRs 3

Twenty-three bird species and 435 bone elements are in the assemblage. Eleven species in the Littoral/Riverine Waters category are 60% (MNI=91) of the sample. Five bird species of the Sheltered Estuarine Waters represent 30% (MNI=45) of the sample, while the Strand-Uplands interface component has 10% (MNI=15) and seven species.

Musqueam NE site, DhRt 4

Three-hundred, sixty-seven bird bones in the assemblage are associated with 20 bird species. Eight species occur in the Littoral/Riverine Water category and represent 62% (MNI=65) of the sample. The Sheltered Estuarine Water category is associated with six bird species (29%, MNI=31), as is the Strand-Uplands area (9%, MNI=9).

Fish

Fish habitat exploitation is examined by a breakdown of fish bone elements into three habitat areas in the delta: the Littoral Water of the delta foreslope; the Tidal Flats associated with the estuary and intertidal flats; and the Riverine areas influenced by freshwater (Table 4.37).

The number of fish species from inshore (tidal flats and riverine areas) and deep water zones (Littoral Waters) does not vary. Yet, the frequency of inshore fish remains dominates the samples. This indicates a preference for inshore species.

Locarno Beach site, DhRt 6

Of the 17 fish species recovered in the assemblage, seven species are found in the deep zone, 10 in the tidal flats and three species in the rivers. Three species (salmon, sturgeon, and midshipmen) dwell in two delta habitats depending on the season. Even though fish diversity (i.e. number of species) for the two major zones does not vary, only 5% (n=33.5) of the 680 identifiable elements in the assemblage are of fish that prefer Littoral Water habitat in the delta compared to 95% (n=646.5) that prefer the inshore tidal flats and rivers.

Table 4.37: Fish Habitat Categories, All Assemblages, E[1].

Habitat / Site	DhRt 6 % (E)	DfRs 3 % (E)	DhRt 4 % (E)	Total % (E)
Littoral Waters	5 (33.5)	7 (48)	5 (223)	5 (304.5)
Tidal Flats	74 (501.0)	60 (405)	64 (2700)	65 (3606.0)
Riverine	21 (145.5)	33 (226)	31 (1298)	30 (1669.5)
TOTAL	680	679	4221	5580

[1] Appendix, Table D.7 lists raw data for Table 4.37.

Whalen Farm site, DfRs 3

Of the 14 fish species present in the assemblage, five species including three varieties of flatfish, prefer the deep littoral water and eight species including two varieties of sculpin prefer the inshore waters. Of the 679 identifiable fish remains, deep water species represent 7% (n=48) of the assemblage. Sixty percent (n=405) of the sample is associated with the tidal flats and 33% (n=226) with the rivers.

Musqueam NE site, DhRt 4

Twenty-two fish species in this assemblage separate into nine species in the littoral zone; eleven in the inshore zone and three (salmon, sturgeon, and steelhead trout) in both major categories. Similar to DhRt 6, there is a strong preference for inshore fishing split between the Tidal Flats (64%, n=2700) and Riverine (31%, n=1298) habitats. Only 5% (n=304.5) represent deep water dwelling fish. Once again, fish diversity between the two major zones does not vary in the DhRt 4 assemblage, demonstrating an inshore fishing pattern.

Locarno Beach Culture habitat exploitative patterns

An economy emphasizing foreshore resources characterizes the Locarno Beach culture vertebrate subsistence economy. Mammal hunting focused on animals preferring Forest and Estuarine/Forest Edge areas of the Fraser Delta. Deer, elk, and black bear are major resources. Although harbour seal and river otter were exploited, they did not dominate the mammal component of each assemblage. This, in addition to the absence of evidence for the extensive hunting of whales, sea lions, and porpoises strongly supports the inference that the vertebrate subsistence economy during the Locarno Beach culture was not based on marine mammal hunting.

Procurement of avifauna focused on birds that preferred the delta's foreshore environment (i.e. estuary) and bays rather than a beach and upland setting. Waterfowl (especially diving birds) dominate each assemblage. This suggests definitive habitat selection, probably through a specialized technology such as submerged nets.

The area of habitat selection for avifauna contrasts with that of land mammal hunting, yet it is complementary. The use of different and distinctive areas within the Fraser River Delta shows that Locarno Beach culture populations of the this area took advantage of available food resources in varied environmental settings.

Locarno Beach culture fishing activities primarily focused on inshore settings. Salmon was a major fish resource. The abundance of salmon in each assemblage suggests that Fraser Delta populations took advantage of the salmon runs in two areas of the delta: (1) the estuarine approaches to the big rivers and (2) the rivers and local streams. This differs from Mitchell (1971b:57-58), who argues that "the locations of sites attributable to the (Locarno) type, do not, at present, suggest the populations had direct access to the Fraser River salmon runs in the river itself."

Harbour seal and littoral dwelling fish remains are infrequent in each assemblage. These fauna probably followed spawning salmon into the delta and in turn were caught by Locarno Beach culture fishermen. Flatfish are the second most abundant fish resource. They prevail in the inshore waters, probably feeding on spawning herring and smelt during the spring. The co-occurence of flatfish and diving waterfowl indicates that herring and smelt may also have been important resources exploited on a seasonal basis in the intertidal areas of the delta. Thus, the low frequency of herring is attributed to poor screening techniques.

Chapter 5

THE NATURE OF THE LOCARNO BEACH CULTURE SUBSISTENCE PATTERN AND ITS PLACE IN THE GULF OF GEORGIA SEQUENCE

Introduction

This chapter compares the results of the Locarno Beach culture vertebrate faunal analysis to documented data from Fraser Delta sites with St. Mungo (4300-3300 B.P.) and Marpole (2400-1200 B.P.) components. As discussed in Chapter 1, the cultural relationship between these three consecutive delta cultures is not well understood (Table 1.2). The Locarno Beach culture data are used to evaluate three hypotheses about the Locarno Beach culture vertebrate subsistence pattern and its relationship to the St. Mungo and Marpole culture patterns in the delta over the last 4500 years.

Hypotheses

Hypothesis 1: The Locarno Beach culture is characterized by a marine mammal hunting economy.

The findings of this study lead to the rejection of Hypothesis 1. Marine mammal exploitation was only part of the subsistence pattern in the Fraser Delta during the Locarno Beach culture. In contrast to evidence for the procurement of open littoral water resources (such as whales, porpoises, and sea lions) in late prehistoric components at Hoko River (45 ca 213) on the Olympic Peninsula (Wigeon 1982) and at Hesquait Harbour on the west coast of Vancouver Island (Calvert 1980), people of the Fraser Delta did not extensively exploit marine mammals during Locarno Beach times. Rather, their subsistence patterns emphasized local non-marine mammals and other non-mammal maritime resources. Harbour seal, river otter, and beaver were the only aquatic mammals captured, and by themselves, these fauna do not form a major part of the exploited vertebrate resources (Tables 4.3, 4.4, and 4.5). Harbour seal is the most abundant mammal resource in the Locarno Beach culture mammal assemblage at DfRs 3. In this case, a small sample size (n=48) and a possibly long history of a large resident group of seals in Boundary Bay (Ham

1982:25) may be factors. I would also expect to find sea lion in larger samples of Locarno Beach culture fauna, as they tend to follow spawning eulachon, herring, and salmon into the Fraser River Estuary (Guiguet 1975:347). However, during the Locarno Beach culture, there is no indication of any exploitation of exotic marine mammal fauna that are not indigenous to the Fraser Delta.

By E, salmon, land mammals, and diving waterfowl were the most important vertebrate faunal resources exploited by inhabitants of the delta. This type of subsistence pattern was probably in conjunction with shellfish gathering, as inferred from the co-occurence of flatfish, diving waterfowl, and spawning herring, and smelt. Ham (1982) and Monks (1977) have documented shellfish and herring harvesting sites in the Gulf of Georgia region during Marpole and Late Prehistoric cultures.

Taking into account its relatively large size, sturgeon may have played a more important role than its frequency of remains indicates. Matson (1981a:75) notes the importance of sturgeon in the Marpole component at DgRr 6; thus a pattern of continuity from Locarno Beach to Marpole in sturgeon exploitation is suggested.

Deer, elk, and harbour seal were the major mammals exploited during the Locarno Beach culture. Their low bone frequency in each assemblage is attributed to the "schlepp

effect" (after Perkins and Daly 1968:104). Thus, the probable rank order of importance for vertebrate fauna was fish, mammals, and waterfowl.

Identifiable leg bone fragments support the hypothesis that portions of deer or elk with large meat value were "schlepped" to the habitation site after most of the carcass was dressed. These bone fragments may also suggest some on-site artifact manufacturing. Sesamoids in each assemblage may have been brought to the site attached to hides. Both of these patterns occurred at DgRr 1 during the Late Prehistoric culture (Ham 1982:363-364) and suggest a long continuity in the use of mammal resources by Fraser Delta archaeological cultures.

This rank order for vertebrate fauna is the same for St. Mungo and Marpole cultures (Matson 1976b:295-305). The continuity in vertebrate faunal exploitation indicates that the Locarno Beach culture subsistence patterns are part of an in situ cultural development.

Hypothesis 2: During the Locarno Beach culture, seasonality of vertebrate fauna suggests year round site utilization.

The findings of this study lead to the rejection of Hypothesis 2.

Due to temperate winter conditions in the delta, few vertebrate resources are migratory. Nevertheless, in addition to remains of fauna with known age of death and bird medullary bone, there are some fauna in the delta that have been used as seasonality markers in this analysis.

Faunal and stratigraphic data in this study indicate that seasonal site utilization characterizes the DhRt 6 and DfRs 3 Locarno Beach culture assemblages. Fish provide some of the strongest evidence of seasonality. Pacific herring in all three Locarno Beach culture assemblages suggest occupation during the late winter and early spring. Migratory waterfowl winter in the delta. Their abundance in each assemblage suggests another time of year when each site was occupied. At DhRt 6, the high percentage of smelt remains suggests spring to early summer occupation. Summer occupation at DhRt 4 is suggested by eulachon remains and a small sample of juvenile mammal remains. Altogether, the evidence for seasonality indicates that Locarno Beach culture people exploited aggregated vertebrate resources in geographically restricted localities in the Fraser Delta.

Abbott (1972) suggests that the Locarno Beach culture is a seasonal variant of the Marpole culture. However, the data indicate that the Locarno Beach seasonality is similar to documented Marpole culture patterns. In both culture types, seasonal occupation is determined by convergent

aggregations of specific resources. For example, spawning smelt and herring attracted diving birds and flatfish to prey on fish roe; salmon runs in the major rivers and streams attracted seals and sturgeon that could become entangled (and hence a nuisance) in fishing nets. Consequently, all these fauna could be simultaneously captured by hunters, as Monks (1977) shows at Deep Cove and Ham (1982) at Crescent Beach.

