

Chapter VI FAUNAL ANALYSIS

I. The Fish

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METHODOLOGY

The fish skeletal material from DgRr 1 was analyzed for each individual 1 by 1 metre excavation unit. Raw data sheets record the number of skeletal elements per species identified, and weight of each species category. Unidentifiable skull and vertebrae fragments for fish were counted and weighed separately; totally unidentifiable fish fragments were weighed only.

Results are tabulated by natural layers, with number of identified specimens (NISP) recorded for each taxonomic category (species identified, for individual unit results; family totals, for summary tables). Tables, unless indicated, combine both 1989 and 1990 excavation material.

Salmon

Only a few skeletal elements in salmonids are identifiable to species; the problem with archaeological remains is that these elements are seldom preserved well enough to distinguish the species with any degree of confidence. Although salmon vertebrae usually preserve fairly well (and small fragments of vertebrae are also very distinctive), bones of the endocranium and neurocranium (skull and “face”) tend to be fragile. However, these “head” elements have a very distinctive texture that is easy to spot. Species identification for salmonids in this site was based on well-preserved samples of the pelvis (or basiptyergium), operculum, basioccipital, post-temporal, and the “caudal bony plate”, a paired element in the tail assemblage. As well, Chinook Salmon (*Oncorhynchus tshawytscha*) was identified most often on the basis of extremely large vertebrae, where it was assumed that none of the other species of salmon would attain that size.

Individual species were recorded in the raw data where possible, but lumped together in the tables for a “salmon” total.

Flatfish

All of the flatfish remains analyzed from this site appear to be Starry Flounder (*Platichthys stellatus*). Although there may be a few other species represented, Starry Flounder definitely predominates. Little attempt was made to distinguish the few bones from other species of flatfish that may have been present. All flatfish recorded in the data tables are simply referred to as “flatfish”.

Partly because of the tendency of Starry Flounder to be both “left-eyed” and “right-eyed”, broken skull elements were particularly difficult to identify with a high level of confidence. Also, broken vertebrae from flatfish were not as recognizable in as small pieces as were salmon vertebrae fragments. Most of the unidentifiable skull and vertebrae fragments in this site appear to be flatfish but they were recorded as “unidentifiable”.

Sucker/Chub

There were skeletal remains from both the Largescale Sucker (*Catostomas macrocheilus*) and the Peamouth Chub (*Mylocheilus caurinus*), freshwater species that inhabit large rivers. The bones of the endocranium and neurocranium of these two species are quite distinctive but the vertebrae are very difficult to distinguish. These species were identified and recorded in the raw data separately where it was possible, but for the data tables included in this report all elements were lumped together for a “sucker/chub” total.

ELEMENT DISTRIBUTION

The recovery of skeletal elements were found to be quite different for flatfish and salmon (the two most abundant fish in the assemblage). In order to examine the possibility that these differences are cultural in nature, the distribution of skeletal elements for these two families was recorded. The expected ratio of body parts ("skull", "face", "appendicular skeleton", "vertebrae" and "tail assemblage") was calculated for both flatfish and salmon. These ratios were then lumped together to give an expected ratio for the particular butchering pattern; for salmon this appears to have entailed removal of the head in front of the "appendicular" skeleton (i.e., the portion comprised of the underside of the gill cover plus the pectoral/pelvic fins), which left the entire vertebral column intact (with or without the tail). This traditional method of butchering salmon for both immediate consumption or drying/smoking (Boehm 1973:95; Stewart 1975), where the heads are processed separately from the rest of the body, seems to be reflected by the faunal remains recovered from this site. The question of taphonomic factors, such as differential skeletal element survivability, may be an issue here that could be addressed partly through comparison with other sites containing large salmon deposits.

SOUTH TRENCH

Because of the different stratigraphic histories – although overlapping in time – of the two trenches (see Chapter III) the two trenches are discussed separated. This section summarizes the remains recovered from the South Trench, all intact layers from CL-0 to CY (Table VI-1). Since the excavation strategy consisted of emphasizing fine-grained excavation of natural layers and water screening, these are whole unit samples of a relatively modest amount of excavated volume. Although the plan was to analyze all the recovered remains, the money obtained did not cover this to the end. In the South Trench, three layers from Unit Inw and four layers from Knw were not analysed, six of these layers were from the St Mungo component and one from the Locarno Beach. These made up less than 5% of the total excavation, although a higher portion than that of the South Trench St. Mungo component.

There was a total of 23,572 fish elements identified from layers CL-0 to CY in the south trench (excluding totally unidentifiable fragments, which were weighed only). Of these, 22,323 were identified to at least family level and more than 1,608 were unidentified skull and vertebral fragments that could be flatfish.

Out of the 22,323 identified elements, 59% were salmon and 27% were flatfish. Minor constituents were Herring (*Clupea pallasii*) [6%], sculpins (4%), sucker &/or chub (1%) and Spiny Dogfish (*Squalus acanthias*) [1%]. Less than 1% of the sample was represented by Sturgeon (*Acipenser* sp.), Pile Perch (*Rhacochilus vacca*), Shiner Perch (*Cymatogaster aggregata*), Eulachon (*Thaleichthys pacificus*), Plainfin Midshipman (*Porichthys notatus*), Skate (*Raja* sp.), and Greenling (*Hexagrammos* sp.).

There were 8 Chum Salmon (*Oncorhynchus keta*) elements identified from layers CL- 1, CM-1 and CR and a total of 89 pieces of Chinook Salmon were tentatively identified, from layers CL-0, C0, CR, CS, CT, CX, CX- 1, CX-2 and CY. Since no species of flatfish other than Starry Flounder were positively identified, it is assumed all of the "flatfish" elements are starry flounder. Almost all of the speciated sculpin elements recovered were Staghorn Sculpin (*Leptocottus armatus*), with only 8 pieces of Great Sculpin (*Myoxocephalus polyacanthocephalus*) and 1 piece of Buffalo Sculpin (*Enophrys bison*) positively identified. It is presumed that most of the elements tallied in the "sculpin sp." category (mostly vertebrae) are those of Staghorn Sculpin as well.

Table VI-1 South Trench Fish by NISP Layers in stratigraphic order, heavy lines separate Marpole, Locarno and St. Mungo Components.

Layer	Salmon	Sturgeon	Sucker/Chup	Flatfish	Sculpin	Midshipman	Herring	Dogfish	Skate	Sh. Perch	Stickleback	Eulachon	Greenling	Total
CL-0	58	24	0	9	1	0	1	2						95
CL-1	164	77	4	65	1	3	2	5						321
CL-2	5	0	0	7	0	0	0	0						12
CM-1	78	3	0	48	2	6	1	1						139
CM-2	6	0	0	0	0	1	1	0						8
CN-1	239	6	1	69	1	9	1	6						332
CN-2	49	0	5	31	4	1	10	4						104
CN-3	44	2	1	181	16	134	2	1			1			382
CN-4	55	0	1	24	2	10	10	5						107
CN-5	34	0	0	14	8	0	6	1						63
CO	370	2	4	67	4	2	4	0						453
CP-1	113	13	3	58	3	0	4	8						202
CP-1&2	111	2	1	17	1	4	9	1						146
CP-2	84	1	2	25	0	2	3	0						117
CQ	56	0	0	16	0	1	1	0						74
CR	772	2	12	211	33	6	20	20	1					1077
CR-2	324	1	3	86	5	1	3	7						430
CS	2485	20	13	391	85	7	104	42	2	3				3152
CS*	4	6	1	1	97	9	124	31						273
CT	3110	6	17	576	121	10	205	40		2		1		4087
CV	278	0	1	135	5	3	24	4		1				451
CV(ash)	116	0	0	39	0	0	19	2						176
CW	316	1	6	110	13	4	79	0		2				531
CX	622	6	6	600	34	3	97	12		1				1381
CX-1	2151	5	21	1879	162	6	313	56	2	6		5	1	4601
CX-2	671	0	9	506	84	8	132	17		1				1428
CY	802	0	31	845	111	0	111	60	1	3		2	1	1964
NISP														
Total	13220	178	147	6111	796	232	1286	327	6	19	1	8	2	22323
Percent	59.2	0.8	0.7	27.4	3.6	1.0	5.8	1.5	0.0	0.1	0.0	0.0	0.0	100.1

NORTH TRENCH

In the North Trench (Table VI-2) fish remains were analyzed from only 3 of the 6 relatively intact units, Fnw (1989), Fsw (1990) and Esw (1990). This situation arose because of the shortage of money and questions about the fieldschool excavation of the determination of the differences between Layers BC-H and BC-I, which was only clarified during the second season. Since Units Fsw and Fnw had by far the largest volume of intact deposits of any units in the North Trench, and Esw had by far the largest volume of Layers H and Hb present of any Units, approximately 2/3 of the recovered fish remains were identified, and perhaps 3/4 of the provenience units with no questions attached. This is, however, a much lower percentage than the South Trench and significantly less than planned.

There was a total 4974 fish elements were identified to at least family level and 413 were unidentified skull and vertebral fragments that could be flatfish. Out of the 4974 identified elements, 43% were salmon and 32% were flatfish. Minor constituents were sculpins (6%), herring (7%), suckers &/or chubs (6%) and dogfish (4%). Less than 2% of the sample was represented by the combined total of sturgeon, midshipman, skate, shiner perch, Eulachon (*Thaleichthys pacificus*), and Threespine Stickleback (*Gasterosteus cf. aculeatus*).

There was 1 Chum Salmon element tentatively identified and a total of 7 pieces of Chinook Salmon, noted from these layers. All of the flatfish elements appeared to be Starry Flounder. One element of a sculpin other than Staghorn was identified: this element was from a Great Sculpin. It is presumed that most, if not all, of the "sculpin sp." category are comprised of Staghorn Sculpin elements.

A total of 1790 elements are tabulated as being identified from Layer BC-H (Feature 9) in Table VI-2. This important Locarno Beach deposit is further subdivided into Layer BC-H and BC-Hb in Table VI-3. A slightly higher total of identified remains (1,815) is shown here as Anchovy (*Engraulis mordax* ?), not identified in significant numbers in any other deposits and thus not included in the previous table are shown here. These remains are notable for their richness and for the highest quantities of herring in any layers from Crescent Beach. [See the further discussion in Subsistence Summary, Section IV, this Chapter.

SALMON VS FLATFISH COMPARISONS:

Considering that flatfish and salmon were by far the major constituents of the faunal samples, we examined in some detail the relationships between the remains of these two resources within the site. Specifically, we considered changes in proportions of flatfish and salmon remains (NISP) and the distribution of skeletal elements of each family group identified over time.

1. Flatfish vs. Salmon NISP OverTime

Table VI-4 shows the changes over time of the percentages of flatfish vs salmon remains for the various natural layers excavated in both North and South Trenches. In the South Trench, there appears to be a rather clear break at layer CX, where at this point and below the proportions of salmon and flatfish are about equal. Above layer CX, the proportions of salmon are almost always substantially greater than those of flatfish. This pattern is not as clearly apparent in the North Trench, with BC I(s) having a high percentage of salmon even though most of this layer is 220-235 cm below datum (see Figure III-4).

However, when natural layers are not examined individually (see Figures VI-1- VI-4, where trench totals are reported by excavation year), the proportions of salmon NISP compared to flatfish do not appear to change over time. This seems to indicate that successful excavation by layers is adding important information that is not apparent when layers are combined together.

Table VI- 2 North Trench Fish, Approximate stratigraphic order.

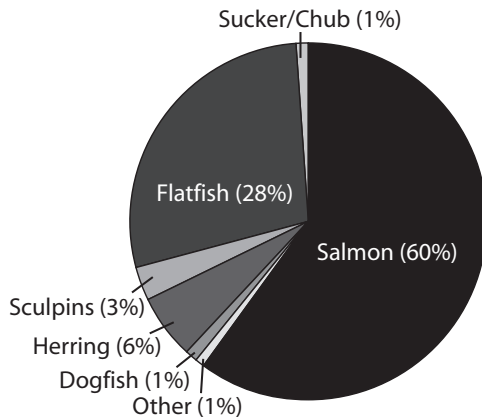
Layer	Perch													Total
	Salmon	Sturgeon	Sucker/Chup	Flatfish	Sculpin	Midshipman	Herring	Dogfish	Skate	Sh. Perch	Stickleback	Eulachon	Greenling	
BC H,	702	0	12	580	110	4	233	113	8	16	0	12	0	1,790
BC I1	589	6	27	327	56	2	94	56	3	0		2		1,162
BC Ii	113	0	16	84	21	1	18	7	0	1				262
BC I(s)	732	5	89	220	49	9	67	15	1	0				1,187
BC g1	429	8	123	532	130	3	48	33	1	2				1,309
BC g3	337	15	94	232	15	1	2	24	0	1				732
Total	2902	34	361	1975	381	20	462	248	13	20	0	14	0	6431

Table VI-3 Fish Remains from Layers BC-H and BC-Hb, Unit Esw, Feature 9

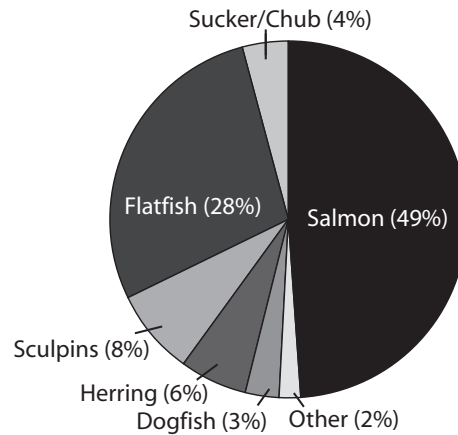
Fish	BC-H (NISP)	(%)	BC-Hb (NISP)	(%)	Total (BC-H,Hb)
Sucker	2		1		3
Sucker/ Minnow	6		3		9
Perch	12	1	4	1	16
Staghorn Sculpin	26	2	5	1	31
Sculpin sp.	60	5	19	3	79
Herring	97	8	136	23	233
Plainfin Midshipman	4		0		4
Eulachon/ Smelt?	6		6		12
Anchovy	20	2	5	1	25
Flatfish	456	37	124	21	580
Salmon	444	36	258	44	702
Dogfish	87	7	26	4	113
Skate	8		0		8
Unidentified Skull	51		11		62
Unidentified Vertebrae	72		20		92
Total Unidentified	123		31		154
Total Identified	1,228		587		1,815

Table VI-4 Salmon vs. Flatfish by Layer (by NISP) Heavy lines separate Marpole, Locarno and St. Mungo components in South Trench, BC li, BC I1 transitional in North Trench

Layer	Salmon	% of Salmon Per Layer	Flatfish	% of Flatfish Per Layer	Total
CL-0	58	61.1	9	9.5	95
CL-1	164	51.1	65	20.2	321
CL-2	5	41.7	7	58.3	12
CM-1	78	56.5	48	34.8	139
CM-2	6	75.0	0	0.0	8
CN-1	239	72.0	69	20.8	332
CN-2	49	47.1	31	29.8	104
CN-3	44	11.5	181	47.4	382
CN-4	55	51.4	24	22.4	107
CN-5	34	54.0	14	22.2	63
CO	370	81.7	67	14.8	453
CP-1	113	55.9	58	28.7	202
CP-1&2	111	76.0	17	11.6	146
CP-2	84	71.8	25	21.4	117
CQ	56	75.7	16	21.6	74
CR	772	71.7	211	19.6	1077
CR-2	324	75.3	86	20.0	430
CS	2485	78.8	391	12.4	3152
CS*	4	80.0	1	20.0	273
CT	3110	76.1	576	14.1	4087
CV	278	61.6	135	29.9	451
CV(ash)	116	65.9	39	22.2	176
CW	316	59.5	110	20.7	531
CX	622	45.0	600	43.4	1381
CX-1	2151	46.7	1879	40.8	4601
CX-2	671	47.0	506	35.4	1428
CY	802	40.8	845	43.0	1964
NISP					
Total	13220		6111		22323
Percent	59.2		27.4		100.1
	North	Trench			
BC H,Hb	702	39.2	580	32.4	1,790
BC I1	589	50.7	327	28.1	1,162
BC li	113	43.1	84	32.1	262
BC I(s)	732	61.7	220	18.5	1,187
BC g1	429	32.7	532	40.6	1,309
BC g3	337	46.7	232	32.2	721
Total	2902		1975		6,431
Percent	45.1		30.7		



DgRr 1 South Trench Fish
Layers CR to CY (*n* =18978)



DgRr 1 North Trench Fish
Layers BC-I to BC-I(s) (*n* = 3554)

Figure VI-1. Layers CR to CY of South Trench

Figure VI-2 Layers BC-I to BC-I(s) of North Trench

2. Flatfish vs. Salmon Skeletal Element Distribution Over Time

In an effort to determine if there was evidence for differential processing of these two fish resources, the ratios of body parts represented for flatfish and salmon remains was calculated for part of the sample. Table VI-5 shows the definition of “head” and “tail” by skeletal elements and Table VI-6 shows the skeletal element distribution of salmon vs flatfish from the South Trench (units I, K, L, & M); for layers CS, CT, CV, CW, CX-1 and CY. Layer CR (1990) is included to show how the pattern of lack of salmon head bones from the upper layers continues in this layer (CR) but changes from CS downward.

While the numbers of elements identified from flatfish and salmon species vary from layer to layer, the total number of each in the comparison shown (Table VI-6) are very similar; 4236 flatfish vs 3534 salmon.

The average proportions of body parts for flatfish (for layers CS to CY only) is 28.4% “headbones” vs 71.6% “backbones”, which is very much the pattern shown in both the North and South Trench element distribution results of flatfish from the 1989 excavation (South Trench 27.4% “headbones”, 72.6% “backbones”: North Trench 30.6% “headbones”, 69.4% “backbones”).

The average proportions of body parts for salmon (layers CS to CY only) are 4.0% “headbones”, 5.0% undetermined headbones/pelvic bones (“salmonid” fragments, other than vertebrae/caudal elements) and 83.3% “backbones”. As well, 7.7% of the sample are unquantified “headbones”, made up of teeth and gill rakers. Since teeth and gill rakers are not quantified in the expected ratios of whole fish, these elements have been tallied separately, even though they clearly represent “headbones”. This is a markedly different pattern than that shown from the 1989 excavation material, where “backbone” elements comprised 99.5% of the sample from both trenches, and seems to indicate that head parts as well as backbone parts of salmon were present at the time of deposition in the older deposits.