In these cases, the Locarno Beach culture is not a seasonal variant of the Marpole culture. Rather, the Locarno Beach culture seasonality is very Marpole-like, with the addition of some summer exploitation of land mammals, smelt, and eulachon.

Hypothesis 3: During the Locarno Beach culture, salmon is the most important fish resource .

The findings of this study do not lead to the rejection of Hypothesis 3. Salmon remains constitute an overwhelming percentage of the total number of identifiable fish remains in each assemblage. This dominant percentage may partially be an artifact of the excavation methodology for each component due to screening techniques. As noted before, 1/4 inch or larger screen does not recover the small boned fish remains of pacific herring, eulachon, northern anchovy, and surf smelt. If an inferential extrapolation occurred for

each assemblage that had some small boned fish, it would proportionally increase the percentage of the small fish and decrease the percentage of the salmon. Why bother going after small fish when one could have the larger salmon? Why not, if there are fresh small fish to eat instead of preserved salmon. Oil from pacific herring, surf smelt, and eulachon would also be an important resource. This situation would certainly account for the large numbers of vertebral salmon remains in each assemblage—a pattern similar to what Ham (1982) discusses in the late prehistoric material at Crescent Beach and to what Calvert (personal communication, January 1982) found in all components at the St. Mungo site.

This contrasts with patterns detected at a freshwater site near Lake Washington in Renton, Washington. Butler (personal communication, August 1983) found heads of spawning male and female salmon (possibly sockeye) in 2000 year old sites. This evidence casts some doubt on the hypothesis that spawning salmons' skull remains deteriorate faster in middens than non-spawning salmon.

A Comparison of St. Mungo, Locarno Beach, and Marpole Culture Vertebrate Subsistence Patterns

In order to evaluate the relationship between the St. Mungo, Locarno Beach, and Marpole subsistence economies, a comparison of vertebrate faunal assemblages that represent each culture is presented.

The comparative data base include:

1. Marpole components at Glenrose Cannery, DgRr 6—Glenrose I (Matson 1976a, 1981a, Casteel 1976b, Imamoto 1974, 1976)

2. Beach Grove, DgRs 1—Layers A, B, C, D, and E (Matson et. al 1981)

3. St. Mungo components at Glenrose Cannery, DgRr 6 (Matson 1976a 1981a; Casteel 1976b; Imamoto 1974, 1976) and St. Mungo Cannery, DgRr 2— St. Mungo Iab (Calvert 1970; Boehm 1973ab).

The Locarno assemblages in this study are used as comparative data for the Locarno Beach culture.

As with the comparison of data from different sites and excavators, excavation methodology is problematic in a comparative study, as are units of quantification (i.e. levels or layers) and units of measurement (i.e. number of skeletal elements [E], minimum number of individuals [MNI], or weight of identifiable bone) in the respective site reports.

To avoid problems associated with the comparison of different units of quantification and measurement in faunal

studies, one must use data having the "least common denominator." In this analysis, a combination of "least common denominators" is used depending on (1) the sites being compared and (2) the major taxonomic groups being compared. Presence-absence information of vertebrate fauna from all assemblages for all components is used to establish continuity of subsistence activities based on procurement of resources identified for each vertebrate assemblage. By comparing the frequency data from each assemblage across the three cultures, variations in resource utilization and seasonality are addressed.

Results

Based on presence-absence, the same major types of vertebrate fauna were exploited in the delta throughout the St. Mungo, Locarno Beach, and Marpole cultures. Mammal hunting focused on land fauna (Table 5.1); bird procurement emphasized the waterfowl associated with the foreshore areas of bays and rivers (Table 5.4); and fishing included those types available in the delta today (Table 5.7). Variations within major animal classes (i.e. mammals, birds, and fish) for all three cultures permit a closer examination of Locarno Beach's relationship to the St. Mungo and Marpole cultures.

Mammals

Emphasis on mammal hunting is examined by a breakdown of mammal remains for all assemblages into aquatic and land mammal categories. By both number of species present (i.e. diversity) and by bone count, land mammals comprise an overwhelming majority of the mammal remains in each St. Mungo, Locarno Beach, and Marpole assemblages (Tables 5.1 and 5.2).

Deer and elk are the focus of land mammal hunting activities throughout the last 4500 years (Appendix, Table E.1). They are large animals with high meat value. With the exception of one sea lion from the DgRs 1 Marpole component and river otter in the three Locarno Beach components, harbour seal and beaver are consistently the only aquatic mammals present in all three delta archaeological cultures. The lack of different types of large marine mammals and their consistently low frequency of remains in each assemblage undermines the Borden (1951) and Drucker (1955) hypothesis of an incipient marine mammal subsistence economy in the delta during the Locarno Beach culture.

Boehm (1973ab) and Imamoto (1974) explain the presence of harbour seal in St. Mungo and Marpole components at DgRr 2 and DgRr 6, respectively as part of an ethnographically reported pattern of clubbing whelping seals

Table 5.1: Presence-Absence of Mammal in St. Mungo, Locarno Beach, and Marpole Components from Fraser Delta Sites.

	St. Mungo		Locarno Beach			Marpole	
	DgRr 6 %(n)	DgRr 2 %(n)	DhRt 6 %(n)	DfRs 3 %(n)	DhRt 4 %(n)	DgRr 6 %(n)	DgRs 1 %(n)
Land Mammals							
Elk	+	+	+	-	+	+	+
Deer	+	+	+	+	+	+	+
Black Bear	+	+	+	-	+	+	-
Canis	+	+	+	+	+	+	+
Porcupine	-	+	-	-	-	-	-
Raccoon	+	+	+	+	+	-	+
Squirrel	-	-	-	-	-	-	+
Striped Skunk	-	-	-	+	-	-	-
Peromyscus	+	+	-	-	+	+	+
Mink	-	+	-	-	+	+	+
Muskrat	-	+	-	+	-	-	-
	40(6)	60(9)	33(5)	33(5)	46(7)	40(6)	46(7)
Aquatic Mammals							
Beaver	+	+	-	+	+	+	+
River Otter	-	-	+	+	+	-	-
Harbour Seal	+	+	+	+	+	+	+
Northern Fur Seal	-	-	-	-	-	-	+
	13(2)	13(2)	13(2)	20(3)	20(3)	13(2)	20(3)
TOTAL %(n)	53(8)	73(11)	46(7)	53(8)	66(10)	53(8)	66(10)

Table 5.2: Comparison of Land and Aquatic Mammal Remains in St. Mungo, Locarno Beach and Marpole Componants, E[1].

	St. Mungo		Locarno Beach			Marpole	
	DgRr 6 %(E)	DgRr 2 %(E)	DhRt 6 %(E)	DfRs 3 %(E)	DhRt 4 %(E)	DgRr 6 %(E)	DgRs 1 %(E)
Land Mammal	69(149)	68(189)	79(38)	69(33)	87(83)	84(64)	86(66)
Aquatic Mammal	31 (67)	32 (91)	21(10)	31(15)	13(12)	16(12)	14(11)
TOTAL	216	280	48	48	95	76	77

[1] Appendix, Table E.1 lists raw data for Table 5.2.

in Harrison Lake or on the shores of the Fraser River (Barnett 1955). Although this possibility might account for the presence of two newborn river otter in the Locarno Beach component at DhRt 6, it would be a difficult task to club whelping seal, as seal whelp in large herds to protect new borns. An alternative hypothesis is that seal are "attracted to the location of net fishing" (Croes 1975:58). Nets are among the perishable remains found in the DhRt 4 waterlogged components. This situation may be broadened to include sea lion, which dwell in the Gulf Islands during the winter, and the river otter during the procurement of any aggregation of maritime resources, such as fish (e.g. pacific herring or surf smelt), waterfowl (e.g. diving ducks) or shellfish. However, at this time, I can not verify any of these hypotheses, so all of them remain viable possibilities.

The known age of non-adult bone remains is used to compare the seasons of exploitation for mammals in the St. Mungo and Marpole assemblages at DgRr 6 to those from the Locarno Beach components at DhRt 6, DfRs 3, and DhRt 4. Age of death for mammal remains was not discussed in the St. Mungo (Calvert 1973) or Beach Grove (Matson et. al 1981) site reports. These sites are excluded from the present discussion. Table 5.3 illustrates that summer-to-fall exploitation of juvenile mammals took place in all three

Table 5.3: Seasons Represented in Mammal Assemblages Based on Presence-Absence of Known Age, St. Mungo, Locarno Beach, and Marpole Cultures.

Site / Season	Winter	Spring	Summer	Fall
ST. MUNGO				
DgRr 6				
Deer	-	-	+	+
Elk	-	-	+	-
LOCARNO BEACH				
DhRt 6				
Harbour Seal	+	+	+	+
River Otter	-	+	+	+
Deer	-	-	+	+
Black Bear	-	-	+	+
Raccoon	-	-	+	+
DfRs 3				
Harbour Seal	-	+	+	+
Raccoon	-	-	+	+
Muskrat		-	+	+
DhRt 4				
Harbour Seal	+	+	+	+
Deer	-	-	+	+
Raccoon	-	-	+	+
MARPOLE				
DgRr 6				
Harbour Seal	+	+	+	+
Deer	-	-	+	+

cultures. Although this type of analysis does not preclude hunting of adult species at other times of the year, it does emphasize some similarity in delta mammal hunting patterns.

Birds

Emphasis in bird utilization is examined by a breakdown of bird remains in the two St. Mungo, three Locarno Beach, and two Marpole components into waterfowl and upland fowl categories. In both number of species present and bone count, waterfowl predominate in all assemblages (Tables 5.4 and 5.5).

A change in the type of waterfowling occurs between St. Mungo to Locarno Beach cultures and Locarno Beach to Marpole cultures (Table 5.6). Frequency data (E) for the St. Mungo components at DgRr 6 and DgRr 2 and the Marpole components at DgRs 1 and DgRr 6 indicate an emphasis in surface-feeding waterfowl, whereas frequency data from the Locarno Beach components at DhRt 6, DfRs 3, and DhRt 4 suggest a selection for diving waterfowl.

This relationship may be related to site locations. Diving waterfowl feed on herring and smelt, which do not spawn in freshwater (Hart 1973:97-99, 148-150). Thus, diving birds, herring, and smelt would not be as easily available to DgRr 2 and DgRr 6.

Table 5.4: Presence-Absence of Bird in St. Mungo, Locarno, and Marpole Components from Fraser Delta Sites.