Because there is a possibility that the lack of headbones in the 1989 samples were the result of taphonomic factors, [(in general, the 1989 excavations were in more recent deposits, with CR the lowest level, see below for our alternative explanation)] we looked at the element distribution layer by layer for the 1990 material (Table VI-6) to see if there appeared to be greater destruction of bone in the older deposits that would explain the lack of head bones in the samples. Of individual layers in the South Trench, although CX-1 was close to the bottom of the deposit, it had the most salmon remains (1207), the lowest percentage of “backbone” remains (73.8%) and the highest proportion of undetermined head/pelvic bones (16.5%) from salmon. This layer also had the most flatfish remains (1879), with vertebrae comprising 68.1% of the

Table VI - 5 Fish Elements by Body Part

ELEMENT	BODY PART	"HEAD" " vs "TAIL"	ELEMENT	BODY PART	"HEAD" " vs "TAIL"
"Neurocranial elements, misc."	Neurocranium	Head	Teeth	Suspensorium	Head
Nasal	Neurocranium	Head	Tooth #1	Suspensorium	Head
Alisphenoid	Neurocranium	Head	Tooth #2	Suspensorium	Head
Basioccipital	Neurocranium	Head	Tooth #3	Suspensorium	Head
Epitotic	Neurocranium	Head	Teeth with bone	Suspensorium	Head
Ethmoid (mesethmoid)	Neurocranium	Head	Beak	Suspensorium	Head
Exoccipital	Neurocranium	Head	Circumoral teeth	Suspensorium	Head
Frontal	Neurocranium	Head	Jaw	Suspensorium	Head
Opisthotic (intercalar)	Neurocranium	Head	Suspensorial\		
Otolith	Neurocranium	Head	Neurocranial elements	Suspen.\Neuro.	Head
Parasphenoid	Neurocranium	Head	"Hyoid elements, undist."	Hyoid arch	Head
Parietal	Neurocranium	Head	Basihyal	Hyoid arch	Head
Prefrontal	Neurocranium	Head	Ceratohyal	Hyoid arch	Head
Prootic	Neurocranium	Head	Epihyal	Hyoid arch	Head
Prootic\			Hypohyal	Hyoid arch	Head
sphenotic (undistinguished)	Neurocranium	Head	Hypohyal #1	Hyoid arch	Head
Pterotic	Neurocranium	Head	Hypohyal #2	Hyoid arch	Head
Supraoccipital	Neurocranium	Head	Interhyal	Hyoid arch	Head
Supraethmoid	Neurocranium	Head	"Pharyngeal elements, undist."	Branchial arch	Head
Sphenotic	Neurocranium	Head	Pharyngeal teeth	Branchial arch	Head
Vomer	Neurocranium	Head	Basibranchial	Branchial arch	Head
Otolith	Neurocranium	Head	Branchiostegal rays	Branchial arch	Head
Suborbitals	Neurocranium	Head	Gill rakers	Branchial arch	Head
Suborbital #1	Dermocranium	Head	Hypobranchials	Branchial arch	Head
Suborbital #2	Dermocranium	Head	Inferior pharyngeal	Branchial arch	Head
Suborbital #3	Dermocranium	Head	Inferior pharyngeal plate	Branchial arch	Head
Suborbital #4	Dermocranium	Head	Pharyngeobranchials	Branchial arch	Head
Suborbital #5	Dermocranium	Head	"Pharyngeals, undist.paired"	Branchial arch	Head
Suborbital #6	Dermocranium	Head	Superior pharyngeal plate	Branchial arch	Head
Supratemporal	Dermocranium	Head	Urohyal	Branchial arch	Head
Angular (retroarticular)	Suspensorium	Head	Epibranchials	Branchial arch	Head
Articular (angular)	Suspensorium	Head	Ceratobranchials	Branchial arch	Head
Dentary	Suspensorium	Head	Radials	Pectoral girdle	Tail
Hyomandibular	Suspensorium	Head	Cleithrum	Pectoral girdle	Tail
Interoperculum	Suspensorium	Head	First interhaemal spine	Pectoral girdle	Tail
Maxilla	Suspensorium	Head	Hypocoracoid	Pectoral girdle	Tail
Mesapterygoid	Suspensorium	Head	Hypercoracoid	Pectoral girdle	Tail
Metapterygoid	Suspensorium	Head	Interhaemal spines	Pectoral girdle	Tail
Operculum	Suspensorium	Head	Mesocoracoid	Pectoral girdle	Tail
Palatine	Suspensorium	Head	Postcleithrum	Pectoral girdle	Tail
Preoperculum	Suspensorium	Head	Postcleithrum #1	Pectoral girdle	Tail
Premaxilla	Suspensorium	Head	Postcleithrum #2	Pectoral girdle	Tail
Pterygoid	Suspensorium	Head	Postcleithrum #3	Pectoral girdle	Tail
Quadrate	Suspensorium	Head	Posttemporal	Pectoral girdle	Tail
Supramaxilla	Suspensorium	Head	Supracleithrum	Pectoral girdle	Tail
Suboperculum	Suspensorium	Head	Pectoral fin ray #1	Pectoral girdle	Tail
Suprapreoperculum	Suspensorium	Head	Pelvis	Pelvic girdle	Tail
Symplectic	Suspensorium	Head	Pelvic spine	Pelvic girdle	Tail
			Clasper sheath	Pelvic girdle	Tail

Table VI-5 Continued.

ELEMENT	BODY PART	"HEAD" " vs "TAIL"	ELEMENTS	BODY PART	"HEAD" "vs" "TAIL"
Clasper spine	Pelvic girdle	Tail	Hyperal #1	Tail assemblage	Tail
Vertebrae 1\2	Vertebral column	Tail	Hyperal #2	Tail assemblage	Tail
Vertebral process	Vertebral column	Tail	Hyperal #3	Tail assemblage	Tail
Vertebral process #1	Vertebral column	Tail	Hyperal #4	Tail assemblage	Tail
"Vertebrae, undistinguished"	Vertebral column	Tail	Hyperal #5	Tail assemblage	Tail
Vertebrae #1	Vertebral column	Tail	Hyperal #6	Tail assemblage	Tail
Vertebrae (abdominal)	Vertebral column	Tail	Hyperal #7	Tail assemblage	Tail
Vertebrae (caudal)	Vertebral column	Tail	Penultimate vertebrae	Tail assemblage	Tail
Weberian complex	Vertebral column	Tail	Ultimate vertebrae	Tail assemblage	Tail
Weberian vert.#1	Vertebral column	Tail	Expanded haemal\neural spines	Tail assemblage	Tail
Weberian vert.#2	Vertebral column	Tail	Hyperal plate	Tail assemblage	Tail
Weberian vert.#3	Vertebral column	Tail	Fin rays	Associated with vertebral column	Tail
Weberian vert.#4	Vertebral column	Tail	Pterygiophores	Associated with vertebral column	Tail
Vertebral fragment	Vertebral column	Tail	Parapophyses	Associated with vertebral column	Tail
"Vertebrae, cartilage bits"	Vertebral column	Tail	Ribs	Associated with vertebral column	Tail
Caudal bony plate	Tail assemblage	Tail	Spines	Associated with vertebral column	Tail
Epural	Tail assemblage	Tail	Dorsal spine	Associated with vertebral column	Tail
Hyperal\epural	Tail assemblage	Tail	Interneural spine	Associated with vertebral column	Tail
Hyperal	Tail assemblage	Tail			

sample. In fact, the two lowest South Trench layers have rather similar ratios of body parts represented for both flatfish and salmon: while these ratios are still not identical to expected ratios calculated for whole fish (indicating some taphonomic destruction of bone), they nevertheless clearly indicate that whole fish were entering the deposits initially.

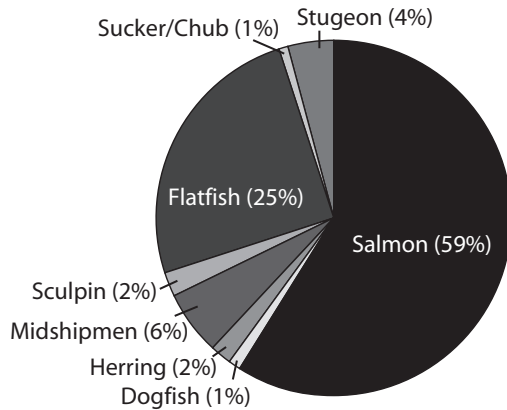
We also looked at the fragmentation of vertebrae for salmon and for flatfish (using for the flatfish comparison, the counts of the "unidentified vertebrae" fragments that are very likely to be flatfish). We found that the lowest fragmentation rates for both flatfish and salmon are in layers CW and CX-1, which are close to the bottom of the South Trench. As well, the proportion of salmon vertebrae (including both whole and fragmented) to the total salmon NISP for each layer actually decreases with depth, from 93.3% in layer CS to 75.2% in layer CY: ie., the proportion of head bones is greatest at the bottom of the deposit.

This is quite a different pattern than the results reported by Wigen and Stucki from the Hoko River rockshelter, where this ratio (vertebrae: total NISP) for salmon increases with depth, from 66.8% to 81.8% (1988:107). Wigen and Stucki interpret this increase as definite evidence of differential preservation of salmon bone, with greater deterioration of bone in the older deposits. In the Hoko site, there are definitely headbones present throughout the depositional period; only the proportions change, due to taphonomic factors, over time. If the pattern exhibited by the Hoko remains is the expected pattern of salmon survivability where there are definitely headbones present, then we can probably safely interpret the Crescent Beach salmon element changes over time as being cultural, rather than taphonomic, in nature.

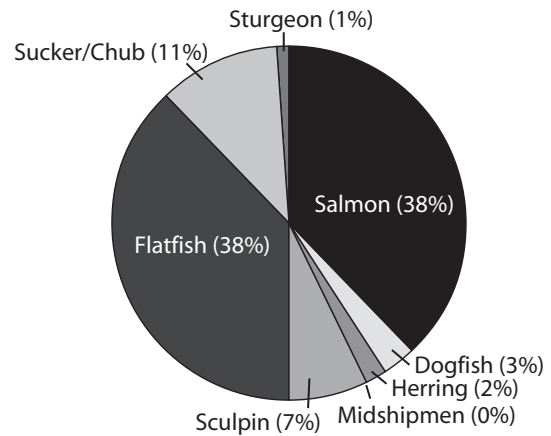
This cultural interpretation involves the suggestion that salmon were being processed and/or consumed in different fashions in the older period than in the younger. The older deposits indicate that whole fish were being consumed, while the younger deposits seem to suggest that only "backbones" were consumed. This may support the hypothesis that the preservation of salmon was a later development in this area (Croes and Hackenberger 1988), since the technique of smoking/drying salmon involves the separation of "head" (skull and other facial and gill parts) and "backbone" (pelvic fins, vertebrae, and tail elements) for processing, and presumably, for consumption as well (Wigen, Crockford and Greenspan 1990). A change of

Table VI -6 Salmon vs Flatfish Element Distribution, selected South Trench Layers.

South Trench Layers (Units I,K,L,M)														(CS-CY Only)		(CS-CY Only)	
Element	CR(90		CS		CT		CV		CW		CX-1		CY		Total	Total%	Percent by
Flatfish sp.		%		%		%		%		%		%		%			Body Part
1 Skull	7	5.5	19	4.9	26	4.3	6	4.5	28	7.2	90	4.8	57	6.8	226	5.3	
2/3/4Suspensorium	35	27.3	128	32.7	178	29.4	38	28.4	80	20.6	357	19.0	197	23.5	978	23.1	28.4 Headbones
5 Pectoral Gird	11	8.6	32	8.2	43	7.1	10	7.5	28	7.2	123	6.5	64	7.6	300	7.1	
6 Verts (Whole)	72	56.3	208	53.2	350	57.8	80	59.7	245	63.1	1280	68.1	508	60.6	2671	63.1	
7 Caudal	3	2.3	4	1.0	9	1.5		0.0	7	1.8	29	1.5	12	1.4	61	1.4	71.6 "Backbones"
Flatfish Total	128		391		606		134		388		1879		838		4236		
<i>Salmon sp.</i>																	
0 Undetermined		0.0	27	3.9	13	1.4	3	2.6	22	6.1	199	16.5	14	3.9	178	5.0	5.0 Headbones/
1 Skull		0.0	2	0.3	15	1.7	5	4.3	5	1.4	49	4.1	8	2.2	84	2.4	Pelvic?
2/3/4Suspensorium		0.0	3	0.4	9	1.0		0.0	10	2.8	28	2.3	5	1.4	55	1.6	4.0 Headbones
2/4Teeth/Gill Raker	10	5.5	49	7.2	101	11.2	4	3.5	4	1.1	40	3.3	74	20.5	272	7.7	7.7 Headbones
5 Pectoral Gird.	14	7.7	23	3.4	34	3.8	5	4.3	13	3.6	55	4.6	27	7.5	157	4.4	(Unquantified)
6 Verts (Whole)	148	80.9	517	75.6	643	71.0	79	68.7	256	70.7	656	54.3	165	45.7	2316	65.5	
7 Caudal	11	6.0	63	9.2	90	9.9	19	16.5	52	14.4	180	14.9	68	18.8	472	13.4	83.3 "Backbones"
Salmon Total	183		684		905		115		362		1207		361		3534		
Unid.Skull (Flat. ?)	6		24		46		19		38		169		85				
Unid. Verts (Flat.?)	44		91		84		17		32		168		93				
Vert.Frags(Salmon)	312		1801		2187		163		231		944		430				



DgRr 1 South Trench Fish
Layers B to CR (89) ($n = 2986$)



DgRr 1 North Trench Fish
Layers BC g1,g3 ($n = 2037$)

Figure VI-3. Fish from Layers B to CR, South Trench

Figure VI-4. Fish from Layers BC g1,g3, North Trench.

this nature would explain the presence of skeletal elements from all body parts in the older deposits but only “backbone” elements in the younger layers. The presence of only “backbone” elements is interpreted as evidence of consumption of preserved fish (smoked/dried) OR of fish processed in the fashion for preservation, but possibly consumed fresh (smoked?).

INTERPRETATION: Habitat Utilization Waters of Boundary Bay \ River mouth

The shallow water of Boundary Bay, with fresh water entering it (from an old arm of the Fraser at the earliest layers?) from the Nicomekl and Serpentine Rivers, would appear to have been prime Starry Flounder habitat. The Peamouth Chub and the sturgeon, freshwater species that also tolerate brackish water, may also have inhabited the bay.

Such a shallow sandy intertidal area would also be good habitat for Staghorn Sculpin, Buffalo Sculpin, midshipman, and Great Sculpin (in winter) (Hart, 1973). It is possible that dogfish and skate would have been available from deeper area of the bay. Since these species generally constitute such a low percentage of the total sample, it is probable that these catches are incidental to the “targeted” species. The “targeted” species here appears to be the Starry Flounder, and since all sizes of fish were taken (from very small to very large), it seems likely that something like a beach seine or tidal trap may have been employed to harvest the flounders, resulting in low numbers of other species to be taken as well.

The River

The rivers flowing into Boundary Bay would have sustained populations of sturgeon, Largemouth Sucker, and Peamouth Chub (Scott and Crossman 1973). It is obvious that the occupants of this site were utilizing anadromous salmon populations. Whether these fish were taken from the river (as they moved upstream) or from the bay (as they congregated before heading upstream), we cannot say for sure. We do note, however, that Largemouth Suckers (and perhaps Peamouth Chub as well) are known to consume salmon eggs (Scott and Crossman 1973). From this we may conclude that it is possible that salmon were

being taken from the river along with sucker, chub and sturgeon.

SUMMARY AND CONCLUSIONS

Figures VI-1 (circa 3000 -3800 RCYBP) and VI-1 (circa 3000 - 4200 RCYBP) illustrate the over-all differences between the two trenches for the remains of major fish groups excavated in 1990, which is a representation of the data reported in Tables VI-1 and 2. Figures VI-3 (circa 2000-3000 RCYBP) and VI-4 (circa 3700-4500 RCYBP) are presented for comparison, to show the results of the fish analysis of the 1989 excavations of the earlier deposits. Tables VI- 1 and VI- 2 present the fish data for both years' excavations by natural layer and should be useful in interpreting different procurement activities from the separate depositional layers.

Since the position of the upper layers of the North Trench in relation to the South Trench layers seems to be more complicated than it first appeared, we will limit our interpretations of apparent changes over time: obviously, integration of all excavation results will be necessary before the faunal data can be adequately assessed. Generally, when natural layers are NOT examined individually (Figures VI-1 to VI-4), it appears that the proportions of salmon NISP to flatfish do not change over time, but that the relative proportions of other fish to these two does. For example, the consistent presence of herring, at 6% of the NISP totals in both of the 1990 trench samples, may be a significant increase over the 2% herring present in the 1989 samples.

When the data is accessed by natural layers, however, different changes are apparent. The changes in element distribution over time for salmon, discussed earlier, seems to coincide with the changes BY LAYER in the proportions of salmon to flatfish NISP and may be the most significant changes in fish remains occurring at this site. There also appears to be a peak of fresh-water species in the North Trench layers BC-g1/g3 that seems to coincide with a decrease in salmon/increase in flatfish.

The presence in the older layers of Eulachon and Greenling is probably not significant, as the numbers identified are so small that their absence in the upper layers may be due to sampling bias alone: the same is probably true of the stickleback identified in the upper layers.

In summary, the analysis of fish remains from both excavation years at Crescent Beach shows a heavy reliance on both flatfish and salmon species, with incidental amounts of other taxa. The technique of excavation by natural layers which allowed the comparison of fish remains by depositional period, rather than arbitrary levels, revealed significant changes over time that otherwise might not have been possible to detect. The evidence for a major change in use of salmon at this site is very strong.

Chapter VI FAUNAL ANALYSIS

II The Bird and Mammal Remains

The material recovered in 1989 was analyzed by Susan Crockford (Pacific Identifications) and that from 1990 by Lisa Stephen as an Anthropology 406, Laboratory Techniques in Archaeology project. After the 1989 material was analyzed it was obvious that the bird and mammal remains were a relatively minor constituent of the Crescent Beach faunal remains, and that the money available was not sufficient to have all the more important 1990 fish remains analyzed by Pacific Identifications, let alone the 1990 bird and mammal remains. Since the bird and mammal assemblage was relatively simpler than the fish, this was portion that Stephens analyzed using the facilities available at the Laboratory of Archaeology at UBC. This present section combining was put together by R.G. Matson from two separate reports, Crockford (1990b) and Stephen (1991). This was feasible to do because Stephen's report was produced after Crockford's, and she followed the previous one closely.

Susan Crockford identified the bird and mammal remains recovered during 1989 using the extensive comparative collection available to Pacific Identifications in Victoria. The 1990 material was identified by Lisa Stephen using the limited faunal type collection available at the Laboratory of Archaeology at the University of British Columbia. In addition, Stephen made use of Anderson (1969), Brown and Gustafson (1979), Gilbert et al. (1985), and Olsen (1964). Although the number of bird and mammal faunal remains is fairly large – 2353 for the South Trench for example – only about 15% of this number were identifiable at all, and most of this only to broad categories such as “large mammal” or “sea mammal”. In addition to the the identification of the bird and mammal remains, the resulting seasonality and site use information are compared with that given in the previous section based the fish remains.

The tables provided list NISP totals only, since the sample sizes of identified remains for individual mammal and bird taxa are so low MNI calculations would not be valid (Klein and Cruz-Urbe (1984:33). In the 1990 analysis, there were a number of occasions where bone fragments were pieced together to find that they represented a single element. This type of ‘puzzlework’ is only possible when the material was found in close proximity. Using the same fashion as for the fish remains, totals are given here for each of the Trenches.

Mammals

South Trench

Total number of mammalian faunal remains from the South Trench in 1989 is 2353. Of these 83.8% were unidentifiable. As listed in Table VI- 7, of the 577 identified remains from both 1989 and 1990, 9.3% (54) were dog (*Canis cf familiaris*), 1.5% (9) were sea mammal, 4.5% (26) were deer (*Odocoileus hemionus*), 2.3 % (13) were elk (*Cervus elaphus*) 21,8% (126) were large mammal (most of which is either deer or elk),

Table VI-7 South Trench Mammals by NISP

Layer	Dog	Fox/Dog/ Raccoon	Sea Mamm.	Beaver	Seal	Bear	Deer	Elk	Rabbit	Vole	Small Rodent	Large Mamm.	Small Mamm.
CL-0						1					1	7	8
CL-1	2				1			7			15	9	4
CM-1/2	1	1					1	3			2	3	7
CN-1	2							1		1	3		10
CN-2/3	6						2				8	11	11
CN-4	1						3					9	8
CN-5							3				1	2	7
CO	3								1		1	2	
CP-1	4	2					1					2	
CP-1/2	14										1		6
CP-2	2				1		2						3
	Marpole /Locarno												
CQ	4							1				8	12
CR	2						2				11	2	29
CR-2							1					6	8
CS	1				2		10	1			12	20	37
CT/CU	3		2		1		1				13	35	47
	Locarno/ St.Mungo												
CV	8				1						6	7	23
CW	1										8	2	11
CX											2		3
CX-1/2				1							6	1	14
CY			1								1		3
Total	54	3	3	1	6	1	26	13	1	1	91	126	251

43.5%(251) were small mammal, and 15.8% (91) were rodent remains. The relatively large amount of identified remains that were small unidentified rodents are believed to be likely site residents and not represent food remains. The three species identified in any number, then, were dog, deer, and elk, with seal (*Phoca vitulina*) a distant fourth. Dog, however, is not likely to be a food item (Crockford 1997). Individual specimens were identified as Bear (*Ursus americanus*), Beaver (*Castor canadensis*), Rabbit (*Lepus* cf. *americanus*), and vole (*Microtus* sp.)

North Trench

The total number of mammalian remains (Table VI-8) from this trench is 461. Of these 84.3% (388) were unidentifiable. Of the 15.7% (120) identified remains from both years, large mammals represented 23.3% (28) Small rodents, again presumed to be site residents, made up 30% (36) of the sample. Other small mammals represented 26.7% (32) and dog 1.7% (2). The high percentage of rodent remains in this trench appear to reflect the presence of an almost complete rodent skeleton found in Unit Ese, Layer BC-Hb (Feature 9). A total of 99 pieces were associated with this skeleton. There was only one positively identified deer remain, along with one elk, in this trench, although the “large mammal” category probably contains deer as well as elk and possibly bear (*Ursus americanus*). Three seal remains were identified, along with 7 Raccoon (*Procyon lotor*) and 6 Beaver.

Table VI-8 North Trench Mammals by NISP

Layer/ Level	Dog	Sea Mammal	Beaver	Seal	Raccoon	Deer	Elk	Small Rodent	Large Mammal	Small Mammal
BC-I									1	2
BC-H	1		1					9		8
BCHb						1		16	1	6
	Locarno/	St.Mungo								
BC-I 200- 210								3	1	5
BC-I 210- 220								6	2	5
BC-I 220- 240		1								5
BC-I 240+		1							3	1
	1989	Results	St.Mungo							
BC-g1	1	1	5	2	7		1	2	20	
BC g3				1						
Total	2	3	6	3	7	1	1	36	28	32

Mammal Summary

The modest numbers of identified remains make comparisons between the components difficult and of low reliability. It does appear, though, that deer and elk were the most important mammals contributing to the diet throughout the Locarno and Marpole components at this site. Seal, especially if you define this category to include the unidentified sea mammal category, was a secondary source of calories. At the St. Mungo components from the Glenrose (S. Imamoto 1976) and St. Mungo (Boehm 1973, Ham et al. 1986) sites, one finds that elk is the most important mammal, followed by deer and seal, and one would expect the same pattern to be true for the St. Mungo component at Crescent Beach as well. However, the remains from this component are too limited to make this statement, as only a single identified elk element is tabulated, no deer was identified, although 4 sea mammal and 4 Harbour Seal remains were. Since it is likely that the residual "Large Mammal" is mostly deer and elk, the Crescent Beach St. Mungo pattern can not be said to be clearly different from that found at Glenrose and St Mungo, but only the sea mammal and Harbour Seal aspects are definitely confirmed.

Birds

South Trench

The bird remains in this trench are listed in Table VI-9. Of the total of 197, 87.2% were not identified in this analysis, although further analysis would undoubtedly reduce this percentage somewhat, as Crockford was able to identify about twice the percentage as Stephen. Of the remaining 12.8% (25) that were identified, 28% (7) were Canada Goose (*Branta canadensis*), 8% (2) were small goose (*Branta bernicla*?), 16% (4) were Bald Eagle (*Haliaeetus leucocephalus*), 8% (2) small hawk (*Accipitrinae* sp.) and single elements of Sanderling (*Crocethia alba*) a sandpiper, with Crow (*Corvus caurinus*), Robin (*Turdus migratorius*), and Common Loon (*Gavia pacifica*). Duck (Anatinae sp.) made up 20% of the identified assemblage.

In terms of food value, the two types of geese and ducks, are the most important, agreeing with the importance of waterfowl in ethnographic descriptions (e.g., Suttles 1951). In terms of remains, all three components have roughly equal amounts of remains, and waterfowl are present in all three. Although the St. Mungo and Locarno Beach components appears to have fewer remains identified to classes, almost all of this material was analyzed by Stephen, so that this difference is probably at least partially an artifact of the inferior type collection at UBC and Stephen's less experience.

North Trench

The total number of bird remains in this trench is 86 (Table VI-10). Of these, 78% were unidentifiable. The remaining 19 elements, consisted of 5 elements of Raven (*Corvus corax*), 3 each of duck and grebe (*Grebe* sp.), and 2 each of small goose, Bald Eagle and Robin. Single elements of a Common Loon and a small gull (*Larus* sp.) were also identified. With the reduced numbers present, not too much can be inferred, but the importance of waterfowl is supported by these identifications. It is also interesting that such a high percentage of the bird remains were identified from Feature 9 (Layers BC-H and BC-Hb)

Reptile

A single vertebrae from a garter snake (*Thamnophis* sp.) was found in Ksw (CN-2), probably a site resident along with the small rodents.

Table VI- 9 South Trench Birds by NISP

Layer	Canada Goose	Small Goose	Eagle	Small Hawk	Robin	Sanderling	Duck	Loon	Crow	Unid. Bird
CL-0										5
CL-1	2								1	6
CM-1							1			7
CM-2										1
CN-1										6
CN-3										12
CN-4										2
CN-5		1								3
CO	2			1	1					3
CP-1							1			5
CP-1/2										6
CP-2		1				2				2
		Locarno							Sum Marpole	58
CQ										2
CR										8
CR-2										5
CS	1						1			17
CT/CU	2		1				1			35
	Locarno/	St.Mungo							Sum Locarno	67
CV			1	1			1	1		19
CW			2							12
CX										2
CX-1										3
CX-2										3
CY	1									7
									Sum St.Mungo	47
Totals	7	2	4	2	1	2	5	1	1	172

Seasonality

A few of the bones recovered from the site can be aged sufficiently to infer a seasonality of site occupation.

South Trench

In the South Trench, the most definitive element is an Elk ulna that is foetal/newborn-sized (from layer CL-0), indicating late May/early June collection. A number of young dog remains that are probably 2-4 months old, likely represent "summer" as a time of death as well. An unfused distal radius of a deer was recovered from Layer CM-1 (Unit Lne) may also indicate spring/summer.

A piece of Canada Goose tarso/metatarsus exhibits what appears to be the precursor/remnant of "medulary bone", an indicator of nesting. If in fact this is medulary bone, it would indicate early summer collection as well. The single Robin is also indicative of a season other than winter.

Table VI-10 North Trench Birds by NISP

Layer/ Level	Small Goose	Eagle	Loon	Grebe	Raven	Robin	Duck	Gull	Unid. Bird
BC-I <200				1		1			11
BC-H	1	1			3		1		6
BC-Hb		1		1			1		9
	Locarno/	St.Mungo							
BC-I 200-210	1				1				3
BC-I 210-240									1
BC-I 240+									5
BC-g1/3			1	1	1	1	1	1	22
Total	2	2	1	3	5	2	3	1	57

North Trench

In the North Trench, there are bones from very young Raccoon (BC-g1) and Harbour Seal (BC-g1 and g3), that indicate summer collection. As well, there are subadult remains of Beaver (skull aged at approximately 1.5 years in BC-g1) and Elk (a mandibular premolar aged at 3 to 3.5 years in BC-g3) that also seem to indicate summer collection. The presence of Robins also indicates a season other than winter.

Although the sample size is too small to confidently use this information to apply seasonality of occupation to the whole site, it does rather strongly imply that at least a portion of the site was used during the late spring/early summer season consistently over a long period of time. As can be inferred from the layers listed above, this spring/early summer season is most evident in the later Locarno and Marpole layers (CT and above)

Also, the seasonality information from the mammal and bird analysis does effect the interpretation of the fish analysis. In conjunction with the site comparison on survivability of salmon elements, presented at the 1990 conference of the International Congress of Archaeozoologists (ICAZ) (Wigen et al. 1990) layers that are dominated by salmon vertebrae and tail elements appear to be indications of the consumption of dried or smoked salmon (i.e., processed elsewhere), rather than fresh whole fish processed and consumed at the site location. With the bird and mammal remains consistently indicating spring/summer and the

salmon remains consistently indicating consumption of processed rather than fresh fish, support the interpretation as spring/summer occupation rather than fall (i.e., during the salmon spawning runs).

Butchering patterns/ "bones of note"

Dog

Although most of the dog remains identified were from juvenile animals, there were a few adult remains that were interesting. From the South Trench layers CO, CN-1 and CP-2, there were dog remains that are noticeably smaller than most of the archaeological remains Crockford has seen (about one inch shorter in an individual long bone, which would indicate a dog 3-5 inches shorter than average). Also, a phalange from the dew-claw from a large dog/wolf [this one was larger than average, making the identification as dog tenuous] had several deep cut marks along the shaft, possibly a result of skinning.

Abrasion was also noted on 9 unidentified small mammal long bone shaft fragments recovered from Unit Isw Layer CT. These may indicate bone tool-making practices.

Cooper's Hawk

In layer CO, the small hawk remain was identified as a Cooper's Hawk (*Accipiter cooperii*) a rear (claw) phalange.

Beaver

The fragment of Beaver skull from layer BC-g3 in the North Trench has had some of the cortex from the maxilla bones removed, also possibly indicating skinning.

Elk

Many of the positively identified Elk elements were accessory phalanges (South Trench; CL-0, CL-1, CN-1) and a majority of Elk and Deer remains are long bone and assorted foot bone elements. The absence of a significant number of the other skeletal elements of these animals may indicate a specialized usage at this site. An alternative idea is that these elements represent riders (Metcalf 1988:488). This is the situation in which "low-ranked parts are more likely to be transported...simply due to their anatomical proximity to higher ranked parts of long bones" (Metcalf 1988:488).

Small Rodents

As stated earlier, it is most probable that the "small" rodents (indicating the identified vole) were site residents and do not represent food items. The 10 bones from layer CL-1 probably represent one individual.

Rabbit

The cervical vertebrae of a rabbit from layer CO is from a very small individual. [The issue here is the ranges of the genera *Lepus* and *Sylvilagus* and whether their biological ranges have changed significantly over time].

Habitat Utilization

Due to the small sample sizes of both the mammals and the birds, little definitive information on habitat utilization can be inferred. There is a rather wide range of species present for such small samples of both birds and mammals and perhaps the interpretation that is best supported at this time is that the use of these

animals was opportunistic. All of the species represented in the samples would have been available to the site inhabitants without travelling very far and none of the species present dominates the sample.

Chapter VI

iii Shellfish

Lisa Rankin

The shellfish remains recovered from Crescent Beach were analyzed to provide a more detailed understanding of prehistoric subsistence patterns in southern British Columbia. The three goals of this research were: 1) To investigate the seasonal use of shellfish at Crescent Beach in order to determine the season and nature of occupation. 2) To identify variations in the use of shellfish through time, with reference to the three cultural phases represented at Crescent Beach (St. Mungo, Locarno, and Marpole). 3) To determine the degree to which the pre-Marpole subsistence was based on shellfish specialization.

Context

The importance of shellfish in the development of the Northwest coast cultural pattern has been cited in numerous studies. Croes' and Hackenberger (1988) have suggested that the pre-storage economies of the Northwest Coast were dependent on shellfish, and that shellfish resources determined the number of inhabitants which could be supported through the winter. Matson (1983) took this argument further suggesting that shellfish played a role in the origins of social stratification on the Northwest Coast. Matson (1985) argued that a resource is worth protecting and controlling if it is dense, predictable and reliable. Ethnographically, the most important resource used on the Northwest Coast is salmon, but shellfish resources are also dense, predictable, reliable, and available in specific locations. Given the simplicity of harvesting shellfish, and their importance to winter subsistence strategies, shellfish resources may well have been owned and controlled before salmon resources.

The ease with which shellfish can be harvested has made them a valuable resource to maritime communities throughout the Pacific Northwest. Glassow and Wilcoxon (1988) suggest that shellfish were important to the coastal communities of Conception, California because procurement costs (effort needed to locate, capture and transport the resource to its place of consumption), and processing costs (reflected in the effort to produce tools and facilities used in the capture, transport, storage and reconstitution of resource) are low. The collection of shellfish requires the simplest of technologies and is not labour intensive. Yesner (1980:729) states that "Shellfish are another critical resource for coastal human populations, since they exist as a highly concentrated resource and are easily collected by all segments of the human population with a minimum of energy input". As such, shellfish can be collected by the very young and the very old allowing each person a degree of self-sufficiency. The value that coastal communities placed on this resource was also reflected in the positioning of their settlements - many of which are located in proximity to shellfish beds (McLay 1999; Yesner 1980:730).

The questions of how and when large scale shellfish use developed on the Northwest Coast remains. It has been suggested that some of the early cultures on the Northwest Coast were already exploiting pelagic sea mammal species and thus had both the technique and ability to create a more complex subsistence technology during the Old Cordilleran phase (Matson 1996b). Certainly, shellfish were harvested at a number of early sites (pre- 70000 RCYBP) on the Northwest Coast such as Chuck Lake, Alaska and Kilgii Gwaay in the Queen Charlotte Islands (Ackerman et al. 1985; Fedje et al. 2001). However, it appears that shellfish was not an important resource to all populations because shell was not present in the Old Cordilleran component at Bear Cove (Matson 1996b). While Stein (1992:12) has argued that this may be due, in part, to chemical dissolution of shell remains in the lower levels of older middens, it is also possible that the environmental conditions needed to support large shellfish beds were not yet available in many parts of the Northwest coast due to the fluctuating shorelines and changing climatic conditions created by

the retreat of the Wisconsin glaciation. As a result, it is unlikely that Old Cordilleran hunter-gatherers resembled the ethnographic communities of the Northwest Coast. However, by the St. Mungo phase some 4500 years ago, shellfish, especially *Mytilus trossulus*, were being exploited extensively. In analyzing the shellfish samples then, we are seeking to discover the relevance of shellfish to the development of the complex ethnographic pattern of the Northwest Coast.

The Use of Shellfish in Archaeological Interpretation

Shell middens are virtually ubiquitous at Northwest coast archaeological sites. The hard shells preserve well and therefore constitute a large part of the available archaeological material. For such a mass of material its scientific worth has often been overlooked. When Charles Hill-Tout visited the Fraser Midden at the turn of the century he recognized the shellfish piles there as archaeological, but thought that they could not even be removed without “crumbling to pieces at the touch” (Hill-Tout 1978:26).

It was not until the mid 1950s that the analysis of shell material for ecological data became a common practice in North America. While the early work began in California at the turn of the century (Gifford 1916; Nelson 1909, 1910), it did not result in shellfish analysis becoming a regular procedure. In 1958, however, C.W. Meighan et al. released a study identifying shellfish remains as the “most important midden components for interpreting ecological conditions”, and recognized that shellfish were capable of providing numerous avenues for analysis including the interpretations of past habitats and environment, as well as past subsistence strategies.

Meighan et al. (1958) stated “that it was possible to make rather positive interpretations concerning the conditions which prevailed when the molluscs lived”. By observing the environmental criteria which specific species of shellfish need today we can interpret past environments. We can also observe changes in environments over time or within regions by looking at the frequency of shellfish species across time and space in relation to their adaptive criteria. Ecological conditions such as salinity, temperature, currents, sea bottom conditions and shoreline levels are all reflections of climate and have direct bearing on what species are available for exploitation by humans (Ford 1995:18-20; Greengo 1951:14). Given that these conditions are subject to change over time the available shellfish species are likely to fluctuate too.