	St. Mungo		Locarno			Marpole	
	DgRr 6 %(n)	DgRr 3 %(n)	DhRt 6 %(n)	DfRs 3 %(n)	DhRt 4 %(n)	DgRr 6 %(n)	DgRs 1 %(n)
Diving Waterfowl							
Loons	+	+	+	+	+	-	-
Grebes	+	+	+	+	+	-	+
Cormorants	-	+	-	+	-	+	+
Murres/Murrelets	-	+	+	-	-	-	-
Diving Ducks	-	+	+	+	+	-	+
	17(2)	42(5)	34(4)	34(4)	25(3)	8(1)	25(3)
Surface-Feeding Waterfowl							
Geese	+	+	+	+	+	+	+
Swans	+	+	-	-	-	-	-
Surface-Feeding Ducks	-	+	+	+	+	-	+
	17(2)	25(3)	17(2)	17(2)	17(2)	8(1)	17(2)
Scavenging Waterfowl							
Gulls	-	+	+	+	+	-	+
Other Scavengers	-	+	-	+	-	-	-
	0(0)	17(2)	8(1)	17(2)	8(1)	0(0)	8(1)
Upland Fowl							
Upland Fowl	+	+	+	+	+	-	+
	8(1)	8(1)	8(1)	8(1)	8(1)	0(0)	8(1)
Other							
Unspecified Ducks	+	+	+	+	+	+	-
	8(1)	8(1)	8(1)	8(1)	8(1)	8(1)	0(0)
TOTAL	50(6)	100(12)	75(9)	84(10)	66(8)	24(3)	58(7)

Table 5.5: Comparison of Waterfowl and Upland Fowl in St. Mungo, Locarno Beach, and Marpole Components from Fraser Delta Sites, E[1].

	St. Mungo		Locarno Beach			Marpole	
	DgRr 6 %(E)	DgRr 2 %(E)	DhRt 6 %(E)	DfRs 3 %(E)	DhRt 4 %(E)	DgRr 6 %(E)	DgRs 1 %(E)
Waterfowl	94(30)	88(199)	91(143)	91(434)	94(382)	100(17)	82(147)
Upland Fowl	6 (2)	12 (27)	9 (15)	9 (45)	6 (23)	0(0)	18 (33)
TOTAL[2]	31	226	158	479	405	17	180

Table 5.6: Comparison of Diving Waterfowl and Surface-feeding Waterfowl in St. Mungo, Locarno Beach, and Marpole Components for Fraser Delta Sites, E[3].

	St. Mungo		Locarno Beach			Marpole	
	DgRr 6 %(E)	DgRr 2 %(E)	DhRt 6 %(E)	DfRs 3 %(E)	DhRt 4 %(E)	DgRr 6 %(E)	DgRs 1 %(E)
Diving Waterfowl	7(2)	33 (46)	82(83)	68(255)	72(249)	33(5)	35(49)
Surface-feeding Waterfowl	93(29)	67 (94)	18(15)	32(122)	28 (95)	67(10)	65(93)
TOTAL[4]	29	140	101	377	344	15	142

[1] Appendix, Table E.2 lists raw data for Table 5.5.
[2] Unspecified duck is included in this total.
[3] Appendix, Table E.2 lists raw data for Table 5.6.
[4] Unspecified duck is excluded from the total.

It is interesting to note that the DgRs 1 Marpole component lacks an abundance of diving waterfowl, especially in view of its close proximity to the DfRs 3 Locarno component (separated by approximately 1.5 miles along the same shoreline). Matson et. al (1981:52) believe that DgRs 1 was occupied for "prolonged periods" as indicated by a wide range of species (mammals, birds, and fish) present. The DfRs 3 assemblage also reflects species diversity, but quantitative and stratigraphic evidence indicate that the site was occupied for a short period. Thus, the high percentage of diving waterfowl at DfRs 3 is probably more related to length of occupation than site location within the study area.

The alternation in waterfowl data may also be related to a change in waterfowl procurement strategies. In the previous chapter, the development of submerged net fowling technology was raised as a possible interpretation for the dominance of diving birds in the Locarno Beach components. This may be substantiated by the absence of a high diving to surface-feeding bird ratio in the St. Mungo component, although it certainly does not preclude the possibility that such a technology existed during the St. Mungo times.

Fish

In the previous chapter, it was established that Locarno Beach subsistence patterns emphasized the exploitation of inshore fish (i.e. tidal flats and riverine species). The same pattern occurs in St. Mungo and Marpole cultures. In a comparison of presence-absence data for two St. Mungo components (DgRr 6, DgRr 2), three Locarno Beach components, and two Marpole components (DgRr 6, DgRs 1) species of the tidal flats and rivers predominate (Table 5.7). With the exception of spiny dogfish and English sole, littoral fish species are absent from the St. Mungo and Marpole components. It follows then that a low frequency of deep water fish for St. Mungo, Locarno Beach, and Marpole culture components is attributed to a lack of deep water fishing in the Gulf of Georgia area (Table 5.8). This is supported by the absence of a deep water fishing tool kit in assemblages from all three archaeological cultures (Borden 1970, Calvert 1970, Matson 1974). Thus, fish exploitation appears to have focused in the inshore areas (e.g. tidal flats and rivers) for the last 4300 years of Gulf of Georgia prehistory.

The presence of pacific herring in archaeological sites has been used as a seasonality indicator for late winter through early spring occupation (Monks 1977, Matson 1976a, Matson et. al 1981, Ham 1982). Herring are absent in the

Table 5.7: Presence - Absence Data for Fish in St. Mungo, Locarno Beach, and Marpole Components from Fraser Delta Sites.

	St. Mungo		Locarno Beach			Marpole	
	DgRr 6 (Col.)	DgRr 6 (Unit)	DhRt 6 (Unit)	DfRs 3 (Unit)	DhRt 4 (Unit)	DgRr 6 (Col.)	DgRr 6 (Unit)
Littoral Water							
Spiny Dogfish	-	+	+	+	+	-	+
Ratfish	-	-	+	-	+	-	-
Northern Anchovy	-	-	+	-	-	-	-
Pacific Hake	-	-	+	-	+	-	-
Petrale Sole	-	-	-	+	-	-	-
Pacific Halibut	-	-	+	+	+	-	-
English Sole	-	-	-	+	-	-	+
Ratfish	-	-	-	-	+	-	-
Lingcod	-	-	-	-	+	-	-
Pacific Cod	-	-	+	+	+	-	-
Walleye Pollack	-	-	-	-	+	-	-
Big Skate	-	-	-	+	+	-	-
Plainfin Midshipman	-	-	+	-	-	-	-
%(n)	0(0)	3(1)	23(7)	20(6)	30(9)	0(0)	7(2)
Tidal Flats							
Pile Perch	-	-	+	-	+	-	-
Great Sculpin	-	-	-	-	+	-	-
Buffalo Sculpin	-	-	+	-	-	-	-
Staghorn Sculpin	-	-	-	+	+	-	+
Sculpin	-	-	-	+	+	-	+
Rock Sole	-	-	+	+	+	-	+
Rex Sole	-	-	-	-	-	-	+
Starry Flounder	-	-	+	+	+	-	+
Flatfish	+	+	+	+	+	-	+
Pacific Herring	-	-	+	+	+	+	+
Surf Smelt	-	-	+	-	-	-	-
%(n)	3(1)	3(1)	23(7)	20(6)	27(8)	3(1)	2(7)
Riverine							
Salmon	+	+	+	+	+	+	+
Sturgeon	+	+	+	+	+	-	+
Steelhead Trout	-	-	-	-	+	-	-
Eulachon	+	-	+	-	+	-	+
Stickleback	+	-	-	-	-	-	-
Minnow	+	+	-	-	+	-	-
%(n)	17(5)	10(3)	10(3)	7(2)	17(5)	3(1)	10(3)
TOTAL	20(6)	17(5)	57(17)	50(15)	73(22)	7(2)	40(12)

At DgRr 2 — Salmon, Sturgeon, Pea-mouth Chub, Flatfish and Spiny Dogfish were also identified.

Table 5.8: Identified Fish Remains for St. Mungo, Locarno Beach, and Marpole Assemblages from Fraser Delta Sites, E.

	St. Mungo	Locarno Beach			Marpole
	DgRr 6 (Column) %(E)	DhRt 6 (Unit) %(E)	DfRs 3 (Unit) %(E)	DhRt 4 (Unit) %(E)	DgRr 6 (Column)
Littoral Water					
Spiny Dogfish	-	1	8	13	-
%(n)	0(0)	.1(1)	1(8)	.3(13)	0(0)
Tidal Flats					
Starry Flounder	1	5	36	184	-
Flatfish	2	32	163	1194	-
Pacific Herring	-	79	1	2	2
Surf Smelt	-	233	-	-	-
%(n)	.5(3)	51(349)	29(200)	33(1380)	5(2)
Riverine					
Eulachon	52	2	-	1	-
Stickleback	18	-	-	-	-
Minnow	-	-	-	7	-
Salmon	154	281	466	2470	4
Sturgeon	2	6	6	180	-
%(n)	35(226)	43(289)	67(452)	61(2586)	25(4)
Other[1]	414	41	19	242	14
%(n)	64.5(414)	5.9(41)	3(19)	5.7(242)	70(14)
TOTAL	643	680	679	4221	20

[1] "Other" includes ratfish, anchovy, hake, lingcod, Pacific cod, walley pollack, skate, perch, and sculpin.

St. Mungo components at DgRr 2 and DgRr 6. The St. Mungo culture faunal data include both material screened through 1/4 inch mesh at DgRr 2 and DgRr 6 and carefully-collected column samples at DgRr 6. In contrast, herring remains are present in the Marpole column sample at DgRr 6, the Marpole component at Beach Grove (DgRr 1), and the three Locarno Beach culture components in this study (DhRt 6, DfRs 3, and DhRt 4).

Matson (1976b:93) attributes the lack of herring in St. Mungo components and its presence in Marpole components to the development and use of "herring rakes." These were observed in the ethnographic period as a method of capturing large aggregations of spawning herring in shallow sheltered waters (Suttles 1951:126-127). Carlson (1960:580, Figure 4D, E, F) describes herring rake barbs as "small, symmetric bone barbs with a circular cross-section and a fairly abrupt wedge-shaped butt." The presence of herring and rake-size bone points and fragments (Appendix, Table B.1) in all Locarno Beach components may push back the development and use of this procurement technology for herring.

Salmon exploitation has a long prehistory in the Fraser Delta. Based on evidence from the Glenrose Cannery site (DgRr 6), Matson (1981:73,75) reports that salmon were probably the most important resource during the St. Mungo and Marpole cultures. This pattern continues throughout the

Locarno Beach culture. Yet, is there a difference in St. Mungo, Locarno Beach, and Marpole salmon exploitation?