Shellfish studies now take a variety of forms including: the study of subsistence technology for the procurement and preparation of the resource; demonstrating cultural preference for particular food types; interpreting household and regional harvesting practices; and interpreting economic change through time. More specifically, the vertical distribution of shellfish within a midden may indicate changes in the utilization of different species over time. Temporal changes in the frequency of species in different areas may be indicative of ecological change, resource depletion, cultural change, preference patterns, shifts in technology, and large scale economic shifts (Meighan et al. 1958:4).

Since the mid 1970s new techniques for the excavation of shell middens have given rise to a greater range of archaeological analyses. Ham and Irvine (1975; Ham 1976, 1982) cross-sectioned midden shell in order to determine the season of harvest (see section iv of this chapter) and were able to detect variation in the frequency of shellfish species exploited seasonally, allowing for the interpretation of seasonal rounds. Using shellfish as a seasonality indicator is now common in Northwest coast studies.

In 1981 Wessen examined the horizontal distribution of shellfish remains in hopes of identifying activity areas related to shellfish processing and discard at the Ozette site in Washington state (Wessen 1981). He proposed that the distribution of shellfish might correlate with rank and access to specific resources (Wessen 1988). In order to determine this Wessen separated the shellfish remains into functional types including primary prey, secondary prey, fish bait, medicinals and others. He then examined their distribution throughout the middens of contemporaneous households at Ozette in order to gain

information about the social structure of the community. He found that high ranking households, which had greater access to exotic goods, also consumed more primary prey species than secondary or inadvertently collected shellfish. Furthermore, some households shared the same shellfish refuse distribution while other households did not even exploit the same species. As a result Wessen (1988:197) suggested that shellfish collection areas were controlled by lineal groups who had access to particular shellfish beds.

Wessen (1988) also claimed that because the shellfish beds were controlled by lineal groups, they were well managed. After examining the sizes of the shellfish collected for subsistence at Ozette, he decided that only the largest of the species were collected - except during the winter when shellfish of any size were harvested. This would maximize the amount of meat taken for the labour invested, but if the beds had not been well managed one would expect to find that the size of the shellfish would decrease over time due to heavy collection stress on the mature populations Wessen (1988, 1994).

Botkin (1980) did not see the same level of resource management at Malibu Creek, California where shellfish gathering practices may have shifted through time in response to over-harvesting. Botkin (1980) argued that as the human population in Malibu Creek increased in size, their energy requirements also increased. Yet, as the population expanded they continued to exploit *Mytilus californianus*, a low cost subsistence food that required little time or effort to collect. Over time, however, this strategy was replaced by collecting *Protothaca staminea*, a slightly more costly subsistence strategy. Botkin (1980:135) believes that this occurred because the *Mytilus californianus* was no longer a cost effective food. Instead this species had succumbed to stress as the human population increased; making the species more difficult to locate and much smaller when collected (Botkin 1980). However, others have pointed out that a shift from mussels to clams is a natural result of sea level stabilization through time and results in a change of habitat as sandy flats replace rocky foreshores (Crabtree et al. 1963; Fladmark 1975; Hanson 1995; Matson 1976).

Recently, Cannon et al. (2008) have suggested that shellfish harvesting strategies on the central coast of British Columbia were variable and dependent on the size and nature of occupation. After examining shellfish collections from 16 sites, they determined that shellfish harvesting at short-term occupation camps may have been opportunistic, while larger, more permanent, settlements may have employed a number of methods such as deliberate size selection and/or periodic avoidance of particular shellfish beds to manage this important resource. Complex management methods would require some level of regulatory control and may reflect local family or group ownership similar to that suggested by Wessen (1988) at Ozette (Cannon et al. 2008:19)

Archaeologists trying to determine the nutritional value of shellfish to human populations have also developed some interesting models based on the hypothesis that shellfish may provide a suitable alternative to diets based on terrestrial or other marine resource (Glassow and Wilcoxan 1988). Some debate has ensued about the use of shellfish for calories and protein requirements. Meehan (1977) completed an intensive ethnographic study with a group of Australian aboriginals who spent 58% of their resource procurement time collecting shellfish. She found that while shellfish did not provide sufficient amounts of calories per person they did provide a small but constant source of fresh protein. Erlandson (1988) has since pointed out that shellfish can provide a good source of daily protein that can be gathered in minutes.

Although calories, protein, and even vitamins may all be viable reasons for shellfish collection, Claassen (1986) indicates that the role of shellfish collection amongst hunter-gatherer peoples varies from a year round supplement to a seasonal staple. Furthermore, shellfish food values might fluctuate within age and sex categories. Archaeologists such as (Moss 1989) regularly use meat weight calculations to determine how many calories and grams of protein populations receive from the shellfish they eat.

The Methodology Used in the Crescent Beach Shellfish Analysis

As stated earlier, shell middens are immediately identifiable because of the abundance of shellfish remains that they contain. It is neither possible nor practical to analyze all of the shell material that is removed from a midden. Because of this, sampling strategies are generally employed during midden excavation. Early strategies described by Meighan et al. (1958) included both field sampling and column sampling. Field sampling involves the collection of some shell from the surface of a site and, like column sampling, involves the continued sampling of material in all excavated strata. Field sampling differs from column sampling because the collector is able to choose the shells from a larger area of the excavation floor. Therefore, field sampling does not provide reliable quantitative data because the selective biases of the collector go unchecked and also because large, whole shells are generally selected ahead of much smaller shell fragments. Thus, more fragile species are likely to be under represented and harder species over represented.

Column sampling was developed in an attempt to achieve more accurate statistics. Column samples are usually taken following the excavation of a unit once the profile is exposed by cutting a "column" into the unit wall. According to Meighan et al. (1958) columns are traditionally 10 square cm. The archaeologist collects all material excavated out of the column from the top to the bottom of the midden. The material is then bagged for laboratory analysis in accordance with the arbitrary level or layer from which it is removed.

More recently, techniques designed and utilized by Ham (1982) and Matson et al. (1980) have further transformed sampling strategies and thus the amount and kinds of information that we are able to extract. In 1977, Ham (1982) decided to excavate part of the Crescent Beach shell midden using natural layers, arbitrary levels, and water-screening so as not to destroy valuable, but friable faunal remains. He also attempted to design a sampling strategy that would provide reliable quantitative data from non-artifactual constituents. Ham (1982) chose to sample 2-3 kg of material from the surface of each new natural layer reached in order to get a representative sample of midden material for analysis. This strategy eliminated sampler bias and ensured material was collected from each stratum.

The excavation of Crescent Beach in 1989 and 1990 followed Ham's 1977 layer/level technique but introduced a more stringent sampling technique (Ham 1982). One in every 10 buckets of midden material excavated was bagged (unscreened) in the field for the purpose of laboratory analysis. In addition, every fifth bucket of excavated material was selected specifically for shellfish analysis and water screened through an 1/8 inch (3 mm) mesh while in the field. This "bucket sampling" strategy was adapted from similar procedures used by the University of Washington at the English Camp site on San Juan Island (Kornbacher 1989; Stein 1992).

Sub-sampling Strategies in the Lab

Because of the sampling strategies employed during the Crescent Beach excavation, approximately 20% of the excavated midden contents were received at the lab. Therefore, it was important to identify an adequate sub-sampling strategy that could be used during laboratory analysis. Previous researchers have experimented with sub-sampling midden material. The most common procedure (followed here) involves sieving the sample through a series of nested screens (usually 1/2 inch, 1/4 inch, 1/8 inch, and 1/16 inch sized mesh). The fractions caught in each of these screens are then sub-sampled. Most frequently the sample caught in the largest screen is completely sorted and analyzed (Matson et al. 1980; Moss 1989). Matson et al. (1980) further suggest sorting and identifying about 50% of the 1/4 inch fraction. After experimenting with different sample sizes from the smaller fractions and logging the hours required for analysis, Moss (1989:141) found a 25% sample of the 1/8 inch fraction and the 1/16 inch fraction to be the best strategy. However, Ham (1982) and Matson et al. (1980) have found the time and difficulty involved in analyzing the 1/16 inch fraction to be excessive and the information derived not of great significance. Nevertheless, Greenwood

(1961) and Ives (2003) have shown that sites which include a high percentage of the *Mytilus* species need to include some sampling of the 1/16 inch screen fraction because *Mytilus* shells are very brittle, fracture into tiny fragments, and are not adequately represented in the larger screen fractions and thus allowing more accurate quantification (Claassen 1998:101).

Taking the experiences of these researchers into account the Crescent Beach shell samples were sieved through nested screens of 1/2 inch, 1/4 inch and 1/8 inch fractions. As these samples were water screened through a 1/8 inch screen in the field a 1/16 inch fraction was irrelevant. However, a limited number of soil samples (described above) which had not been field screened were also examined. In the lab the soil samples were water screened through a 1/16 inch screen. When water screening was complete the remaining shell samples were sieved through nested screens providing a 1/16 fraction. In the end 100% of both the 1/2 inch fraction and the 1/4 inch fraction were analyzed and although previous studies have shown that little evidence can be gained from the smaller screens, 25% of the 1/8 inch screen was usually analyzed. However, in some cases (samples 236, 261, 264, 279, 284, 715, and 784), very little material ended up in the 1/8" fraction (and even less in the 1/2" and 1/4" fractions, see Table VI-12), so 50% of the 1/8" sample was analyzed. Conversely in four samples (208, 209, 483 and 643), only 12.5% was analyzed because of the large size of the fraction. The 1/16 inch fractions were analyzed in four cases (two from material water screened through 1/8 inch screen, #208, and #210, and two from soil samples #634, and #279). The latter two 1/16 inch screen samples were created while sieving the shell samples through nested screens and demonstrate the fragility of the archaeological shell. In all four cases 12.5% of the 1/16 inch fraction was analyzed. In order to avoid biased sampling, a geological sample splitter was used to sub-sample the fractions.

The Analysis

The identification of the shellfish species present in each of the fractions was carried out with the aid of published keys and comparative collections available at the UBC Laboratory of Archaeology. There were shellfish remains which were not identifiable to either species or genera. The inability to identify species or genera may occur for several reasons: a) the fragments are too small, b) the features used for identification of the fragments have been eroded, or c) the features used for identification of the fragment may not be present on the portion for analysis. Two categories were established in which to house these remains. The first was Veneridae. This term is commonly used as the family name for genera such as *Saxidomus* and *Protothaca*, but it is used here to identify shells from the Subclass Heterodonta and the orders of Veneroida and Myoida (Ricketts et al. 1985). A second category, Pelecypoda (Ham 1982:253) was instituted to recognize that portion of shellfish remains which were completely unidentifiable. Although taxonomic classification recognizes Pelecypoda (or Bivalvia (Ricketts et al. 1985) as a Class which represents all bivalves, including clams and mussels, all the unidentifiable shellfish material was placed into this category including both bivalves and univalves, such as small fragments of whelks. Because mussel and barnacle fragments are identifiable to class even in small fragments, Pelecypoda does not include these. Species taxa, weight of shell, MNI where possible (occurs when greater than half of the valve is preserved), provenience and screening procedure were recorded on standardized forms. From this information, percentages and absolute weights were calculated in order to determine frequency of species per sample. To store and efficiently recall this data, a data base was created to easily access data by layer, unit or site. Thus the relative importance of each species to the diet could be assessed.

Applications to Hypothesis

The first goal of this study was to elucidate the seasonal changes in shellfish use at Crescent Beach site.

Shellfish remains are capable of providing information about seasonality in more than one way. Morphologically, growth rings may be examined in order to determine the season of death - as examined in section iv of this chapter. Another option lies with the examination of well established natural behaviours of the different shellfish species. Different species will be more or less common to a region at different times of the year. Thus, collection of the species will be considerably easier at certain times of the year than others. Shellfish data were identified and then compared to the faunal remains (fish species in most cases) collected from the same layers at Crescent Beach in order to help refine the season of collection.

The second goal was to determine if the use of particular shellfish species changed over time by analyzing the shellfish assemblages from different site strata separately.

The final goal was to determine the degree of shellfish specialization in the pre- Marpole economy. In order to interpret the pre-Marpole phases it was necessary to integrate information recovered from the analysis of the shell samples with that derived from the artifact and faunal analyses. The significance of shellfish to the Crescent Beach population is only accessible when compared and contrasted with the other resources being exploited, particularly since populations tend to minimize the labour required for resource harvesting by accessing multiple resources from a single locale (McLay 1999). Thus, it is necessary to know what species were and were not found in the faunal record. As well, artifacts and their possible functions may provide clues to patterns of resource use.

Analysis

The shellfish remains from Crescent Beach represent eight “genera”, as well as the categories of Veneridae and Pelecypoda described above. These eight shellfish “genera” are:

<i>Mytilus</i>	(<i>Mytilus trossulus</i>)
<i>Protothaca</i>	(<i>Protothaca staminea</i>)
<i>Tresus</i>	(<i>Tresus nuttallii</i> , <i>Tresus capax</i>)
<i>Clinocardium</i>	(<i>Clinocardium nuttallii</i>)
<i>Saxidomus</i>	(<i>Saxidomus giganteus</i>)
<i>Nucella</i>	(<i>Nucella</i> (formerly <i>Thais</i>) <i>lamellosa</i> , <i>Nucella canaliculeta</i>)
Limpet	(<i>Fissurella volcano</i>)
Barnacle	(<i>Semibalanus cariosus</i> , <i>Chthamalus dalli</i> , <i>Balanus crenatus</i> , <i>B. glandula</i> , <i>B. nubilus</i>)

These eight “genera” plus the larger categories of Veneridae and Pelecypoda made up the 10 shellfish categories used in most of the following analyses. The “Barnacle” includes three genera, but most remains are likely *Balanus glandula* (Ricketts et al. 1985:270). Limpets turned out to be rare, identified in only 3 of the 29 samples processed (634, 791, and 483).

The eight genera are all marine dwelling species. They also inhabit similar environments. Most of these species can exist in deep water but all prefer shallow inter-tidal zones in sheltered bays. Some of the species such as *Mytilus trossulus* require rocky habitats but others such as *Tresus nuttallii* flourish in open mudflats. In all, 29 (nine litre bucket) samples were completely analyzed (Table VI-11). Seventeen of these samples were generated during the 1989 field season and 12 were generated during the 1990 season. Samples were chosen from a variety of excavation units including Isw, Inw, Ksw, Knw, Lne, and Mne in the South Trench and from the units Esw, Ene, Fnw, and Fsw in the North Trench.

Twenty samples were selected for analysis from the South Trench and nine from the North Trench. The samples come from various levels within these trenches ranging from a depth of 20-30 cm (Isw, CL-1) to 240-250 cm (Fnw, BC-G3). As such, they represent the full range of excavated layers and levels and are diverse enough to make comparisons.

Table VI-11. Number of Analyzed Samples Generated From Each Excavation Unit.

Excavation		
<u>Unit</u>	<u>n of Samples</u>	<u>Sample Numbers</u>
South Trench		
Isw	8	170,169,178,209,265,283,293,292
Inw	4	454,208,210,715
Ksw	1	791
Knw	4	216,262,508,677
Lne	2	634,693
Mne	1	625
North Trench		
Esw	2	483,643
Ene	1	542
Fsw	1	784
Fnw	5	284,261,236,264,279

Bar graphs were constructed for all samples to represent both the absolute weight in grams of the material being analyzed as well as the percentages of the different classes of shellfish present per sample (see Figures VI-5-12 for examples). Several significant patterns have emerged from this analysis and represent the differential distribution of shellfish within each trench and layer. Each shellfish category, provenienced by layer and screen size, is represented by weight in Table VI-12.

The South Trench

The South Trench contains 10 types of identified remains. *Mytilus trossulus* and barnacle account for the majority. Limpet is not well represented, accounting for less than one percent (therefore not listed in Table VI-12), and will no longer be referred to. *Tresus* and *Clinocardium* are fairly well represented with an overall percentage of approximately 7% and 9% in the South Trench (see Figure VI-5). The remaining classes are less substantial, but offer more significant information when one observes their distribution between individual layers (see Figures VI-6, 7, and 8).

Certain layers produced substantially more shellfish remains than others. Layers CN-3, CQ, CT, and CY are relatively high in shellfish remains. Each of these layers appears to be dominated by different genera with *Mytilus*, barnacle, *Clinocardium*, or *Tresus* contributing the high weights.

Layer CN-3 is particularly rich in the species *Clinocardium nutallii* (see Figure VI-6). The three samples analyzed from this layer are distinct from the layers immediately above and below it. Layer CL-1, located above CN-3, and layer CP-1, located beneath CN-3 have more generalized shellfish distributions (see Figure VI-7). The absolute value of shellfish in grams from the three CN-3 sample includes the highest value of any sample analyzed. The absolute weights of the three samples from layer CN-3 are as follows - sample #208 (taken from unit Inw at a depth of 45-60cm) has 2184.4 grams of shellfish, sample #209 (taken from unit Isw at a depth of 45-60 cm) has 2184.5 grams of shellfish, sample #210 (taken from unit Inw at a depth of 40-50 cm) has 472.5 grams of shellfish, and sample #210 (taken from unit Inw at a depth of 45-60 cm) has 1006.26 grams of shellfish present. The next highest absolute shellfish value comes from sample #508 (unit Knw, layer CT, depth 80-90 cm) which has a shellfish weight of 1416.47 grams.

The sample taken from the 1/2 inch screen of layer CN-3 (#208) had an absolute weight of 360.0 g of shellfish and the 1/4 inch screen had a total of 679.7 grams. This can be compared to shellfish weight

Table VI-12 Shellfish Analysis

UNIT	LAYER	SAM	NESTE	Mytilus	Barnacle	Proto	Tresus	Clino	Saxido	Nucel	Vener	Pelyc
I-SW	CL-1	170	.5		6.39		12.28	9.48	8.43	10.03	25.14	12.56
I-SW	CL-1	170	.25	1.23	3.37	6.69	3.21	18.80	1.06	8.46	27.19	93.60
I-SW	CL-1	170	.125	12.80	9.47			0.46		0.16	2.85	25.53
I-SW	CL-1	169	.5		1.23	1.17	27.70	13.19	9.80		48.45	
I-SW	CL-1	169	.25	2.80	1.70	2.20	2.23		1.40		46.67	50.80
I-SW	CL-1	169	.125	13.60	6.23						3.85	19.25
I-SW	CL-1	178	.5		0.07		14.14	1.05	12.00	22.95	15.53	9.91
I-SW	CL-1	178	.25	0.91	4.46	4.82	1.07	19.06	6.36	18.30	15.84	41.57
I-SW	CL-1	178	.125	7.89	6.48	0.23		1.00		0.45	1.80	16.31
I-SW	CN-3	209	.5				46.40	36.80		2.50	14.80	22.90
I-SW	CN-3	209	.25	10.98	19.82	1.04	1.15	71.50	1.11	2.66	20.43	79.50
I-SW	CN-3	209	.125 ²	10.38	4.94			0.06		0.05	0.07	2.13
I-SW	CP1&2	265	.5				10.56	0.52	6.52	4.45	6.30	2.63
I-SW	CP1&2	265	.25	7.70	8.67			4.36		0.25	6.56	39.30
I-SW	CP1&2	265	.125	21.90	13.56					0.01	1.05	14.90
I-SW	CQ	283	.5	0.27			5.97	0.48	3.63		10.54	2.35
I-SW	CQ	283	.25	28.90	38.70	1.39	2.30	6.74	1.52	4.41	9.40	45.73
I-SW	CQ	283	.125	31.55	48.30	0.08		0.67		0.09	0.76	9.39
I-SW	CR	293	.5					0.32			1.82	
I-SW	CR	293	.25	0.45	0.83			1.32			1.33	7.67
I-SW	CR	293	.125	6.17	2.07							3.01
I-SW	CR	292	.5				12.60				2.60	4.70
I-SW	CR	292	.25	0.88	1.43	0.27	1.43	1.98			4.10	7.46
I-SW	CR	292	.125	9.62	4.96	0.08		0.32			0.91	3.34
K-NW	CN-2	216	.5							10.47		0.53
K-NW	CN-2	216	.25	1.07	0.57			0.59			2.49	2.22
K-NW	CN-2	216	.125	11.44	3.33			0.18			0.27	2.70
K-NW	CP	262	.5									
K-NW	CP	262	.25	4.54	2.89			0.22				1.64
K-NW	CP	262	.125	12.54	7.10			0.03				0.77
F-NW	BC-G1	261	.5									
210-220	cm	261	.25	0.70							0.62	0.05
"BG1b"		261	.125 ¹	3.43	0.20							0.24
F-NW	BC-G3	284	.5									
240-250	cm	284	.25				0.19			0.91		
"BCG3"		284	.125 ¹	4.27	0.46							0.55

Table VI -12 Shellfish Analysis Continued (p. 2)

UNIT	LAYER	SAM	NESTE	Mytilus	Barnacle	Proto	Tresus	Clino	Saxido	Nucel	Vener	Pelyc
F-NW	BC-G1	236 .5									0.70	
200-210	cm	236 .25						2.06			8.23	1.45
"BG1a"		236 .125 ¹		9.10	1.16			0.28			0.23	6.70
F-NW	BC-G1	264 .5										
220-230	cm	264 .25		0.40							0.97	0.97
"BG1c"		264 .125 ¹		6.67	0.31							1.67
E-SW	BC-H1	643 .5				1.70		4.12	2.75	3.44	9.37	
210-220	cm	643 .25		8.44	5.60	15.35		37.59			42.98	2.60
E-SW	BC-H1	643 .125 ²		19.12	3.04	0.05		0.73			1.67	5.44
K-SW	CY	791 .5			0.07	0.16		3.97			0.45	0.38
K-SW	CY	791 .25		13.28	3.59	1.11		2.62		0.12	3.17	3.82
K-SW	CY	791 .125		48.78	9.95			0.31			0.52	1.32
I-NW	CS	454 .5										0.90
I-NW	CS	454 .25		0.30	0.11			0.54			0.09	4.02
I-NW	CS	454 .125		1.17	0.91						0.14	0.64
E-SW	BC-H	483 .5				8.61	1.75	13.58	1.78	1.30	8.72	4.80
290-200	cm	483 .25		8.86	16.65	8.42		28.04			53.80	32.99
E-SW	BC-H	483 .125 ²		25.32	9.77	0.10		0.44	0.02		2.43	4.88
K-NW	CW	677 .5										
K-NW	CW	677 .25		0.23							1.16	1.13
K-NW	CW	677 .125		4.62	0.35						0.36	1.02
F-NW	BC-G1	279 .5								0.94		
230-240	cm	279 .25		1.03						0.66		0.17
"BG1d"		279 .125 ¹		12.60	4.54			0.02			2.17	
F-NW	BC-G1	279 .0625		10.56	4.53						0.45	
I-NW	CN-3	208 .5				5.29	77.65	128.68	44.82		48.56	55.64
I-NW	CN-3	208 .25		25.35	22.71	17.30		209.90		1.46	35.83	201.65
I-NW	CN-3	208 .125 ²		74.73	42.51			5.00		0.04	7.78	33.64
I-NW	CN-3	208 .0625		13.80	5.19							3.19
I-NW	CN-3	210 .5		0.24		17.56	22.45	41.56	4.67		12.56	19.34
I-NW	CN-3	210 .25		23.19	29.12	5.23		79.67		3.35	72.12	50.12
I-NW	CN-3	210 .125		65.57	65.58	0.18		4.60			8.87	11.47
I-NW	CN-3	210 .0625		13.44	8.26		0.03					3.86
F-SW	BC-IS	784 .5										
230-240	cm	784 .25										0.13
F-SW	BC-IS	784 .125 ¹		2.23	0.05							0.30
E-NE	BC-I1	542 .5				0.78						
200-210	cm	542 .25		1.55	0.10	0.09		0.40			5.25	3.47
E-NE	BC-I1	542 .125		10.64	0.91			0.08			0.54	0.90

Table VI -12 Shellfish Analysis Continued (p. 3)

UNIT	LAYER	SAM	NESTE	Mytilus	Barnacle	Proto	Tresus	Clino	Saxido	Nucel	Vener	Pelyc
K-NW	CT	508	.5			1.23	228.70	36.16	7.39		593.22	49.52
K-NW	CT	508	.25	9.14	6.14	1.05		15.52			93.82	144.21
K-NW	CT	508	.125	18.87	8.85						0.78	29.24
I-NW	CX	715	.5			0.54						
I-NW	CX	715	.25	0.53	0.10			0.70				0.20
I-NW	CX	715	.125 ¹	31.82	2.96	0.13		0.56		0.08		1.80
L-NE	CV-1	693	.5									0.84
L-NE	CV-1	693	.25	5.51	1.81	0.36		1.34				1.76
L-NE	CV-1	693	.125	31.89	8.29							1.59
M-NE	CT/U	625	.5									
M-NE	CT/U	625	.25	0.24	0.24			0.95		0.42		1.33
M-NE	CT/U	625	.125	6.92	0.56			0.10				1.18
L-NE	CT	634	.5	0.42		0.52	158.51	7.06		18.13	144.30	46.96
L-NE	CT	634	.25	35.76	25.85	0.77		9.87		11.45	72.99	150.40
L-NE	CT	634	.125	22.56	17.18			0.15				15.30
L-NE	CT	634	.0625	13.95	8.46							5.77

Notes:

UNIT = Excavation Unit, Layer = Natural layer, used to designate samples in Figures VI-16 and 17, North Trench samples designations used within "", i.e., "BG1c"; SAM = 9 litre Bucket Sample Number, NESTE = Nested Screen size portion analyzed, in inches, Mytilus = Mytilus category in gms, Barnacle = Barnacle, Proto = Protothaca category, Tresus = Tresus Category, Clino = Clinocardium category, Saxido = Saxidomus category, Nucel = Nucella category, Vener = Veneridae category, Pelycepoda = "Pelycepoda" category. See text for definition of the last two categories. The weights given are those actually measured. 100% of the 0.5 and 0.25 inch screen samples were identified, 25% of the 0.125 inch screens (but see^{1,2} below), and where done, only 12.5% of the 0.0625 inch screens.

1. In these samples 50% of the 0.125" samples were analyzed; the values given are the weights of the 50% samples.
2. In these four samples 12.5% of the 0.125" samples were analyzed. The values given are the weights of the 12.5% samples.

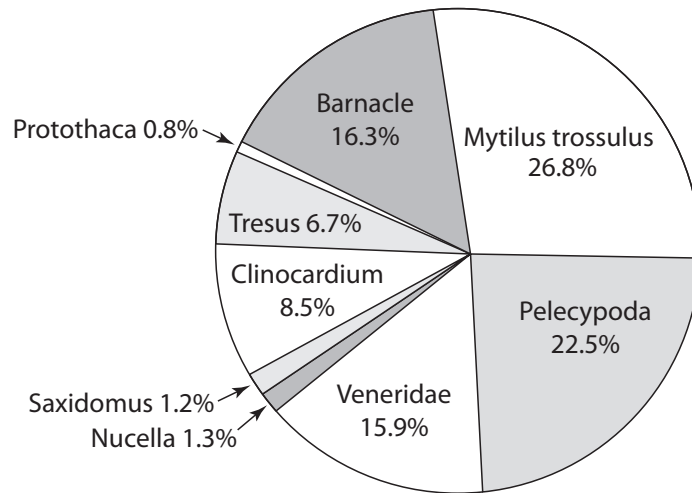


Figure VI-5. South Trench Shellfish. Total Percent of Shellfish Classes by weight.

values from the other analyzed samples which range between 0.0 and 101.0 grams for the component from the 1/2 inch screen. This large 1/2 screen weight is only exceeded in the two samples from layer CT; however the total CT sample weight is considerably less than that from CN-3. The total weights for the 1/4 inch screen in other samples do not exceed 307 grams, considerably less than the CN-3 sample.

The dominance of *Clinocardium* in the CN-3 layer (which makes up approximately 35% of the shellfish in sample #209) suggests a shift in the subsistence pattern occurred here. The fish analysis completed by Crockford and Wigen (this Chapter) can help to explain this. Their analysis shows that Flatfish and Midshipman dominate this layer.

Both Flatfish (mostly Starry Flounder) and Midshipman (see Chapter II) are most easily harvested in the spring when Flatfish migrate much closer to shore and Plainfin Midshipman nest beneath the lower intertidal rocks. *Clinocardium nutallii* can be found on intertidal beaches and mud flats throughout the year, but rarely in large quantities. In the late spring, however, when the water begins to warm they can be found in patches of eel grass. According to J.E.M. Kew (personal communication to Matson) Musqueam

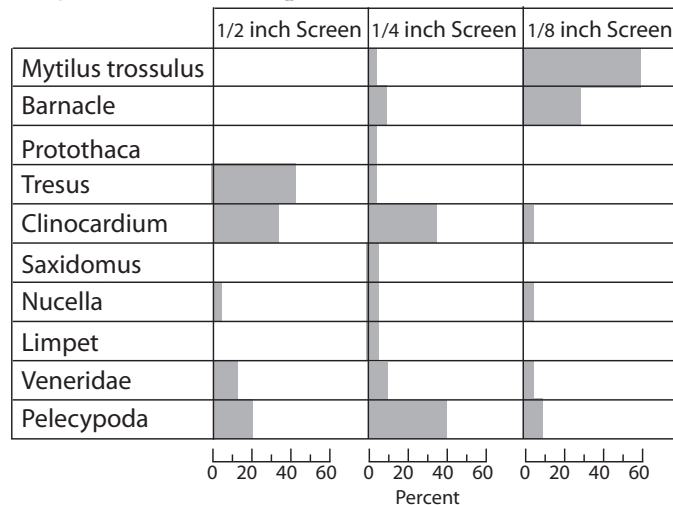


Figure VI-6. Shellfish from Layer CN-3, Unit Isw, 40-50 cm, South Trench (Sample 209).

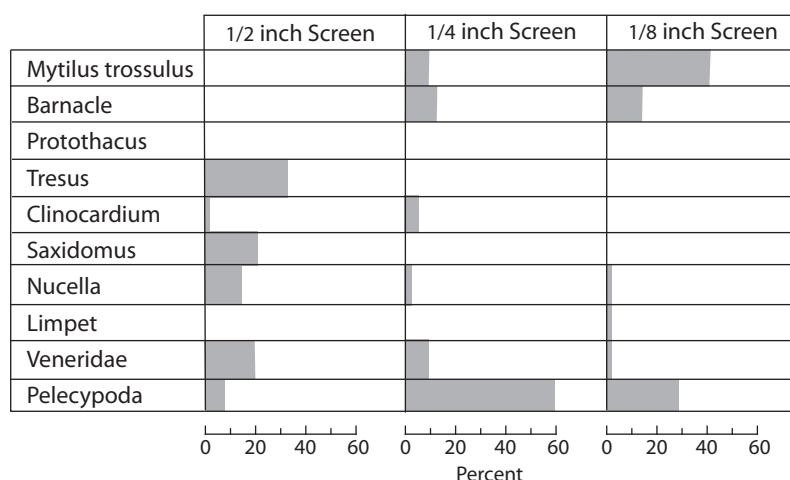


Figure VI-7. Shellfish from Layer CP-1,2, Unit Isw (Sample 265).

informants indicated that during spring low tides it is possible to wade into the eel grass and feel for these bivalves with your toes. They tend to locate themselves near the surface making them easy to pick and deposit in adjacent watercraft. Therefore, the associations between the fish and shellfish patterns in layer CN-3 appear to result from late spring gathering and fishing.

When Layer CN-3 fauna is contrasted with the layers immediately above and below it (Figure VI-7) we see a change in seasonal shellfish gathering patterns. The layers immediately above and below CN-3 have a more diverse shellfish assemblage and contain the largest proportions of herring remains recovered during the excavation of Crescent Beach. The presence of herring is indicated of late winter, early spring occupations, a time when any species of shellfish would be considered more palatable than stored foods (Crockford and Wigen, this Chapter and Chapter II; Moss 1990).

There are several other patterns in the shellfish data from the South Trench that deserve recognition. These include layers dominated by *Nucella* or whelks, and other layers with a predominance of barnacle or *Tresus* species shell. *Nucella* is a significant genera in at least two samples taken from layer CL-1. The presence of whelks here coincides with the presence of *Saxidomus giganteus* remains. These two shellfish generally appear together, occasionally in similar quantities. This co-occurrence is demonstrated by their clustered relationship in the Pearsons correlation scaling and cluster analysis (see “Statistical Analysis” below) and is visually represented by Figure VI-8.

This relationship is a somewhat confusing one as *Saxidomus* are generally thought to be gathered in the late spring and summer, while whelks are best gathered in the winter or early spring when they aggregate to breed (Ricketts et al. 1985: 276). However, the total weight of whelks represented in the analyzed Crescent Beach samples is relatively low with 43 grams being the largest sample. Erlandson (1988:132) has suggested that whelks of the *Nucella* genera may be used as dye. Therefore, their appearance may be related to opportunistic gathering or for dye making. Ricketts et al. (1985) also point out that whelks generally live in close relationships to species such as *Mytilus trossulus*, indicating that they may have been gathered while searching for other species. Nevertheless, analyses of growth rings (this chapter) indicated that *Saxidomus* specimens from layer CT may have been collected in winter. Thus, the whelks and *Saxidomus* may have been collected in late fall and winter. Observations made on Valdes Island in 1996 (Matson et al. 1999) indicated that some *Saxidomus* beds are located in areas where they can be procured in winter adding variety to the diet.

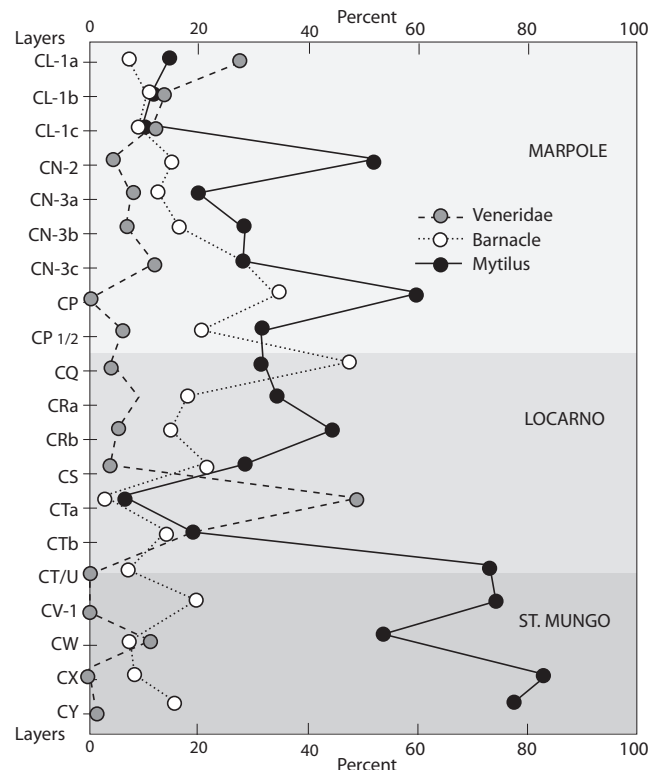
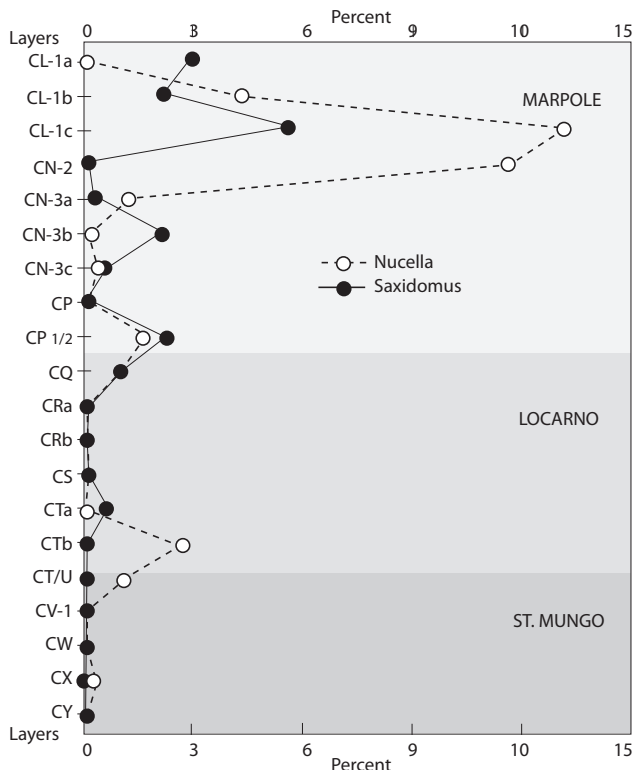


Figure VI-8. *Nucella* and *Saxidomus*, South Trench. Figure VI-9. *Tresus* and unidentified clam, South Trench.