The DhRt 4 Locarno Beach component yields salmon packing baskets, salmon-gauge fishing nets (personal communication, Croes, July 1984), and a high percentage of 8mm-9mm salmon vertebrae (91%). This information suggests intensive exploitation of Fraser River salmon runs. The size of vertebrae may suggest a selection for sockeye salmon, which run in the Fraser River from late summer to fall. To date, there is no such evidence for known St. Mungo culture components.

Such an intensive exploitation of salmon in the fall would probably have necessitated some preservation and storage technology. However, this is highly speculative at this time. With the exception of packing baskets, there is no evidence to suggest that the Locarno Beach culture people had a method for storing salmon. This contrasts with evidence for storage technology during the Marpole culture (Burley 1980:70-72). Nevertheless, Burley (1980:71) points out that "although the potential for storage may have been present during the Locarno Beach culture, it had yet to be fully developed."

Discussion

What are the differences between St. Mungo, Locarno Beach and Marpole vertebrate subsistence patterns?

Faunal and stratigraphic evidence suggest that DhRt 6 was a seasonal resource extraction site during the Locarno Beach culture. The abundance of herring and surf smelt remains in the assemblage indicates that these resources were procured during their respective spawning seasons (i.e. herring February to April; surf smelt; April to June). In addition, the steep sloping stratigraphy associated with large rolling shell middens at this site attest to the probable importance of seasonal shellfish gathering and on-site shellfish preparation (i.e. steaming). By the Locarno Beach culture, the simultaneous aggregation of spawning herring or smelt with shellfish and other resources suggests that DhRt 6 was occupied for short periods (perhaps five or six weeks) at any one time between late winter and early summer. This pattern is very similar to ethnographic Northwest Coast seasonal camps described by Barnett (1955:18-19) and Suttles (1951:261).

This situation differs from the St. Mungo vertebrate subsistence patterns at DgRr 6 and DgRr 2. To date, a pattern of aggregated resource procurement (a la herring-flatfish-waterfowl-shellfish) has not yet been documented for the St. Mungo culture. The procurement of aggregated

resources (such as diving waterfowl and herring) may have been possible by the development of new technology, such as submerged nets and "herring rakes."

Vertebrate remains of aggregated resources from the Locarno Beach component at DfRs 3 support this hypothesis. That a large harbour seal herd existed 3000 years ago in Boundary Bay, as it does today (Ham 1982:25), may account for the high frequency of seal in the DfRs 3 mammal assemblage during the Locarno Beach culture. The presence of large diameter (13-15mm) salmon vertebrae in the DfRs 3 assemblage may suggest that Chinook salmon (personal communication, Raymond, January 1985), which arrive in the Boundary Bay area at the same time as spawning herring, were obtained in Boundary Bay during the Locarno Beach culture. Thus, DfRs 3 may have been a location for early season salmon procurement. However, salmon fishing was probably not as important at this site as was herring and shellfish procurement, as inferred from the co-occurence of flatfish, diving waterfowl, and the shell midden.

Many similarities exist between the Locarno Beach component at DfRs 3 and the Marpole component at DgRs 1. The two sites are about 1.5 miles apart on the eastern shore of Point Roberts. Flatfish, herring, and salmon abound in both fish assemblages; waterfowl predominate the avifauna assemblages. Yet the percentage of diving waterfowl is

greater at DfRs 3 than at DgRs 1. In addition, relatively level or "0-slope" stratigraphy (possibly a house floor, personal communication, Matson, January 1985) at DgRs 1 suggests a prolonged period of habitation (Matson et. al 1981:18, Figure 8). This is in agreement with Matson et. al (1981:84), who based their conclusion on faunal assemblage diversity. Thus, the difference between these two Boundary Bay sites may be due to site type. DfRs 3 is a seasonal resource extraction site, whereas DgRs 1 has many attributes associated with Northwest Coast winter villages. A winter village is charcterized by permanent dwellings that were occupied for at least five months between November and March. Winter villages were reoccupied every year, and they may have had some occupants throughout the year (Barnett 1955:18-19). Therefore, diving waterfowl are probably predominate at DfRs 3 and not DgRs 1 because the former was occupied for a shorter season of the year.

Located at approximately the mouth of the Fraser River during the Locarno Beach culture, the DhRt 4 site is somewhat of an anomally among the three Locarno Beach delta components. Its stratigraphy is level, suggesting a prolonged period of habitation. This is similar to the Marpole component at DgRs 1. Of the three sites with Locarno Beach components, DhRt 4 has the largest diversity of mammals and fish species. This species diversity may

reflect an accumulation of discarded resources, which is often attributed to a lengthy period of occupation (Ham 1982: 182-184).

Unlike the other two Locarno Beach components, the DhRt 4 fish assemblage abounds in 8mm-9mm diameter salmon vertebrae (91%). These may represent sockeye salmon (personal communication, Raymond, January 1985), which run in the Fraser River from late summer to fall. In addition, basketry remains from the waterlogged component are typologically similar to historic period packing baskets, which were used to move fresh-caught salmon to a processing area. With the exception of the absence of post moulds that are associated with Marpole and Late Prehistoric winter dwellings (Ham 1982: 182-184), DhRt 4 appears to have many Northwest Coast village-like attributes.

Summary

The results of this analysis suggest that the Locarno Beach culture is more similar than different from the St. Mungo and Marpole cultures. In all three consecutive archaeological cultures, the populations subsisted on land mammals more than marine mammals; waterfowl more than upland fowl; and inshore fish (tidal flats and riverine adapted species) more than littoral water fish species. It also appears that for the last 4300 years, fish were the most

important vertebrate subsistence resource, followed by mammals and then waterfowl (Calvert 1970:72, Boehm 1973ab, Matson 1981:80). The broad similarities in subsistence patterns provide strong evidence for an in situ cultural development.

Despite these broad similarities, subtle differences in vertebrate remains exist between the St. Mungo, Locarno Beach, and Marpole components compared in this study. Unlike Locarno Beach culture, high percentages of diving waterfowl are absent from the St. Mungo and Marpole components; herring is also absent from the St. Mungo components at DgRr 6 and DgRr 2; and conversely, mainly freshwater fish are present in the St. Mungo components. These differences may be related to: (1) site location (the ecological setting of the site), (2) site type (the type(s) of activities at the site), (3) site seasonality (the time of year that the site was occupied), and (4) changes in technology.

Archaeologists who work in the Fraser Delta area are confronted with two basic sampling problems: (1) a range of site types (function and seasonality) and (2) a range of site locations. The ultimate goal for the archaeologists is to come to grips with how prehistoric populations "made their living" as the Fraser Delta environment became "increasingly more riverine-deltaic rather than marine-

deltaic" (Calvert 1970:55).

Despite this sampling problem there appears to be enough evidence to suggest that Locarno Beach culture populations adopted new technologies to procure aggregated resources.

Chapter 6

SUMMARY AND CONCLUSIONS

Contributions to Northwest Coast anthropology and archaeology are reviewed in this chapter.

The Fraser Delta during the Locarno Beach culture was ecologically and geographically different from earlier or more recent periods. During the Locarno Beach culture, the delta was building outward into the Gulf of Georgia. Except possibly at low tides, Roberts Island was only accessible by water transportation. Point Grey protruded farther out into the gulf than today (Clague et. al 1983). Many of the Delta islands (Iona, Sea, and Lulu) were in the process of formation. At low tide, they would have been part of the tidal flats.

Although specific locations of plant and animal communities have changed as the Fraser Delta has emerged, there have been no major changes in the vertebrate fauna available in the delta during the last 4300 years. The location of shellfish communities follows a similar pattern, as noted by Ham (1976) in the Fraser Delta and Grabert and

Larson (1978) at Semiahoo Spit (near Bellingham, Washington).

Through the use of information from site records, (e.g. profiles, maps, field notes, artifact and photo records, and correspondence with excavation participants), specific provenience units at DhRt 6, DfRs 3, and DhRt 4 were associated with the Locarno Beach culture. Tabulations of artifacts from sampled areas from each of the Locarno Beach culture components were classified by Mitchell's (1971b) criteria.

This made possible the first quantitative and qualitative analysis of Locarno Beach culture vertebrate faunal remains. Furthermore, the data base permitted an intersite analysis of Locarno Beach culture subsistence patterns by seasonality and habitat selection, as well as a cross-chronological test of how the Locarno Beach culture vertebrate subsistence economy fits into the Northwest Coast pattern.

The Locarno Beach culture vertebrate subsistence economy in the Fraser Delta region is not based on marine mammal resources. Although harbour seal, river otter, and beaver are found in Locarno Beach components in this study and sea lion at Montague Harbour, DfRu 13 (Mitchell 1971b), marine mammals rank lower in importance to land mammals of the Forest and Estuarine/Forest Edge areas. Deer and elk

are the most important land mammal resources. They were probably hunted away from each site in the sample throughout the year and then "schlepped" to the habitation areas, as suggested by the presence of leg bone fragments and sesamoids in each assemblage. This pattern continues through the Late Prehistoric culture (Ham 1982:363-364).

Birds, especially waterfowl, are the second most abundant vertebrate bone element found in each Locarno Beach culture component. The abundance of wing tip bones is part of a recurrent delta pattern from at least Locarno Beach through the Late Prehistoric period. This pattern may be related to the use of bird feathers for clothing. In the ethnographic period, Straits people mixed nettlefiber with duck down to make "blankets" (Suttles 1951:263). This type of clothing was very popular along the mainland coast due to an abundance of waterfowl (Suttles 1951:263-264), which were attracted to the Fraser Estuary. Archaeological data indicates that migrating waterfowl were extensively exploited in the Fraser Delta 3000 years ago. However, in general, birds (and expecially wing bones) are not major sources for meat. Nevertheless, considering their availability during the Locarno Beach culture, waterfowl may have been a popular commodity for duck down in the prehistoric Fraser Delta.

A preponderance of diving waterfowl indicates that a submerged net procurement technology may have been developed by Locarno Beach times. Supporting this hypothesis is a low diving to surface-feeding bird ratio during the St. Mungo culture. However, this relationship may reflect site locations within the emerging Fraser River delta front. More research is needed to clarify the hypothesis of a change in waterfowl procurement strategies between St. Mungo and Locarno Beach cultures.

Pacific herring, flatfish, and waterfowl are present in all three Locarno Beach culture faunal assemblages. However, this triad is associated with large sloping middens at only two Locarno Beach culture components—DhRt 6 and DfRs 3. Monks (1977) and Ham (1982) report the same co-occurance of vertebrate fauna and sloping stratigraphy at late winter-early spring (February through April) limited activity sites for herring and shellfish harvesting during the Marpole and Late Prehistoric cultures. Such evidence at DhRt 6 and DfRs 3 establishes a 3000+ year resource procurement pattern and a definite similarity between Locarno Beach, Marpole, and the Late Prehistoric cultures. DhRt 6 was also occupied during the spring to early summer (April to June) surf smelt runs, a pattern that has persisted through historic times with Musqueam and Samish Indians (Matthews 1955:395).