Layer CT is rich in *Tresus* shells (containing 50% of the total genera weight). This large horse clam can exist both on rocky foreshores and along the open coast (Ricketts et al. 1985), although local experience indicates that large beds of this clam are found in sand bars, often near eel grass beds. The relationship of this species to the large amounts of unidentified Veneridae and Pelecypoda is demonstrated in both the Pearson's distance cluster (Figure VI-14) and Figure VI-9. It is believed that many of the unidentified remains are in fact *Tresus*, but this clam fragments easily and unfortunately most *Tresus* fragments lack any identifying characteristics.

Layer CT may represent a late spring - early summer occupation. It is unlikely that *Tresus* would be collected during the fall or winter months because it buries itself quite deeply in the intertidal sediment - often up to 1 m (Ricketts et al. 1985). In order to dig for this species one would have to stand in shallow water or tide pools for a considerable length of time. Its size however, would make its food value worth the effort if the water were warm. Nevertheless, small amounts of *Saxidomus* recovered in Layer CT (Table VI-12) were collected late in the year (see growth rings - this chapter). Therefore, the early Locarno Beach layer CT appears to represent a late spring - early summer occupation, but may include a later seasonal component as well.

A soil sample from layer CT was also analyzed and both *Mytilus trossulus* and Veneridae were well represented in the 1/16 inch screen. The presence of Veneridae was to be expected given the breakage which the large clams such as *Tresus* undergo. The fact that this screen was dominated by *Mytilus* was not surprising either, because this shell fragments very easily. Neither *Mytilus* nor Veneridae alter our understanding of seasonality in this layer.

Barnacles are another class which, like *Mytilus* and Veneridae is present in every layer analyzed (see Figure VI-10), but dominates layer CQ, where it represents almost 50% of the shellfish species. Barnacle is

generally considered to be irrelevant to the diet of the Northwest coast people because the shells found in archaeological sites are so small and because barnacles grow by attaching themselves to other marine life such as whales, kelp and other shellfish species (Morris et al. 1980) suggesting that their appearance in shell middens is accidental.

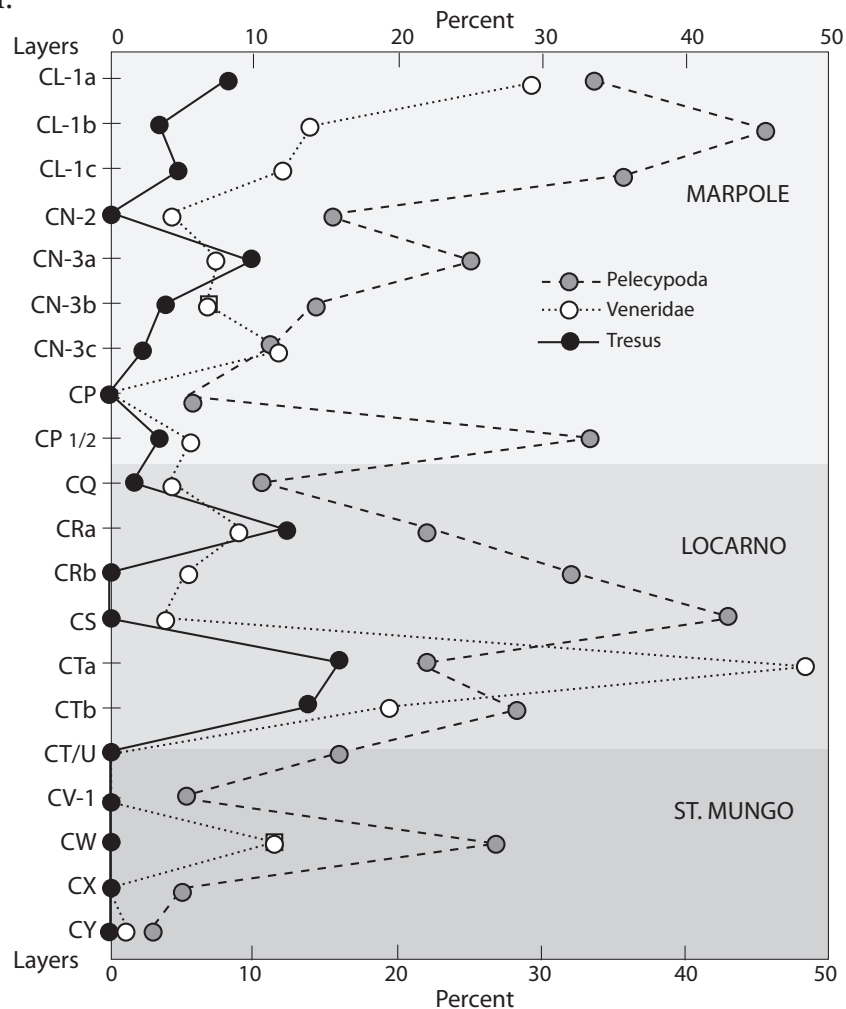


Figure VI- 10. Mytilus, Barnacles and Veneridae by Depth, South Trench.

Nevertheless, barnacle is well represented shell middens from California to Alaska, and Ellis and Swan (1981:26) record that the “old people” of the west coast Manhousat, ate barnacles, particularly the larger *Semibalanus cariosus* variety, regularly. These were pried from rocks with sticks and steamed or boiled. They were considered best in the summer months when the water was warmer and if there was “no poison about” (Ellis and Swan 1981:27). Boas also recorded the consumption of barnacles on the Northwest coast, explaining the cooking, serving and eating procedures (Gray 1988:10). Apparently, barnacle meat was removed from the shell by cracking or pushed out by small cedar sticks (Gray 1988:10). The practice of breaking the barnacle shell would contribute to the fragmentation of shells found in archaeological context.

The majority of the barnacles from Crescent Beach can be considered tiny and are likely the *Balanus glandula* species which only grows to a diameter of only 20 mm. Fournier and Dewhirst (1980:95) believe that this species would be collected incidentally rather than actively pursued. While not the preferred species of barnacle, Gray (1988:30) suggests that *Balanus glandula* might have been a food source because it is

available year round and is easily collected and prepared. Barnacle is present in all layers at Crescent Beach and in layer CQ (see Figure VI-10) it account for 48% of the total shellfish weight present. Therefore, it may have been used as a food resource, regardless of the small size.

The North Trench

The North Trench contains 10 classes of shellfish with *Mytilus*, barnacle and unidentifiable fragments making up the majority of the assemblage. *Clinocardium* and *Protothaca* are also significant. The other classes present in this trench are statistically insignificant, but do contribute to the individual characteristic of the different layers. The samples from the North Trench are much more homogenous than the samples in the South Trench and variability between layers is minimal except for the samples associated with Feature 9. Layers are characterized by the relative amounts of *Mytilus trossulus* and barnacle, but most fall within the same range.

Samples from Fnw and Fsw, in the North trench came from the deepest part of the excavation (220-250 cm) and are representative of shellfish use during the St. Mungo phase of occupation at Crescent Beach. These samples are dominated by finely crushed *Mytilus* shell, in the smallest screen with few remains recovered in the larger screen sizes (see Figure VI- 11). The absolute weight of the shellfish in the samples from Fnw was very low, ranging between 1.0 and 17.0 grams. In order to correct for the fact that much of the *Mytilus* was escaping the 1/8 inch screen, soil sample, #279, taken from Fnw, BC-G1 (230-240 cm) was fully prepared and analyzed in the lab, allowing a 1/16th inch screen to be used. The results of this analysis confirmed that much of the shell was lost during water screening, but did not alter the results. *Mytilus* made up 65% of the shell from the smallest screens of the soil sample. The absolute weight of *Mytilus trossulus* was greater than double that of the second most abundant shellfish (10.56 grams of *Mytilus* in the 1/8 inch screen compared to 4.54 grams of *Balanus*, and 12.60 grams of *Mytilus* to 4.53 grams of Barnacle in the 1/16 inch screen). This dominance of Bay Mussel in Fnw in St. Mungo occupations has been demonstrated at other sites (see Ham 1976, Glenrose Cannery).

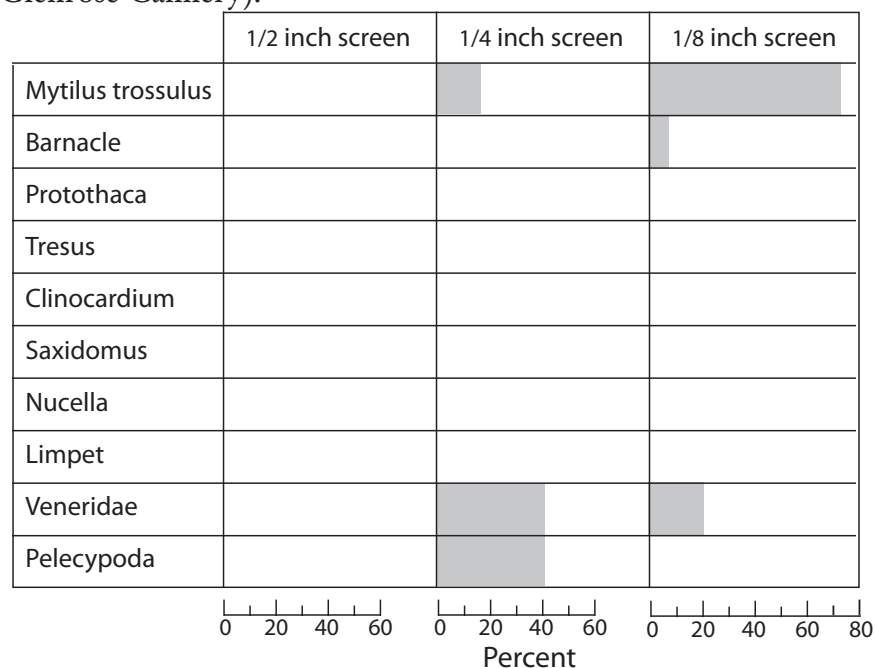


Figure VI-11. Shellfish from Layer BC G1, Unit Fnw, 220-230 cm, North Trench, Sample 264.

Altogether eight samples from both the North and South Trenches are believed to have been taken from St. Mungo deposits. These come from units Fnw and Fsw in the North Trench and units Knw, Ksw, Inw, and Lne in the South Trench. The 1/8 inch screen portion in all St. Mungo samples was dominated by *Mytilus trossulus* remains (ranging from 50%- 83%). However, unlike the North Trench, *Clinocardium* were present in large screen samples that were taken from the South Trench. Nevertheless, the high percentage of clams in the large screens is largely insignificant because the percentage values overestimate their importance. In this case, absolute weight is a much better indicator of significance. For example, *Clinocardium nutallii* made up 72% of the 1/2 inch screen portion of sample #791, taken from unit Ksw, Layer CY at a depth of 150 cm (See Figures 11 and 12), but only weighed 3.97 g. Conversely, the 1/8 inch screen portion of the same sample was dominated by *Mytilus trossulus* at 80.0% and a weight of 48.7 g.

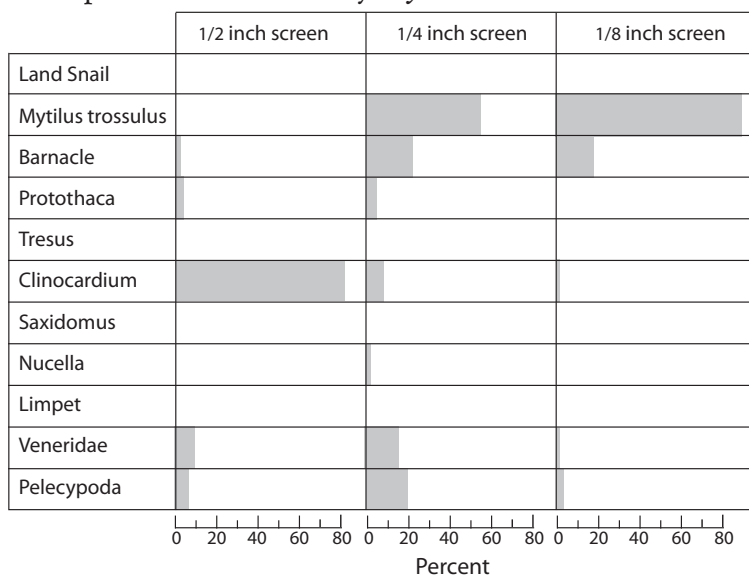


Figure VI-12. Layer CY, Unit Ksw, Shellfish, Sample 791.

Of the nine samples analyzed from the North Trench only three samples vary from this pattern. Two of these are associated with Feature 9 - the third was taken directly above Feature 9. Two samples (#643 and #483), excavated at depths of 190- 220 cm were taken from layers BC-H (Figure VI-13) and BC-Hb, and are associated with the Feature 9 living surface. These two samples date to the Locarno Beach phase (WSU 4246; 3010±85 is from BC-Hb). In both samples *Clinocardium*, *Saxidomus*, and *Protothaca* are all present in the larger screen samples in relatively equal proportions. The 1/8 inch screen samples are dominated by *Mytilus*. The combination of these shellfish species is indicative of spring harvesting. The results of the faunal analysis from Layer BC-Hb and BC-H (this chapter), show a late fall to early spring seasonality for this pit house with varied amounts of salmon, herring and flatfish procured over the period of occupation. Once again, fresh shellfish may have been a welcome addition to winter stores by the early spring.

When the analyzed shellfish samples taken from the North Trench are compared they reveal a change in shellfish exploitation through time. *Mytilus trossulus* dominates many of the earliest samples from the St. Mungo and early Locarno Beach occupations, but clams such as *Clinocardium nuttallii* are dominant in the more recent Locarno Beach layers (including Feature 9). This is in keeping with a greater Northwest Coast pattern reflected in sites from California to Alaska (Wessen 1988) and supports Croes and Hackenberger (1988) model that *Mytilus trossulus* supported early populations in the pre-storage economy of the Northwest coast. As the populations developed new techniques for storage of other types of food such as

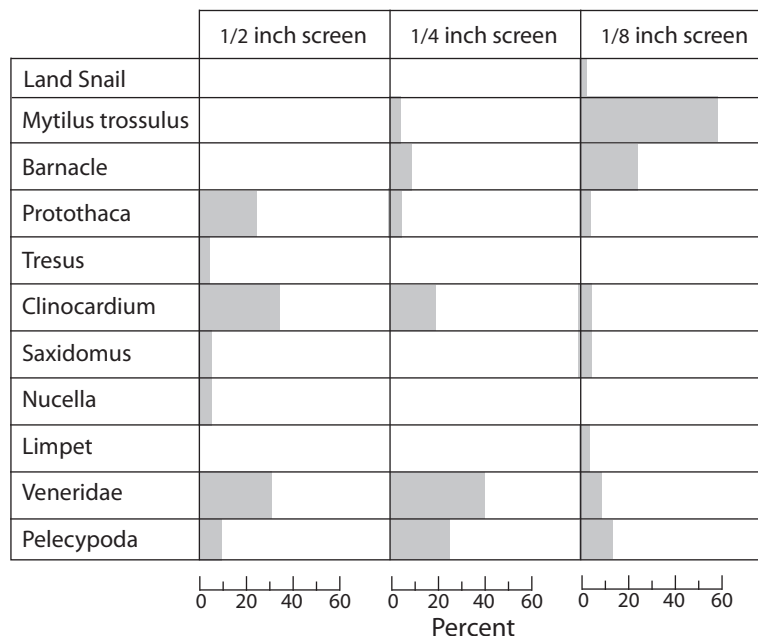


Figure VI-13. Shellfish From Layer BC-H (Feature 9), Unit Ese, 190-200 cm, North Trench (#483).

anadromous fish, other types of shellfish which were available at different times of the year became more significant.

Statistical Analysis

In order to gain a greater understanding of the relationships between the layers in both trenches the shell samples were subject to a number of statistical tests. To begin, an r-mode analysis using Pearson's correlation coefficient was conducted in a single case study to determine if using the raw weight data or the percentage of total weight gave different results in quantitative analyses. This was conducted using correlation coefficients as a measure of similarity in order to see which shellfish categories were most closely related. Both the raw weight and the percentages gave very similar results in tests using Furthest Neighbour (Matson and True 1974; Sneath and Sokal 1973) and metric multidimensional scaling or Principal Coordinates Analysis (Davis 2002; Matson and True 1974).

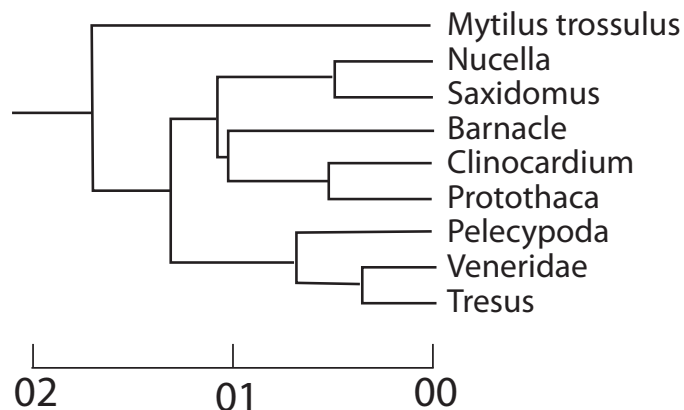


Figure VI-14. Furthest Neighbour Cluster analysis of "Pearson Distances" of Shellfish Classes.

Multivariate analyses using the percentage weight of shellfish to examine the relationship between the different shellfish classes (r-mode) are illustrated below (see Figures VI- 14 and 15). A distance measure based on Pearson's correlations coefficient was used and the results of analyses run in 2008 are illustrated by the Furthest Neighbour (Figure VI -14). All 29 shellfish samples were used but the category of limpet was not included because it was so rarely present (Table VI-12). Figure VI-14 shows three clusters, – the first links the clams *Tresus* and Veneridae to unidentified remains, the second links *Protothaca*, *Clinocardium*, and (weakly) Barnacle with *Saxidomus*, and *Nucella*. (Slightly different results were found in 1991 [Rankin 1991:102]). The third is *Mytilus* by itself. The basic pattern is clear – that mussels are at one end of the spectrum while all sorts of clams are found together, surprisingly with Barnacle. The association between *Tresus* and unidentified clam fragments likely results from the horseclam fragmentation as *Tresus* produces less identifiable fragments than the other clam species when broken. The results using raw weight data resulted in a very similar dendrogram (not illustrated), except that *Clinocardium* is linked with *Tresus* and the residual unidentified categories. It is surprising that *Mytilus* is not linked with Barnacle (as was found in Rankin 1991) but close inspection shows that the two shellfish are often, but not always found together.

The metric scaling (Matson and True 1974; Torgerson 1958) of the percentage data (which used the same distance matrix as used in Figure VI-14), shown in Figure VI-15, clearly contrasts mussels (and secondarily, Barnacles) collected from the rocky foreshore with the clam species in the first dimension (50.7% of trace). The position opposite *Mytilus* is the previously recognized cluster of *Tresus*, Veneridae and Pelecypoda. The less important second dimension (Figure VI-15) (20.0%) contrasts Whelks (and secondarily *Saxidomus*) with the rest. It may be that this is a seasonal difference of winter versus spring/summer. The

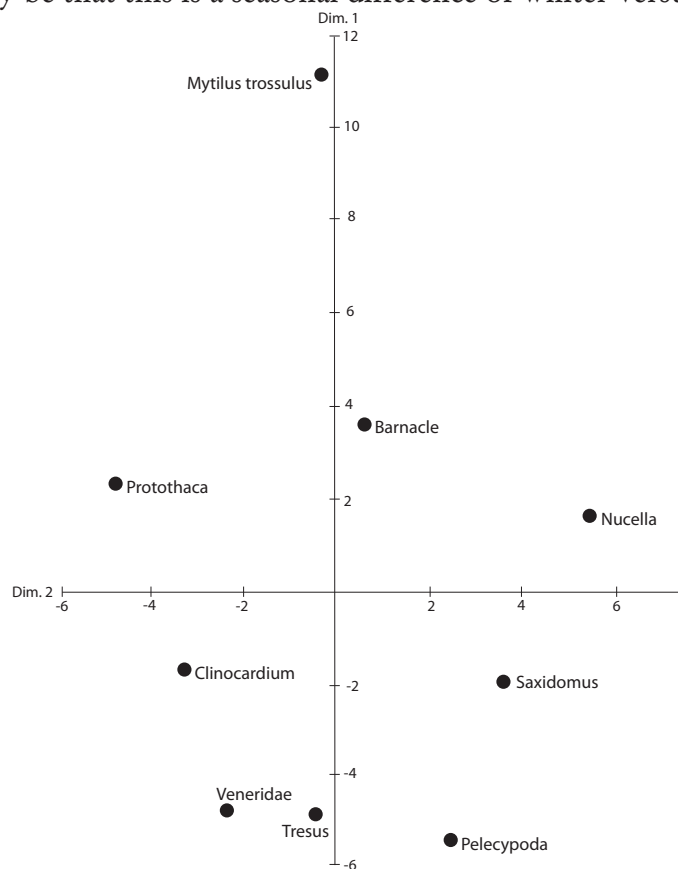


Figure VI-15. Metric Multidimensional Scaling of R-mode Shellfish categories, "Pearson Distances". Dimension 1 50.7% of trace, 2, 20.0% of trace, 3, 14.9% of trace, and 4, 13.1% of trace.

third (14.9%) and fourth (13.1%) dimensions (not illustrated) contrast Barnacle and *Tresus* with the other shellfish, respectively. Overall, the interpretations of the metric scaling are similar to those from the cluster analysis. Finally, the metric scaling of the raw weights (not illustrated) was also run and is relatively similar to that based on the percentages.

After examining the layers from the North and South Trench independently (Rankin 1991:57-74), a final test examined the relationships among all cultural layers from both the North and South Trenches using the 29 shellfish samples. In order to do this the same nine shellfish categories for all 29 samples were used to characterize the samples using both Ward's cluster analysis and metric scaling, a q-mode analysis in contrast with the previous r-mode, where the relationship between the layers rather than the types of shellfish is of interest. Ward's cluster analysis, using Chord distances (Overpeck et al. 1985) as shown in Figure VI-16, illustrates two main clusters, each divided into two. The two clusters are, of course, those layers dominated by *Mytilus* (CY to BCI1), and includes all the St. Mungo samples and those dominated by clams (CL1a to BG1b; BG1b is sample 236 which is 200-210 cm below datum in Fnw, equivalent with Feature 9) which includes no clear St. Mungo layer. Within the first cluster, the subcluster of CY to BCI1s, is dominated by *Mytilus* and often large amounts of Barnacle, and that of CW to BCI1, *Mytilus* and clams, as shown by abundant Veneridae and Pelecypodea. The "clam" cluster is subdivided into a subcluster with abundant horseclam and Veneridae (CL1a to CTb) and one (BCH1 to BG1b) with less horseclam (and Veneridae) and more *Mytilus* and Barnacle.

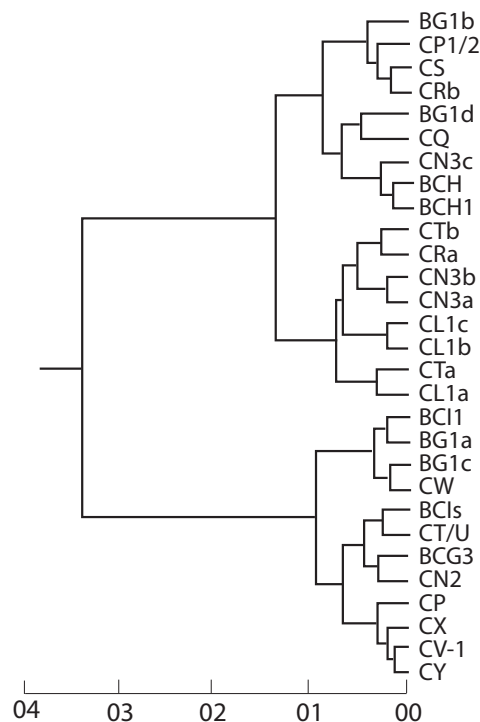


Figure VI-16. Q-mode Ward's Cluster Analysis of Shellfish Samples, Chord Distances.

The metric scaling of the Chord distances (Figure VI- 17) also distinguishes *Mytilus* (bottom) from clams (top, with CTb being in the extreme clam position) in the first dimension (55.7% of Trace) and shows barnacle (right) relative to *Mytilus* as the second dimension (13.6%). The metric scaling of City-Block distances (not illustrated) is remarkable similar and a principle components analysis (not illustrated) was also similar. The rank of the samples according to proportion of total shellfish weight being *Mytilus* compared

with their positions on the first dimension results in a Spearman Rank order correlation of + 0.966; that of amount of Barnacle with dimension 2, +0.828. Layer CQ, with 47.5% Barnacles, is the most extreme Barnacle case. The third dimension (not illustrated, 9.5%) appears to be amount of Pelecypoda and the fourth (7.1%) contrasts Whelks and *Clinocardium*.

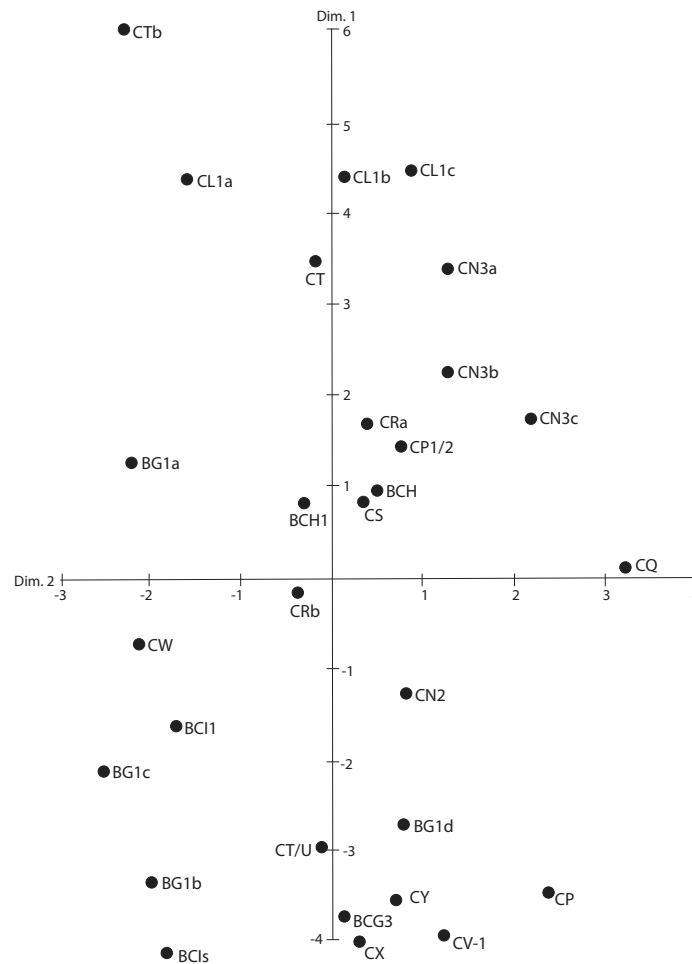


Figure VI-17. Q-mode Metric Multidimensional scaling of Shellfish samples, Chord distances. Samples with abundant clams at the top, *Mytilus* at the bottom, and Barnacles to the right.

Discussion

The results of the laboratory analysis can now be used to address the three research questions a) to determine the seasonality of shellfish use at the Crescent Beach b) to determine if there was changes in shellfish use over time, and c) to determine if the shellfish data from Crescent Beach can shed light on the pre-storage economies of the Northwest coast (Croes and Hackenberger 1988) and the development of social complexity (Matson 1983).

Clearly, the shellfish data from Crescent beach indicate both seasonal variation in shellfish use and change over time in the shellfish species collected. *Mytilus* makes up 70%-80% of the weight of shellfish in the early lower levels of both excavation trenches. As we move toward more recent levels, the proportion of *Mytilus* drops, but it is not eliminated, as more clams are added to the subsistence economy. The use of

Tresus, *Clinocardium*, and *Protothaca* then becomes more intensive through time.

Mytilus is available year round but according to Ellis and Swan (1981:84) in 1925 it was the source of a lethal PSP poisoning so its use was likely restricted during certain periods of the year. Erlandson (1989:148) citing De Laguna (1960:29) suggests that the Tlingit believe that “mussels are poisonous during the season that salmonberries flower (late April, May and June)”. He further claims (1989:149) that ethnographic accounts of Tlingit shellfish use indicate that the use of mussels is curtailed “in the late summer months of July through September when PSP toxicity is a common factor”. Therefore, *Mytilus* is best gathered during the winter months. Their habitat on the rocky foreshores allows them to be easily acquired during cool winter temperatures without having to wade in deeper waters or dig in the mudflats. The earliest Crescent Beach occupation layers were dominated by *Mytilus* and were most likely occupied during the winter months.

The more recent layers of South Trench can also be used to establish a seasonal chronology. The layer CN-3 (see Figure VI-26) is linked to the spring collection of *Clinocardium*. This is supported by local Salish ethnographic data as well as the faunal analysis (Crockford and Wigen, this volume) which indicates that herring are being procured at the same time *Clinocardium* is collected. Layer CT in the South Trench may also be a spring occupation as the collection of *Tresus* which dominates this unit is best accomplished when the waters begin to warm. *Tresus* collectors must dig up to 1 m in depth in the cool tidal pools in order to locate this species. Nevertheless, sectioning of the *Saxidomus* specimens from this layer indicate a winter occupation may also be possible (this chapter).

Ham (1976:60), Fladmark (1975) and Hanson (1995) have explained the transition from *Mytilus* based shellfish exploitation to the exploitation of clams as the result of sedimentary evolution of the coastal mudflats because different species inhabit different coastal environments. As described earlier *Clinocardium* and *Tresus* inhabit the lower intertidal mudflats, while *Protothaca* and *Saxidomus* inhabit the sandy and gravelly substrates higher in the intertidal zone and *Mytilus* can be found in the rocky foreshore. Fladmark (1975) has suggested that beach development limited the amount and types of shellfish available for exploitation in the early development of the Northwest Coast. Cannon et al. (2008:9) have also suggested that low salinity in regions such as the early Fraser River delta might have prevented the growth of extensive clam populations. Nevertheless, at Decatur Island, beach development is unable to account for the switch from *Mytilus* based harvesting to clam harvesting because no mussel shell habitat has ever existed in proximity to archaeological site 45-SJ-169 (Ives 2003:325). Furthermore, contemporary clamming at Crescent Beach indicates that all the shellfish species coexist in very similar environments - though some attach themselves to rock while others burrow. What can be said is that all species found at Crescent Beach existed in the past, as they do today, in the protected bay rather than the open coast.

Others have suggested that the early over-exploitation of *Mytilus* species might explain the switch to clam based harvesting (Ives 2003:326). But this does not adequately explain the transition either because *Mytilus* continues to be used at most Northwest coast sites, although in reduced numbers while clamming is added to the harvesting strategy. Therefore, the season of shellfish availability and exploitation may be a more significant explanation of the change in shellfish exploitation patterns over time.

Croes and Hackenberger (1988:43) have suggested that prior to the development of storage economies on the Northwest coast shellfish resources were a “critical determiner in human population regulation” because they were the one resource which could support populations through the winter when many other resources were not available. Following this, they suggest that the early population of the coast was limited in size to that which could be maintained during the winter season on a diet based on 20% shellfish consumption (Croes and Hackenberger 1988). Because *Mytilus trossulus* is the one species of shellfish that is readily available, abundant and easy to access during winter months it makes sense that this is the species

that is always recovered from coastal sites during early periods of occupation. Not only is this the case for Crescent Beach, but it can be said for other early sites such as Hidden Falls (Davis 1989), Glenrose (Matson 1976, 1996b), St. Mungo (Calvert 1970; Boehm 1973) and Namu (Conover 1978).

At the Hidden Falls site in Alaska, Erlandson (1989:143) reports that as much as 90% of the shellfish assemblage of the lowermost layer of component two (3200-4600 RCYBP) at this site is made up of *Mytilus trossulus*. Similarly, Conover (1978:97) claims an abundance of *Mytilus* from 4540 RCYBP at Namu. Ham's (Ham et al. 1986:120) excavation and analysis of the St. Mungo site indicates that *Mytilus trossulus* is the predominant shellfish species accounting for 72% of the shellfish in the St. Mungo midden between 3370 and 4480 RCYBP (Ham et al. 1986:ii). At Glenrose, *Mytilus trossulus* was utilized as long ago as the Old Cordilleran period and by the St. Mungo phase was more significant than that of all mammals combined (Matson 1976:299).

Mytilus does not appear to be significant at the Chuck Lake site where clams such as *Saxidomus* and *Protothaca* appear to be a more important resource even as far back as 8000 RCYBP (Ackerman et al. 1985). However, this interpretation may be the result of a sampling problem. During the Chuck Lake excavation, no screens smaller than 1/4 inch were used perhaps allowing the highly friable *Mytilus trossulus* remains to go undetected.

If the early populations of the Northwest coast relied heavily on shellfish resources prior to the development of storage techniques, this dependence did not disappear once the storage of resources became commonplace. During the more recent occupations of the Northwest coast new shellfish species - namely the clams, generally harvested in warmer months, were added to the subsistence strategy. Thus, there is a shift in shellfish procurement strategies allowing greater access to spring clam beds once fish species such as salmon can be stored as a winter resource. This shift in harvesting strategies from winter to spring primacy indicates that other resources were used for winter subsistence, but the shellfish were a welcome addition in the spring to add variety and fresh food to the diet. Furthermore, the varieties of shellfish available in the spring - the clams - have high meat weights, allowing harvesters to maximize their labour investment (Wessen 1994). This shift in harvesting strategy is recognized at many Northwest coast site including Crescent Beach (Ham 1982; Matson et al. 1991), Beach Grove (Matson et al. 1980), Shingle Point (Matson et al. 1999), Pender Canal (Hanson 1995), Yuquot on the west coast of Vancouver Island (Fournier and Dewhurst 1980), as well as sites in Washington State (Ives 2003; Bard et al. 2007) and on the Alaskan coast Moss (1989).

This movement toward a greater incorporation of clam species is evident at Crescent Beach particularly in association with the early Locarno Beach phase Feature 9 (Figure VI-13). Feature 9 contains an abundance of clam species such as *Clinocardium*, *Protothaca*, and *Saxidomus* and stands in contrast to the earlier *Mytilus* dominated St. Mungo occupation. This shift is also visible in the South Trench where *Tresus* is the dominant species recovered from layer CT and the *Clinocardium* dominated CN-3. Ham (1982:251) also noted the shift to clam species at his excavations at Crescent Beach where *Clinocardium* made up 47% of the shellfish assemblage in the more recent phases. *Tresus*, *Protothaca*, and *Saxidomus* were also important, but *Mytilus trossulus* was no longer significant at just 1.7%, indicating how complete the switch away from mussel was.

Beach Grove is a more recent Marpole phase site. It has a shellfish assemblage dominated by *Tresus*, *Clinocardium*, and *Protothaca* (Matson et al. 1980). There is some evidence from growth ring analysis carried out on collected shell fragments to indicate that these clams were gathered in the summer. However, layer E at the Beach Grove site (Matson et al. 1980) also contains a high amount of *Mytilus* indicating that it continued to be a significant resource at this site, perhaps used in lean years, or to add variety. It is also possible that *Mytilus* may have become significant in the more recent prehistoric period if other resources

were suffering from over exploitation (Maschner 1997; Wessen 1988). In the Gulf Islands Pender Canal shows a similar transition from mussels to clams (Hanson 1995). While the very recent site of Shingle Point, on Valdes Island had a shellfish assemblage that was dominated by clams (Matson et al. 1999), with *Mytilus* collected in winter months (Matson et al. 1999:181-182).