In all three Locarno Beach culture faunal assemblages, inshore species are the dominant fish, even though an equal number of deep water varieties are present. The abundance of salmon remains suggests that Locarno Beach culture people took advantage of the major Fraser River runs, possibly by using nets up river from the DhRt 4 site. According to Berringer (1982:53), the physical requirements for intensive salmon exploitation in the Fraser River during the ethnographic period included: (1) fishing from shoals in the river, (2) having high water turbidty that reduces salmons' ability to see, and (3) having fishing nets. It is possible that shoals and sand bars up river from DhRt 4 during the Locarno Beach culture would have provided the appropriate physical conditions for trawling with nets. Fishing nets and net anchors in the DhRt 4 wet zone may support the "up river" hypothesis.

Other perishables at DhRt 4 include the remains of baskets and wood chips. The DhRt 4 basketry may have been used to carry fresh fish or to store heavy loads of preserved salmon (Croes 1975, Matson 1981b, Burley 1981). Thus, the presence of salmon, fishing nets, and basketry provides strong evidence for a long term occupation for either a spring to fall salmon fishing camp, or for a prolonged winter village, or both.

In the DhRt 4 Locarno Beach culture component, a large sample of wood chips suggests that an established wood technology existed. This type of evidence is usually associated with the capacity to build large winter dwellings (Matson 1981b:84). The level unsloping stratigraphy at DhRt 4 typifies criteria of a winter village site (Ham 1982:281-283). However, the lack of post moulds in the sampled area prevents a statement identifying it as a winter village of the Late Marpole and Late Prehistoric type.

The Fraser Delta's Locarno Beach and Marpole vertebrate subsistence patterns are similar in seasonality at resource extraction sites (e.g. herring and shellfish) and some procurement technologies (e.g. herring rakes, submerged waterfowl nets, and fishing nets). However, to date, there is no undisputed evidence for an established pattern of winter village habitation and salmon preservation and storage technologies during the Locarno Beach culture. Furthermore, gaps in our knowledge about shellfish subsistence and an analytic and systematic comparison of Locarno Beach and Marpole lithic remains prevent combining the archaeological cultures at this time.

The Locarno Beach subsistence economy is disparate to contemporaneous vertebrate patterns at Hoko on the northwestern tip of the Washington Peninsula. Although Croes and Hackenberger (1984) report an emphasis on land

mammals, migratory waterfowl, and salmon at 3000 B.P., they have uncovered evidence for intensive halibut exploitation. The difference in Hoko and Fraser Delta faunal assemblages is attributed to site locations in different environments. It is interesting to note, however, that by 3000 B.P., populations in the Fraser Delta and Washington Peninsula are both intensively exploiting fish resources, salmon and halibut, respectively.

The close distance between the Gulf Islands and the Fraser Delta area would increase the probability of some sort of relationship between Gulf Island and delta sites during the Locarno Beach culture. Mitchell (1971b) describes artifacts, mammals, birds, and fish species in the Locarno Beach component at Montague Harbour that are similar to those reported in this study.

In spite of these studies, more work needs to be done to resolve the relationship between Locarno Beach Fraser Delta and Locarno Beach Gulf Island sites. Were they the same group(s) travelling around to different island and delta sites? Were there different Locarno Beach culture groups with different home bases in the areas? If so, did they aggregate at a winter village and disperse to resource procurement areas during the non-winter months?

Although this study identifies Locarno Beach patterns of procurement based on seasonal aggregations of vertebrate

resources, more work needs to be done on Locarno Beach culture seasonality. Comparison of fauna and flora from core and column samples from both Fraser Delta and Gulf Island sites during the last 4300+ years would resolve some questions about seasonality and use of plant resources in coastal prehistory. A systematic analysis of shellfish cross-sections would also help archaeologists gain better control of seasonality, dietary importance, and the transition of the delta from marine-deltaic to riverine-deltaic conditions. Studies that compare artifacts and lithic detritus would clarify issues in site utilization for delta prehistory.

Vertebrate subsistence patterns in the San Juan Islands were studied by Carlson (1954, 1960). Reported data suggest a foreshore-riverine subsistence orientation. Artifacts are also very similar to those found in contemporaneous Fraser Delta assemblages.

At the Mayne site (DfRs 8), located across from the Montague Harbour site (DfRs 13), a multi-component site with complex stratigraphy was excavated by Carlson and his students (Carlson 1970). One student analysed the major taxanomic classes of vertebrate fauna and presented all raw data by species (Boucher 1976). In the DfRs 8 Locarno Beach culture component, the vertebrate fauna are very similar to those in the Fraser Delta. However, there is slightly more

emphasis on seal, porpoise, and sea lion at DfRu 8. This is not surprising, as sea lions dwell today in Porlier Pass (Suttles 1952:12). Diving waterfowl appear to be the dominate waterfowl type in the bird assemblage. Salmon, mammals, and shellfish appear to be the major subsistence resources.

Finally, a strong practical contribution of this study is that at least initial pattern detection is possible through an analysis of archaeological data from sites excavated before the "age of thorough excavation methodology" on the British Columbia coast. As archaeologists and developers begin to deplete the number of sites to excavate, there will be an increased need to exhaust available data bases that are now in storage. Regardless of condition, research designs can be developed and implemented to extract useful information, whether it is lists, presence-absence data, or quantitative data. In turn, extracted data can be successfully used to help resolve gaps in our knowledge of Northwest Coast prehistory.

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APPENDICES

Table A.1: List of Identified Mammal Fauna Found in Locarno Beach, St. Mungo, and Marpole Culture components in the Fraser Delta area.

Common Name	Latin Name
Elk	Cervus elaphus (Linnaeus)
Black-tailed Deer	Odocoileus hemionus (Rafinesque)
Black Bear	Ursus americanus Pallas
Dog Family	Canis Kuhl
Raccoon	Procyon lotor (Linnaeus)
Striped Skunk	Mephitis mephitis (Schreber)
Small Rodent Family	Peromyscus (Wagner)
Mink	Mustella vison Schreber
Muskrat	Ondatra zibethica (Linnaeus)
Beaver	Castor canadensis Kuhl
River Otter	Lutra canadensis (Schreber)
Harbour Seal	Phoca vitulina (Gray)
Northern Sea Lion	Eumetopias jubata (Schreber)

Table A.2: List of Identified Avifauna Found in Three Locarno Beach Culture Assemblages.

Common Name	Latin Name
Common Loon	Gavia immer (Brunnich)
Arctic Loon	Gavia arctica(Lawrence)
Horned Grebe	Podiceps auritus Linnaeus
Western Grebe	Aechmophorus occidentalis (Lawrence)
Double-crested Cormorant	Phalacrocorax auritus Ridgeway
Oldsquaw	Clangula hyemalis (Linnaius)
White-winged Scoter	Melanitta deglandi (Brooks)
Common Scoter	Oidemia nigra Swainson
Common Murre	Uria aalge Salomonsen
Rhinoceros Auklet	Cerorhinca monocerata (Pallas)
Greater Scaup	Aythya marila Stejneger
Bufflehead	Bucephala albeola (Linnaeus)
Common Merganser	Mergus merganser Cassin
Canada Goose	Branta canadensis (Baird)
Snow Goose	Chen caerulescens (Pallas)
Mallard	Anas platyrhynchos Linnaeus
Pintail	Anas acuta Vieillot
American Widgeon	Anas americana (Gmelin)
American Coot	Fulica americana Gmelin
Glaucous-winged Gull	Larus glaucescens Naumann
Heermann's Gull	Larus heermani Cassin
Great Blue Heron	Ardea herodias Linnaeus
Bald Eagle	Haliaeetus leucocephalus (Audubon)
Black Oystercatcher	Haematopus bachmanni Audubon
Northwestern Crow	Corvus caurinus Ridgway
Raven	Corvus corax Ridgway
Great Horned Owl	Bubo virginianus (Oberholser)
Ruffed Grouse	Bonasa umbellus (Douglas)
Unspecified Duck	Anatidae

Table A.3: List of Identified Fish Fauna Found in Three Locarno Beach Culture Assemblages.

Spiny Dogfish	Squalus acanthias Linnaeus
Ratfish	Hydrolagus colliei (Lay and Bennet)
Northern Anchovy	Engraulis mordax mordax Girard
Pacific Hake	Merluccius productus (Ayres)
Petrale Sole	Eopsetta jordani (Lockington)
Pacific Halibut	Hippoglossus stenolepis Schmidt
English Sole	Parophrys vetulus Girard
Rockfish	Sebastes
Lingcod	Ophiodon elongatus Girard
Pacific Cod	Gadus macrocephalus Tilesius
Walleye Pollack	Theragra chalcogramma (Pallas)
Big Skate	Raja binoculata Girard
Plainfin Midshipman	Porichthys notatus Girard
Pile Perch	Rhacochilus vacca Girard
Great Sculpin	Myoxocephalus polyacanthocephalus (Pallas 1811)
Buffalo Sculpin	Enophrys bison Girard
Staghorn Sculpin	Leptocottus armatus Girard
Sculpin Family	Cottidae
Rock Sole	Lepidopseta bilineata (Ayres 1858)
Starry Flounder	Platychthys stellatus
Flatfish Family	Pleuronectidae
Pacific Herring	Clupea harengus pallasi Valenciennes 1847
Surf Smelt	Hypomesus pretiosus pretiosus Girard
Euchalon	Thaleichthys pacificus (Richardson 1836)
Minnow Family	Cyprinidae
Salmon	Onchorhynchus sp. (Walbaum 1792)
Trout	Salmo (Richardson 1836)
Sturgeon	Acipenser (Richardson 1836)

Table B.1: Distribution of Catalogued Artifacts, All Assemblages.

	DhRt 6	DfRs 3	DhRt 4-A2	DhRt 4-A1
Stone				
Chipped Stone				
Leaf-shaped points	1	1	2	
Contracting-stem points	2	1	3	
Chipped and ground points		1		
Scrapers	1		2	
Microblades			1	
Chipped-slate scrapers	1			
Chipped-slate points	3			
Chipped slate knives	3		3	1
Quartz crystal tools			5	3
Retouched flakes			34	11
Utilized flakes			43	9
Miscellaneous chipped stone				1
Total(n)	(11)	(3)	(93)	(25)
Ground Stone				
Stemless slate points	8	3	3	2
Stemmed slate points		2		
Ground slate blades		1		
Ground slate knives	7		10	3
Gulf Island Complex artifacts		none in sampled area		
Barrel bead			1	
Labret	1		1	
Pendant		1		
Miscellaneous ground stone			5	
Total(n)	(16)	(7)	(20)	(5)
Pecked and Ground Stone				
Hand mauls	2	6		
Hammerstones			4	10
Perforated stones		1		
Stone vessels		1	1	
Anvil stones		1	5	1
Abrasive stones	5	20	11	6
Ochre		1	6	
Miscellaneous pecked stone	1			
Total(n)	(8)	(30)	(27)	(17)

Table B.1: (continued).

	DhRt 6	DfRs 3	DhRt 4-A2	DhRt 4-A1
Bone				
Barbed bone points			2	
Bone bipoints	2	1		
Bone points	5	1	5	1
Bone ulna tools	6	2		
Bone scraper		1		
Bone knife	2	1		
Bone awls	14	4	3	
Bird bone awls	3			
Bird bone pin			1	
Bird bone needles	1	4		
Bird bone whistle			1	
Bird bone tribe bead		1		
Bone rings			2	1
Miscellaneous decorated bone	1			
Miscellaneous bone objects	9	9	14	1
Chisels or wedges	1		1	
Bone fish hook	1			
Total(n)	(45)	(24)	(29)	(3)
Antler				
Barbed harpoons		3		
Harpoon foreshafts	1	1	1	
Wedges		1(?)		
Atlatl hooks	1			
Miscellaneous worked antler	1		1	1
Total(n)	(3)	(5)	(2)	(1)
Shell				
Mytilus shell celts		1		
Mytilus shell points		1		
Mytilus shell knifes		1		
Mytilus shell blades		10		
Shell pendants	1			
Shell with pigments		2		
Miscellaneous shell objects		1		
Total(n)	(1)	(16)		
Wood				
Wood points			2	
Worked wood			10	22
Pointed stake				3
End-slotted haft				1
Complete baskets				1
Basket and nut fragments			3	70
Basket handles				11
Cordage			3	28
Rope rings			1	1
Net fragments				6
Wrapped stone sinkers				4
Knots of cord or fibre				28
Hanks of split roots				11
Coiled fibre				1
Total(n)			(19)	(187)
Total	84	85	190	238

Table C.1: DhRt 6 Mammal Remains, Skeletal Element Raw Counts.

Skeletal Element \ Taxa		Elk	Deer		Black Bear		Canis	Raccoon	Striped Skunk	Peromyscus	Mink	Muskrat	Beaver	River Otter		Harbour Seal	Human	Total
			A	J	A	J		J						A	J			
MNI		2	1	1	1	1	1	2							2	2		13
E		6	8	4	6	5	2	7							6	4		48
Basio-Occipital																		
Temporalis	L	1			1													
	R																	2
Petrosal	L																	
	R																	
Teeth		1	1		2													4
Mandible	L							1							2			
	R																	3
Maxilla	L																	
	R																	
Hyoid																		
Axis						1										1		2
Atlas																		
Thoracic Vertebra		1	1															2
Cervical Vertebra				1														1
Sacrum																		
Rib	L																	
	R			2														2
Humerus	L													1				
	R													1				2
Radius	L																	
	R																	
Ulna	L																	
	R																	

Table C.1: (continued).

		Elk	Deer		Black Bear		Canis	Raccoon	Str. Skunk	Peromyscus	Mink	Muskrat	Beaver	River Otter		Harbour Seal	Human	Total
			A	J	A	J								A	J			
Femur	L													1		2		
	R							1						1				5
Tibia	L	2																
	R	1					1											4
Fibula	L																	
	R																	
Scapula	L			1				1										
	R							1										3
Innominate	L							2								1		
	R							1										4
Talus	L		1															
	R																	1
Ostrale	L																	
	R		1															1
Ulna Carpus	L		1															1
	R																	
Magnum	L																	
	R																	
Uniciform	L																	
	R																	
Coccygeal	L																	
	R																	
Astragalus	L		1															
	R																	1
Calcaneus	L																	
	R																	
Metacarpus	L				4													
	R																	4
Metatarsus	L						1											1
	R																	
Phalanx	L		2		1													
	R				2													5
Flipper bones[1]																		

[1] Phalanx bones for seal are designated "flipper bones."

Table C.2: DfRs 3 Mammal Remains, Skeletal Element Raw Counts.

Skeletal Element \ Taxa		Elk	Deer	Black Bear	Canis A	Canis J	Raccoon A	Raccoon J	Striped Skunk	Peromyscus	Mink	Muskrat A	Muskrat J	Beaver	River Otter	Harbour Seal	Human	Total
MNI			1		1	1	1	1	2			1	1	1	1	1	1	13
E			1		2	1	2	8	14			1	4	1	2	12	7	55
Basio-Occipital																		
Temporalis	L																	
	R																	
Petrosal	L																	
	R																	
Teeth																		
Mandible	L								1									1
	R																	
Maxilla	L								1									1
	R																	
Hyoid																		
Axis									1									1
Atlas																		
Thoracic Vertebra																	1	1
Cervical Vertebra																		
Sacrum																	1	1
Rib	L																	
	R																	
Humerus	L							1	1									
	R				1			1	2									6
Radius	L								1								1	
	R																1	3
Ulna	L							1	1									
	R							1	2							1		6

Table C.2: (continued).

		Elk	Deer	Black Bear	Canis		Raccoon		Str. Skunk	Peromyscus	Mink	Muskrat		Beaver	River Otter	Harbour Seal	Human	Total
					A	J	A	J				A	J					
Femur	L					1	1		1								1	
	R						1						1				1	7
Tibia	L							1	1									
	R							1	2				1					6
Fibula	L																	
	R																	
Scapula	L												1				1	
	R												1				1	4
Innominate	L							1								1		
	R																	2
Talus	L																	
	R																	
Ostrale	L																	
	R																	
Ulna Carpus	L																	
	R																	
Magnum	L																	
	R																	
Uniciform	L																	
	R																	
Coccygeal	L																	
	R																	
Astragalus	L																	
	R																	
Calcaneus	L														1			
	R														1			2
Metacarpus	L					1												
	R		1															2
Metatarsus	L																2	
	R																	2
Phalanx	L											1		1		1		
	R															4		7
Flipper bones[1]																3		3

[1] Phalanx bones for seal are designated "flipper bones."

Table C.3: DhRt 4 Mammal Remains, Skeletal Element Raw Counts.

Skeletal Element \ Taxa		Elk	Deer A	Deer J	Black Bear	Canis A	Canis J	Raccoon A	Raccoon J	Striped Skunk	Peromyscus	Mink	Muskrat	Beaver	River Otter	Harbour Seal	Human	Total
MNI		1	2	1	1	4	2	2	2		2	1		1	1	2	1	23
E		12	19	2	2	26	5	2	9		4	2		2	1	9	6	101
Basio-Occipital																1		1
Temporalis	L																	
	R																	
Petrosal	L															1		
	R																	1
Teeth		2				4										2	2	10
Mandible	L	1				4		2			2							
	R		1			1			1		1							13
Maxilla	L																1	
	R																	1
Hyoid			1															1
Axis																		
Atlas							1											1
Thoracic Vertebra		1	1			2			4								1	9
Cervical Vertebra		1	2			2												5
Sacrum																	1	1
Rib	L	1																
	R		1			1												3
Humerus	L						1		1						1		1	
	R												1					4
Radius	L						2		2				1			1		
	R																	6

Table C.3: (continued).

		Elk	Deer		Black Bear	Canis		Raccoon		Striped Skunk	Peromyscus	Mink	Muskrat	Beaver	River Otter	Harbour Seal	Human	Total
			A	J		A	J	A	J									
Ulna	L		1			1												
	R						1							1				4
Femur	L																	
	R								1									1
Tibia	L																	
	R																	
Fibula	L					1												
	R															1		2
Scapula	L	1																
	R		1															2
Innominate	L										1							
	R		1															2
Talus	L		1															
	R					1												2
Ostrale	L		2															
	R																	2
Ulna Carpus	L					1												
	R																	1
Magnum	L	1																
	R																	1
Uniciform	L	1																
	R																	1
Coccygeal	L																	
	R				1	5												6
Astragalus	L	1																
	R																	1
Calcaneus	L																	
	R																	
Metacarpus	L			2		2												
	R																	4
Metatarsus	L				1													
	R		3			1												5
Phalanx	L	1														1		
	R	1	3											1				8
Flipper bones[1]																2		2

[1] Phalanx bones for seal are designated "flipper bones."

Table C.4: DhRt 6 Bird Remains, Skeletal Element Raw Counts.

Element			Coracoid		Radius		Ulna		Carpometa-carpus		Humerus		Femur		Tibiatarsus		Tarsometa-tarsus	
Taxa	MNI	E	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Arctic Loon	1	4				1	1									1	1	
Western Grebe	1	5			1			1			1	1			1			
Double-Crested Cormorant																		
Oldsquaw	1	2					1	1										
White-Winged Scoter	1	3							1			1				1		
Common Scoter	19	55					19	14	8	11	1		1			1		
Common Murre	1	1							1									
Rhinoceros Auklet																		
Common Loon	2	2					2											
Horned Grebe	1	2									1	1						
Greater Scaup	4	10					4	2	3			1						
Bufflehead																		
Common Merganser																		
Canada Goose	1	1							1									
Snow Goose																		
Mallard	2	4	2															2
Pintail	2	7	2	1			1	1	1	1								
American Widgeon	3	5						2	3									
American Coot																		
Glaucous-Winged Gull	2	2				2												
Heerman's Gull	2	8	1								2	2	2			1		
Great Blue Heron																		
Bald Eagle	1	3						1				1			1			
Black Oystercatcher																		
Northwestern Crow	2	12		2	1			1		2	1	2	2					1
Raven																		
Great-horned Owl																		
Ruffed Grouse																		
Unspecified Duck	19	32			19	13												
TOTAL	65	158	8		37		51		32		15		5		6		4	

Table C.5: DfRs 3 Bird Remains, Skeletal Element Raw Counts.

Element			Coracoid		Radius		Ulna		Carpometa-carpus		Humerus		Femur		Tibiatarsus		Tarsometa-tarsus	
Taxa	MNI	E	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Arctic Loon	9	22				3	4	9		5							1	
Western Grebe	1	5					1	1	1	1			1					
Double-Crested Cormorant	1	2									1				1			
Oldsquaw	2	9	2	1			1	2		1					1			1
White-Winged Scoter	2	11		1			1		2	1	1	1			1	1		2
Common Scoter	53	156	1	2			24	17	53	42			2		2	4	5	4
Common Murre																		
Rhinoceros Auklet	1	1										1						
Common Loon	3	7				1	1	1		1							3	
Horned Grebe																		
Greater Scaup	15	36		1			1	2	11	15						1	3	2
Bufflehead	3	5							2	3								
Common Merganser	1	1							1									
Canada Goose	1	1										1						
Snow Goose	3	5			1					3		1						
Mallard	17	43					1		17	12		2			1		4	6
Pintail	17	59	2	5			2	1	17	14	2	4					7	5
American Widgeon	7	14					7	6			1							
American Coot																		
Glaucous-Winged Gull	4	6				4				1							1	
Heerman's Gull	2	5									1		1	1	2			
Great Blue Heron	1	1												1				
Bald Eagle	1	1										1						
Black Oystercatcher	1	1								1								
Northwestern Crow	5	42	1	1		1	4	5	3	2	4	3	3	3	5	3	3	1
Raven	1	2												1	1			
Great-horned Owl																		
Ruffed Grouse																		
Unspecified Duck J	1	2			1	1												
A	22	42			22	20												
TOTAL	174	479	17		54		91		209		24		13		23		48	

Key: A = Adult
J = Juvenile

Table C.6: DhRt 4 Bird Remains, Skeletal Element Raw Counts.

Element			Coracoid		Radius		Ulna		Carpometa-carpus		Humerus		Femur		Tibiatarsus		Tarsometa-tarsus	
Taxa	MNI	E	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R
Arctic Loon	3	5												3		1		1
Western Grebe	1	1						1										
Double-Crested Cormorant																		
Oldsquaw	8	37	2	2			8	2	7	7	3	2	2	1		1		
White-Winged Scoter	8	38					1	2	2	7	3	6	2	1	4	1	8	1
Common Scoter	26	115	7	3			26	19	13	21	5	8	4	3	2	4		
Common Murre																		
Rhinoceros Auklet																		
Common Loon	2	4										1	1					2
Horned Grebe	2	3				2	1											
Greater Scaup	15	46	3	2				5	3		3	15			7	4		4
Bufflehead																		
Common Merganser																		
Canada Goose	1	2			1							1						
Snow Goose	2	8			1	1			1	1	1				1	2		
Mallard	17	47	2	1				2	1		1	1			10	17	3	9
Pintail	9	36	9	4			1	2			6	3				3	5	3
American Widgeon	1	1									1							
American Coot	1	1									1							
Glaucous-Winged Gull	1	1				1												
Heerman's Gull																		
Great Blue Heron																		
Bald Eagle	1	4	1		1				1	1								
Black Oystercatcher																		
Northwestern Crow J	1	1									1	1						
A	4	15	1			1	4	4	1		1	2			1			1
Raven	1	1						1										
Great-horned Owl	1	1							1									
Ruffed Grouse	1	1								1								
Unspecified Duck	28	37			9	28												
TOTAL	134	405	37		45		79		68		64		17		58		37	

Key: A = Adult
J = Juvenile

Table C.7: DhRt 6 Fish Remains, Skeletal Element Raw Counts.

Element		Abdominal Vertebra	Caudal Vertebra	Misc. Vertebra	Atlas	Spine	Pharyngeal	Dentary	Articulum	Premaxillary	Maxillary	Quadrate	Preoperculum	Clatherym	Upper Teeth	Lower Teeth	Scute	Misc. Bone	Protic
Taxa	E						IS	LR	LR	LR	LR	LR	LR	LR	LR	L R			
Dogfish	1					1													
Ratfish	6														3	1 2			
Northern Anchovy	8			8															
Pacific Hake	3			3															
Petrale Sole																			
Pacific Halibut	9	1	6			1						1							
English Sole																			
Rockfish																			
Lingcod																			
Pacific Cod	1				1														
Walleye Pollock																			
Big Skate																			
Plainfin Midshipman	11			11															
Pile Perch	1						1												
Great Sculpin																			
Buffalo Sculpin	2							2											
Staghorn Sculpin																			
Sculpin																			
Rock Sole	4	3	1																
Starry Flounder	5		2			3													
Flatfish	28	3	9			16													
Pacific Herring	79			76															3
Surf Smelt	233			233															
Eulachon	2			2															
Minnow																			
Salmon	280	189	91																
	1B	1B																	
Trout																			
Sturgeon	6																	6	
TOTAL	680	197	109	333	1	21	1	2				1			3	3		6	3

Key: B = Burnt

Table C.8: DfRs 3 Fish Remains, Skeletal Element Raw Counts.

Element		Abdominal Vertebra	Caudal Vertebra	Misc. Vertebra	Atlas	Spine	Pharyngeal		Dentary		Articulum		Premaxillary		Maxillary		Quadrate		Preopercul um		Catherym		Upper Teeth		Lower Teeth	Scute	Misc. Bone
Taxa	E						I	S	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L		
Dogfish	8			4		4																					
Ratfish																											
Northern Anchovy																											
Pacific Hake																											
Petrale Sole	15	15																									
Pacific Halibut	12	3	4			4					1																
English Sole	8	3	5																								
Rockfish																											
Lingcod																											
Pacific Cod	4	4																									
Walleye Pollock																											
Big Skate	1			1																							
Plainfin Midshipman																											
Pile Perch																											
Great Sculpin																											
Buffalo Sculpin																											
Staghorn Sculpin	1								1																		
Sculpin	1								1																		
Rock Sole	9	2	3			4																					
Starry Flounder	36	12	16			8																					
Flatfish	131	36	61			34																					
Pacific Herring	1			1																							
Surf Smelt																											
Eulachon																											
Minnow																											
Salmon	446	314	132																								
Trout																											
Sturgeon	6																									2	4
TOTAL	679	389	221	6		54			2		1															2	4

Key: B= Burnt

Table C.9: DhRt 4 Fish Remains, Skeletal Element Raw Counts.

Element		Abdominal Vertebra	Caudal Vertebra	Misc. Vertebra	Atlas	Spine	Pharyngeal		Dentary		Articulum		Premaxillary		Maxillary		Quadrate		Preoperculum		Clatherym		Upper Teeth		Lower Teeth	Scute	Misc. Bone
Taxa	E						I	S	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L	R	L		
Dogfish	13			13																							
Ratfish	5																						3	1	1		
Northern Anchovy																											
Pacific Hake	9			9																							
Petrale Sole																											
Pacific Halibut	70	23	28	8	1	3	1	1			1	2			2												
English Sole																											
Rockfish	36			32	1							2		1													
Lingcod	37	11	11	9	1	1				1						1	1	1									
Pacific Cod	15	10	1								1				1		1	1									
Walleye Pollack	3																1	2									
Big Skate	35			35																							
Plainfin Midshipman																											
Pile Perch	2																2										
Great Sculpin	4								1	1		2															
Buffalo Sculpin																											
Staghorn Sculpin	15			2					1				1	1	3				5	2							
Sculpin	9	2		2					2				3														
Rock Sole	75	16	59																								
Starry Flounder	184	48	128				1	1						1	1	1	2	1									
Flatfish	1119	12	54	996		5	5	2	9	9	2	4	8	7			1	5									
Pacific Herring	2			2																							
Surf Smelt																											
Eulachon	1			1																							
Minnow	7						6	1																			
Salmon	2456	1266	1190																								
	14B	6B	8B																								
Trout	2		2																								
Sturgeon	108																				1					52	55
TOTAL	4221	1394	1481	1109	3	9	18		24		14		22		9		18		7		1		4		1	52	55

Key: B= Burnt

Table D.1: Estimated Grams of Used Meat For Mammals (After Imamoto 1976:29).

Species	Usable Meat (grams)
Harbour Seal	59000
River Otter	7000
Beaver	5700
Muskrat	*
Mink	*
Peromyscus	*
Striped Skunk	*
Raccoon	3800
Canis	5700
Black Bear	95000
Deer	32400
Elk	146000

* = negligable estimated usable meat value

Table D.2: Diving Bird/Surface Feeding Bird Breakdown Worksheet.

Taxa/Site	DhRt 6 %(E)	DfRs 3 %(E)	DhRt 4 %(E)	DhRt 6 %(MNI)	DfRs 3 %(MNI)	DhRt 4 %(MNI)
Diving Birds						
Common Loon	2	7	4	2	3	2
Arctic Loon	4	22	5	1	9	3
Horned Grebe	2	-	3	1	-	2
Western Grebe	5	5	1	1	1	1
Double-crested Cormorant	-	2	-	-	1	-
Greater Scaup	10	36	46	4	15	15
Buffle Head	-	5	-	-	3	-
Oldsquaw	2	9	37	1	2	8
White-winged Scoter	3	11	38	1	2	8
Common Scoter	55	156	115	19	53	26
Common Merganser	-	1	-	-	1	-
Common Murre	1	-	-	-	-	-
Rhinocerous Auklet	-	1	-	-	1	-
	86(84)	68(255)	72(249)	79(31)	67(91)	68(65)
Surface-feeding Birds						
Canada Goose	1	1	2	1	1	1
Snow Goose	-	5	8	-	3	2
Mallard	4	43	47	2	17	17
Pintail	7	59	36	2	17	9
American Widgeon	5	14	1	3	7	1
American Coot			1			1
	17(17)	32(122)	28(95)	21(8)	33(45)	32(31)
Total	101	377	344	39	136	96

[1] Scavenging waterfowl (e.g. gulls, great blue heron, and oyster catcher) are excluded from this analysis.

Table D.3: Avifauna Seasonality Category Raw Data.

Category	Taxa/Site	DhRt 6 %(E)	DhRt 6 %(MNI)	DfRs 3 %(E)	DfRs 3 %(MNI)	DhRt 4 %(E)	DhRt 4 %(MNI)
Year Round (1)	Common Merganser	-	-	1	1	-	-
	Canada Goose	1	1	1	1	2	1
	Snow Goose	-	-	5	3	8	2
	Great Blue Heron	2	2	1	1	-	-
	Glaucous-winged Gull	8	2	6	4	1	1
	Heerman's Gull	-	-	5	2	-	-
	Bald Eagle	-	-	1	1	4	1
	Northwestern Crow	12	2	42	5	16	5
	Raven	-	-	2	1	1	1
	Great-horned Owl	-	-	-	-	1	1
	Ruffed Grouse	-	-	-	-	1	1
	%(n)	21(26)	17(8)	14.5(64)	13(19)	9(34)	12(13)
Winter/ Early Spring (2)	White-winged Scoter	3	1	11	2	38	8
	Common Scoter	55	19	156	53	115	26
	Horned Grebe	2	1	-	-	3	2
	Western Grebe	5	1	5	1	1	1
	Oldsquaw	2	1	9	2	37	8
	Mallard	4	2	43	17	47	17
	Pintail	7	2	59	17	36	9
	American Widgeon	5	3	14	7	1	1
	American Coot	-	-	-	-	1	1
	Common Loon	2	2	7	3	4	2
Winter/ Early Spring (3)	Arctic Loon	4	1	22	9	5	3
	Greater Scaup	10	4	36	15	46	15
Winter Early Spring (4)	Double-crested Cormorant	-	-	2	1	-	-
	Bufflehead	-	-	5	3	-	-
	%(n)	78.5(99)	81(37)	85(369)	86(130)	91(334)	88(93)
Spring Fall (5)	Common Murre	1	1	-	-	-	-
	Rhinocerous Auklet	-	-	-	-	-	-
	Black Oystercatcher	-	-	1	1	-	-
	%(n)	0.5(1)	2(1)	.5(2)	1(2)	0(0)	0(0)
	TOTAL*	126	46	435	151	368	106

* Unspecified duck is excluded from the total.

Table D.4: Fish Fauna Seasonality Category Raw Data.

Cate-	Taxa/Site	DhRt 6 %(E)	DfRs 3 %(E)	DhRt 4 %(E)
Year Round (1)	Ratfish	6	-	5
	Rockfish	-	-	36
	Lingcod	-	-	37
	Big Skate	-	1	35
	Sculpin	-	1	9
	Rock Sole	4	9	75
	Minnow	-	1	7
	Sturgeon	6	6	108
	%(n)	4(16)	7(17)	17.8(312)
Spring/ Early Summer (2)	Staghorn Sculpin	-	1	15
	Dogfish	1	8	13
	Pacific Hake	3	-	9
	Walleye Pollack	-	-	3
	Pacific Cod	1	4	15
	Starry Flounder	5	36	184
	Flatfish	28	131	1119
Spring/ Early Summer (3)	Petrale Sole	-	15	-
	Pacific Halibut	9	12	70
	English Sole	-	8	-
	Eulachon	2	-	1
	%(n)	12.2(49)	92(215)	81.7(1429)
Summer (4)	Northern Anchovy	8	-	-
Summer (5)	Surf Smelt	233	-	-
	Trout	-	-	2
	%(n)	60.4(241)	0(0)	0.1(2)
Late Winter/ Early Spring (7)	Pacific Herring	79	1	2
	Plainfin Midshipman	11	1	-
	Pile Perch	1	-	2
	Great Sculpin	-	-	4
	Buffalo Sculpin	2	-	-
	%(n)	23.4(93)	1(2)	0.4(8)
	TOTAL	399	233	1751

Table D.5: Mammal Fauna Habitat Category Raw Data.

Category	Taxa/Site	DhRt 6 %(E)	DhRt 6 %(MNI)	DfRs 3 %(E)	DfRs 3 %(MNI)	DhRt 4 %(E)	DhRt 4 %(MNI)
Forest	Elk	6	2	-	-	12	1
	Deer	12	2	1	1	21	3
	Black Bear	11	2	-	-	2	1
	%(n)	60(29)	47(6)	2(1)	8(1)	37(35)	23(5)
Littoral Forest Edge	Raccoon	7	2	10	2	11	4
	Striped Skunk	-	-	14	2	-	-
	Peromyscus	-	-	-	-	4	2
	Mink	-	-	-	-	2	1
	Muskrat	-	-	5	2	-	-
	Canis	2	1	3	2	31	6
	%(n)	19(9)	23(3)	67(32)	67(8)	51(48)	59(13)
Riverine	Beaver	-	-	1	1	2	1
	River otter	6	2	2	1	1	1
	%(n)	13(6)	15(2)	6 (3)	17(2)	3(3)	9(2)
Open Littoral Waters	Harbour Seal	4	2	12	1	9	2
	%(n)	8(4)	15(2)	25(12)	8(1)	9(9)	9(2)
	TOTAL	48	13	48	12	95	22

Table D.6: Avifauna Habitat Category Raw Data.

Category	Taxa/Site	DhRt 6 %(E)	DhRt 6 %(MNI)	DfRs 3 %(E)	DfRs 3 %(MNI)	DhRt 4 %(E)	DhRt 4 %(MNI)
Littoral/ Riverine	Common loon	2	2	7	3	4	2
	Arctic Loon	4	1	22	9	5	3
	Horned grebe	2	1	-	-	3	2
	Western Grebe	5	1	5	1	1	1
	Double-crested Cormorant	-	-	2	1	-	-
	Greater Scaup	10	4	36	15	46	15
	Bufflehead	-	-	5	3	-	-
	Oldsquaw	2	1	9	2	37	8
	Common Scoter	55	19	156	53	115	26
	White-Winged Scoter	3	1	11	2	38	8
	Common Merganser	-	-	1	1	-	-
	Common Murre	1	1	-	-	-	-
	Rhinocerous Auklet	-	-	1	1	-	-
	%(n)	67(84)	67(31)	59(255)	60(91)	68(249)	62(65)
Shletered Estuarine Water	Canada Goose	1	1	1	1	2	1
	Snow Goose	-	-	5	3	8	2
	Mallard	4	2	43	17	47	17
	Pintail	7	2	59	17	36	9
	American Widgeon	5	3	14	7	1	1
	American Coot	-	-	-	-	1	1
	%(n)	13(17)	17(8)	28(122)	30(45)	25.8(95)	29(31)
Strand/ Littoral Interface	Great Blue Heron	-	-	1	1	-	-
	Glaucous-Winged Gull	2	2	6	4	1	1
	Heerman's Gull	82	2	5	2	-	-
	Black Oystercatcher	-	-	1	1	-	-
	%(n)	8(10)	9(4)	3(13)	5(8)	0.2(6)	1(1)
Mixed Woodlands	Bald Eagle	3	1	1	1	4	1
	Northwestern Crow	12	2	42	5	15	4
	Raven	-	-	2	1	1	1
	Great Horned Owl	-	-	-	-	1	1
	Ruffed Grouse	-	-	-	-	1	1
	%(n)	12(15)	7(3)	10(45)	5(7)	6(22)	8(8)
	TOTAL	126	46	435	151	367	105

Table D.7: Fish Fauna Habitat Category Raw Data.

Category	Taxa/Site	DhRt 6 %(E)	DfRs 3 %(E)	DhRt 4 %(E)
Littoral Water	Spiny Dogfish	1	8	13
	Ratfish	6	-	5
	Northern Anchovy	8	-	-
	Pacific Hake	3	-	9
	Petrale Sole	-	15	-
	Pacific Halibut	9	12	70
	English Sole	-	8	-
	Rockfish	-	-	36
	Lingcod	-	-	37
	Pacific Cod	1	4	15
	Walleye Pollack	-	-	3
	Big Skate	-	1	35
	Plainfin Midshipman	5.5(11)*	-	-
	%(n)	5(33.5)	7(48)	5(233)
Tidal Flats	Plainfin Midshipman	5.5(11)*	-	-
	Pile Perch	1	-	2
	Great Sculpin	-	-	-
	Buffalo Sculpin	-	-	-
	Staghorn Sculpin	-	1	-
	Sculpin	2	1	28
	Rock Sole	4	9	75
	Starry Flounder	5	36	184
	Flatfish	28	131	1119
	Pacific Minnow	79	1	2
	Surf Smelt	233	-	-
	Salmon	140.5(281)*	223(446)*	1235(2470)*
	Sturgeon	3(6)*	3(6)*	54(108)*
	Steelhead Trout		-	1(2)*
	%(n)	74(501)	60(405)	64(2700)
Riverine	Salmon	140.5(281)*	223(446)*	1235(2470)*
	Sturgeon	3(6)*	3(6)*	54(108)*
	Steelhead Trout	-	-	1(2)*
	Eulachon	2	-	1
	Minnow	-	-	7
	%(n)	21(145.5)	24(160.1)	31(1298)
	TOTAL	680	679	4221

* = number appears in more than one habitat category.

Table E.1: Frequency Data, Mammal Remains in St. Mungo, Locarno, and Marpole Components from Fraser Delta Sites (Imamoto 1974, Boehm 1973a).

	St. Mungo		Locarno			Marpole	
	DgRr 6 %(E)	DgRr 2 %(E)	DhRt 6 %(E)	DfRs 3 %(E)	DhRt 4 %(E)	DgRr 6 %(E)	DgRs 1 %(E)
Elk	57	77	6	-	12	5	24
Deer	44	58	12	1	21	34	3
Bear	5	1	11	-	2	4	-
Canis	36	41	2	3	31	19	22
Porcupine	-	1	-	-	-	-	-
Raccoon	4	3	7	10	11	1	2
Squirrel	-	-	-	-	-	-	1
Skunk	-	-	-	14	-	-	-
Peromyscus	3	1	-	-	4	-	12
Mink	-	5	-	-	2	1	2
Muskrat	-	2	-	5	-	-	-
	69(149)	68(189)	79(38)	69(33)	87(83)	84(64)	86(66)
Beaver	44	68	-	1	2	6	2
River Otter	-	-	6	2	1	-	-
Seal	23	23	4	12	9	6	8
Northern Fur Seal	-	-	-	-	-	-	1
	31(67)	32(91)	21(10)	31(15)	13(12)	16(12)	14(11)
TOTAL	216	280	48	48	95	76	77

Table E.2: Frequency Data, Bird Remains in St. Mungo, Locarno, and Marpole Components from Fraser Delta Sites (Imamoto 1974, Boehm 1973a).

	St. Mungo		Locarno			Marpole	
	DgRr 6	DgRr 2	DhRt 6	DfRs 3	DhRt 4	DgRr 6	DgRs 1
	%(E)	%(E)	%(E)	%(E)	%(E)	%(E)	%(E)
Loons	1	8	6	29	9	-	-
Grebes	1	10	7	5	4	-	2
Cormorants	-	20	-	2	-	-	1
Murres/Murrelets	-	2	1	-	-	-	-
Diving Ducks	-	6	69	219	236	5	46
	6(2)	24(46)	66(83)	59(255)	68(249)	33(5)	27(49)
Geese	22	72	1	6	10	6	7
Swans	3	17	-	-	-	4	-
Surface-Feeding Birds	-	5	17	116	85	-	86
	88(27)	49(94)	14(18)	28(122)	26(95)	67(10)	52(93)
Gulls	-	22	10	11	1	-	5
Other Scavengers	-	2	-	2	-	-	-
	0(0)	13(24)	8(10)	3(13)	.2(1)	0(0)	3(5)
Upland Fowl	2	27	15	45	23	-	33
	6(12)	14(27)	12(15)	10(45)	5.8(23)	0(0)	18(33)
Unspecified Ducks[1]	1	38	32	44	37	7	-
TOTAL	31	191	126	435	368	15	180

[1] Unspecified duck remains are excluded from the total.