The analysis of shellfish remains from Yuquot on Vancouver Island indicates that *Mytilus californianus* became less significant over time in relation to *Tresus*, *Saxidomus*, and *Protothaca*. Unfortunately, the authors do not indicate when this change took place (Fournier and Dewhirst 1980). Nevertheless, it demonstrates that a similar change in resource use was taking place on Vancouver Island. In Washington State the early component at West Point (3700-3390 RCYBP) was dominated by mussel shell only to be replaced by clam shell between 3250-2760 RCYBP (Larson 1995). On Decatur Island we see the same pattern occurring again at approximately 2500 RCYBP (Ives 2003:327). Finally, Moss' (1989) work in Alaska indicates that *Saxidomus*, *Clinocardium*, and *Protothaca* formed the majority of the late prehistoric shellfish assemblage in that region.

While none of the work done here can alone support Matson's 1983 model which suggests that shellfish beds were the first resource locations to be owned, it does not dispute it either. Shellfish were an important year round food resource and fit Matson's categories necessary for making a resource desirable for controlling - they are at once dense, predictable and reliable. While it would appear that *Mytilus trossulus* was the first shellfish to contribute substantially to the subsistence of the Crescent Beach occupants other species were eventually added to their seasonal diets.

In the recent layers, spring shellfish collection appears to have become the norm, perhaps offering a pleasant change from the stored winter foodstuffs. However, the value of species such as *Mytilus trossulus* which may have been very important to the pre-storage economies of the Northwest Coast people was not forgotten. Their year round availability of mussels would make them valuable even after the storage economy came into existence, perhaps serving a supplement during lean years, for exchange, or as a fresh food supplement to add variety to the diet. If shellfish were one of the first resources to be owned and managed on the Northwest coast -they were not forgotten later.

Chapter VI

IV Shellfish Seasonality

R.G. Matson

In addition to the inferences made elsewhere about the seasonality of the shellfish remains, two species of clams were sectioned to infer seasonality from annual shell growth. In this we followed the work of Ham (1976; 1982) and Ham and Irvine (1975). It is now well-known that clams lay down their shell only when the mantle is extended, and that layers occur because of factors such as tides, storm disturbances, and temperature changes. These often result in “winter check rings” when because of cold temperatures or winter storms there are marked disjunctions in the production of the shell that are visible on the surface of the shell. These variations in shell growth are usually more visible if the shell is sectioned and polished, and the “winter check rings” show up as translucent bands.

One of the first successful uses of shellfish seasonality on the west coast of North America was that by Weide (1969) using the Pismo clam in southern California. This led to the application on the Northwest Coast by Ham (1976) – under my direction – and Keen (1975), Monks (1977), and many others. Koike (1980,1986; Koike et al.1992) in Japan raised this approach to a high level, including cross-dating individual shells. Shellfish seasonality can include very detailed analysis with a very fine-grained interpretation or be a relatively coarse-grained analysis. Such things as the length of the year have been inferred from paleontological specimens, for instance.

In the Northwest Coast, the most careful and detailed study yet carried out is that of Ham (1982) who compared the results of 161 sectioned clams from his excavation on Crescent Beach with two samples of modern shellfish collected from Crescent Beach in 1980 and 1981. We followed the procedures and information developed by Ham closely.

An important feature of Ham’s work was the comparison of two modern shellfish samples (one of which I collected) with modern temperatures, to see when check rings occurred and to see if they were correlated with modern air temperatures (Ham 1982:198-200). Ham was able to show that for three species (*Clinocardium nuttallii*, *Protothaca staminea*, and *Saxidomus giganteus*) the period of slow winter growth which corresponds to the “winter check ring” occurred when the lowest winter air temperatures were present. This Ham determined occurred between mid-November and mid-February. Koike (1980:19) determined that ocean temperature had the highest correlation with shell growth; presumably, the air temperature relationship found by Ham is a proxy measure for that. The two modern samples were collected in March and April and showed 14 and 16% of the previous years growth after the check ring.

Ham’s analysis shows not only the time of winter check ring in the local, Crescent Beach environment, but also that about 15% of the previous year’s growth would be expected by the first of April, thus giving a firm foundation for further analysis. The comparison, though, does assume that the weather has remained relatively the same over the last 3500 years, a relatively safe assumption, given the coarse-grained analysis which follows.

During the 1989 and 1990 Crescent Beach investigations, steps were taken to collect shellfish at other seasons to confirm and extend Ham’s work, but this was never brought to completion. Ham (1982:198) also noted that a heat wave in 1979 have resulted in translucent bands on three modern samples, showing that high temperatures as well as cold ones may have similar consequences for shell-growth.

The actual procedures used to analyze the shellfish was that described by Ham and Irvine (1975) and

Ham (1982:200). First, likely archaeological specimens of *Protothaca* and *Saxidomus* were selected from various layers. Only specimens with intact edges and without evidence of “senility”, i.e., shells that seemed to show a regular series of winter growth checks. Senile clams are those which are no longer laying down much shell and so have a series of winter checks all crowded together near the lip. This can not be successfully analyzed using the Ham and Irvine procedures.

The selected shells were cut into strips so that they could be placed into plastic 35 mm film containers. Modelling clay was used to hold them upright, with lip edge up, while the film containers were filled with Quickmount mounting fluid. This material hardens into a clear plastic mounting material that enables the further processing. The film containers and mounted shell were cut in half using a band saw, and then the longitudinal sections of shell polished by using a progression of grit sizes.

Some problems were encountered in these procedures. The Quickmount was probably mixed “too hot” on occasion, resulting in bubbles. This mixture did not always give the support the fragile archaeological shells needed. Thus when cut by the band saw, the shell would shatter or crumble for some distance from the saw, making it difficult or impossible to polish the full section. This process often included the edge, making it impossible to date the time of death. It also appears that in some cases the edges were lost when the shells were first sectioned to be placed in the film containers. Having raised these problems I hope others will take steps to avoid these and produce better results.

Once the samples had been sawed in half by the band saw, both halves were ground using 220 grit on a aluminum polishing wheel. At this point, one half was selected as being the best and selected for further polishing at 600 and 900 grit (Figure VI-18). Lisa Rankin carried out the procedures up to the 900 grit, at which point I tried to finish the polishing. I sometimes resorted to 600 grit, and on some occasions, 220, when I tried to polish the “rejected” half. Some of the repolishing occurred in 2007, when I went through all the samples again (and re-ground 12 at 600 grit or lower) and tried to read them in a consistent fashion. It was not always possible to be certain to decide which translucent band is winter; sometimes it was possible to see the daily rings (Koike 1980) and make a rough count of them to see if two adjacent translucent rings were really approximately a year apart. As found by others (Koike 1980:35), the actual number of daily rings easily seen is quite a bit less than the 365 one expects.

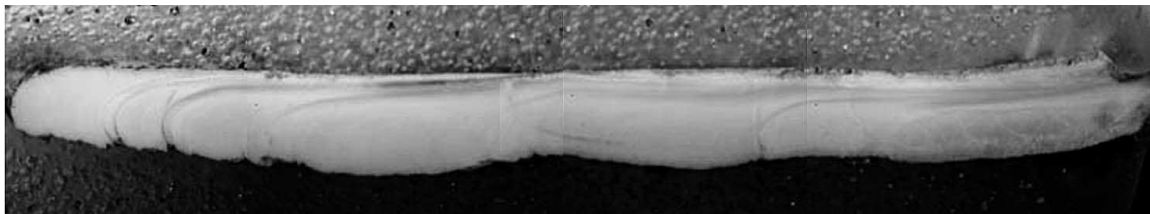


Figure VI-18. A cross-sectioned shell for seasonality. This is a *Saxidomus* shell mounted in QuickMount, as were the ones from Crescent Beach, but from Shingle Point, Valdes Island (DgRv 2).

A total of 26 samples were polished using 900 grit, with two others samples being rejected before this stage. Of these only 17 were judged readable. Ham (1982:200) was able to read two-thirds of his much larger sample, approximately the same ratio. Given the large number of layers, 17 is not a very large number. No readable clams were found lower than Layer C-T in South Trench. In the North Trench, all readable clams were from Feature 9. The results in Figure VI-19 are shown as histograms of the distances between the last three to five winter check rings, with the first bar being the amount of growth since the last translucent winter check, following Ham (1982). In addition, a judgemental evaluation is sometimes given, where the number of daily increments since the last winter check ring appeared to be clear.

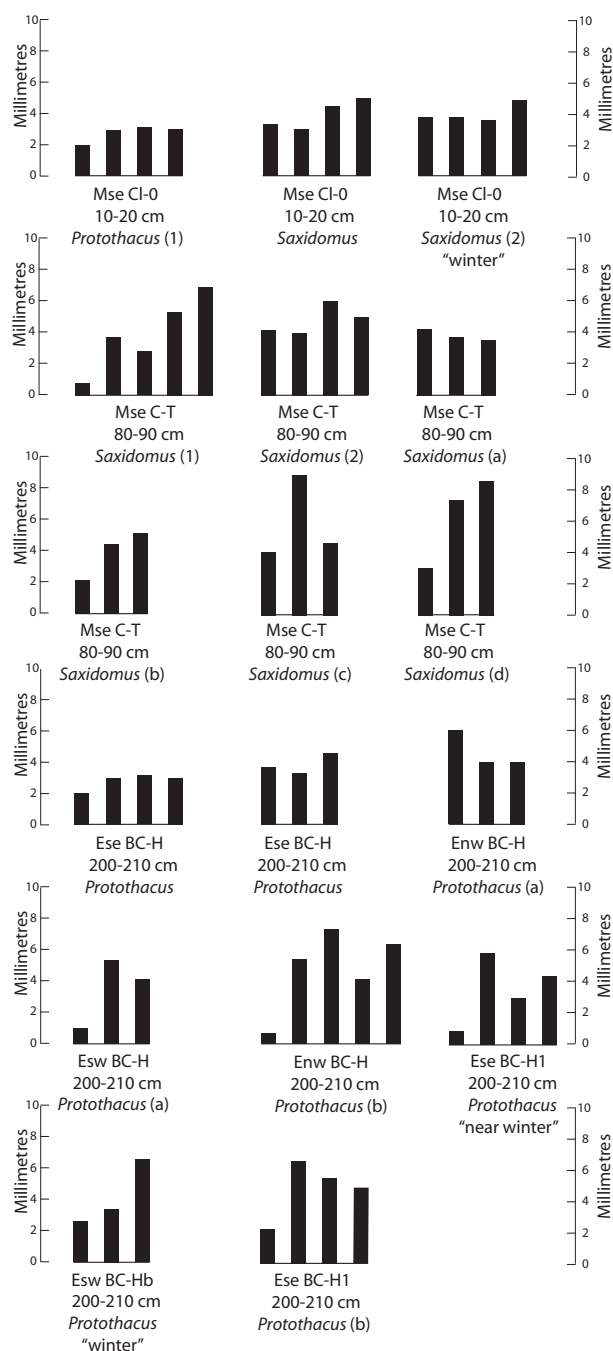


Figure VI-19. Seasonality of sectioned shells.

Three clams were from Layer C-L0, near the top of the midden (Figure VI-19). Although the seasonality expected was that of spring, i.e., March 21- June 21, only one of the three show that. The other two indicate late summer or winter in terms of amount of growth, and one was judged winter in terms of daily increments since the winter check band. These results were surprising, but a sample of three, with varying interpretations is not much to base anything on. Since the top-most layers appear to be very similar to, and may overlap in age with, the Crescent Beach material excavated by Ham (1982), his findings of spring are likely also valid for these layers.

Six samples were read from Layer C-T, the earliest Layer in the South Trench with any abundance of clams, and the earliest layer (when grouped together with C-U) defined as Locarno. The figures show that three or four of the six are indicative of winter. All are *Saxidomus*, although the dominant clam is *Tresus* in this layer, and most were found in a single cluster. As argued by Rankin (this chapter) it is very unlikely that *Tresus* was collected in the winter, although *Saxidomus* occurs higher in the inter-tidal zone and is a more likely candidate for winter collection. Two, and possibly three of the *Saxidomus* shells are indicative of spring time. What is clearly present is the results of a winter-time *Saxidomus* collection in early Locarno Beach times, within a layer that has evidence of earlier in the season shellfish collecting. Since we also have evidence of a winter-time habitation in the Locarno Beach component at Crescent Beach, this presence is not surprising in that terms, but is in that this South Trench layer is mainly thought of as the result of spring time activities. It is true, though, that salmon cranial bones are present in this layer (Table VI-6), the most recent to have substantial numbers of these in the South Trench, indicating the a seasonality of occupation that likely includes later summer and fall days.

The final set of 8 clams are from Feature 9. Six from Layers BC-H and Hb indicate winter or very early spring, all consistent with the winter-time to spring nature of these layers. All samples are *Protothaca*, which can be obtained in the upper intertidal zone, and thus can be obtained in winter and early spring. The final two specimens in Figure VI-19 are from BC-Hb, and are less clear. The *Protothaca* from Unit Ese was interpreted as ending at a translucent winter check and so is “Winter” but the one from Unit Ese is not so interpreted and its amount of growth would indicate spring. The sectioned *Protothaca* clams from Feature 9 support the interpretation of winter seasonality, consistent with the other evidence from this feature.

In summary, the shellfish seasonality was only really definite for Feature 9. The results from Layer CL-O, based on three samples can not be used for much, except to suggest that the seasonality may include a longer period of time than we have previously inferred. The general idea that most of the Locarno and Old Musqueam layers are the result of spring-time occupation, one of the inferences most strongly supported on other evidence, and consistent with Ham’s later Crescent Beach material, is only weakly supported by the three shells read from the upper layers. The six clams read from Layer C-T both support the springtime interpretation made on other grounds but also show evidence of a much later seasonality, not originally expected, but now seen as consistent with other evidence from the same layer. Furthermore, the presence of Feature 9, some 50m away, certainly indicates that wintertime occupations was certainly part of the Locarno Beach occupation of Crescent Beach. The strongest inference is the seasonality of Feature 9, with a winter or early spring time period is clearly supported by the eight clams read from this context.

Chapter VI
V. Subsistence Summary

R.G. Matson

How did the inhabitants of Crescent Beach make their living? And how did this vary during the 2500 years revealed by the 1989-1990 excavations? This is not necessarily self evident from the individual analyses, which focussed on subsets of the faunal remains and often without full knowledge of the other analyses or other relevant information that was being simultaneously – or subsequently – produced. In this section I attempt to bring the various analyses and other relevant information together and compare them with the models briefly summarized at the beginning of this report. After most of the other analyses were completed, the fish remains were identified from Feature 9, so special attention is spent on this material. My integration of the subsistence information parallels, but supersedes that reported by Matson (1992).

Fish

What can we now say about the economic basis of Crescent Beach and about the origins of the Northwest Coast ethnographic pattern? Since fish has long been understood to be the underpinning of the Northwest Coast adaptation, and salmon is the most important fish, let us begin to by examining what can be said about salmon at Crescent Beach. First, it dominates the assemblages beginning with layer C-T, or approximately from 3300 RCYBP onward (see Figure VI-20). With the exception of layer CN-3, salmon remains make up more than 60 percent of the identified fish throughout that 1300-year span from Layer C-T to C-L0. It appears that salmon was the dominant fish at Crescent Beach from Locarno Beach times (3300-2500 RCYBP) through the Old Musqueam Marpole subphase (2400-2000 RCYBP). Just as interesting, though, salmon does not dominate the assemblages before or after.

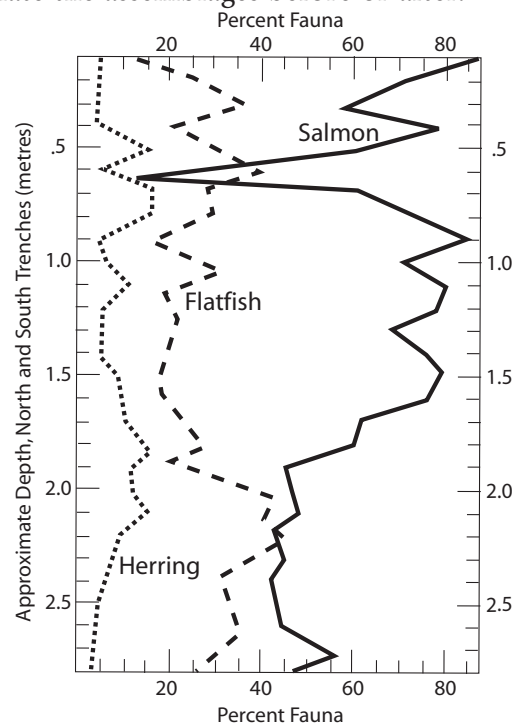


Figure VI-20. South Trench Salmon, flatfish, and Herring abundance NISP.

Although our 1989/1990 excavations did not recover material more recent than 2000 RCYBP, L. Ham's (1982) work, based on an excavation some 300m to the south (see Figure I- 2), covers at least the last 1500 years at Crescent Beach. Ham's excavations produced a fish assemblage that is not dominated by salmon. He interprets this later material as resulting from an early springtime, limited activity component focussed on clam harvesting and Herring fishing. Ham suggests that other places were used for salmon fishing, perhaps across Boundary Bay at the historic reef-netting locations near Point Roberts in late summer. Interestingly enough, the only real exception to the 1300-year dominance of salmon in our excavations, Layer CN-3, was also interpretable in a manner that closely parallels Ham's inference, albeit an occupation slightly later in the spring. Layer CN-3 was dominated by flatfish, Midshipmen, and *Clinocardium*, all resources obtained easiest in the middle spring. Midshipmen, it will be recalled, are fish which build nest under rocks in the intertidal zone in the spring and thus are easily 'collected' during shellfish gathering, as we demonstrated on several occasions at Crescent Beach. In total only 44 salmon remains were found in Layer CN-3 compared to 181 flatfish and 134 Midshipman (and 2 Herring). The relative lack of Herring in CN-3, though, indicates a use slightly later in the year than Ham's excavations, which included substantial amounts of herring.

If salmon was the basis of the economy at Crescent Beach during Locarno and early Marpole times (3300-2000 RCYBP), we would expect it to have been stored (Matson 1976:303-4; Schalk 1977; Croes and Hackenberger 1988). If Crescent Beach was not the location where salmon was obtained, or if it was mainly occupied in seasons other than fall, we would expect few head parts and a disproportionately large amount of post-cranial parts, as the latter would be the only pieces that would be regularly transported with the processed salmon (Boehm 1973:95, Matson and Coupland 1995:166-69; Crockford and Wigen, this chapter). Since we did find some (more than two dozen) intact vertebrae columns in 1989 in one small place within

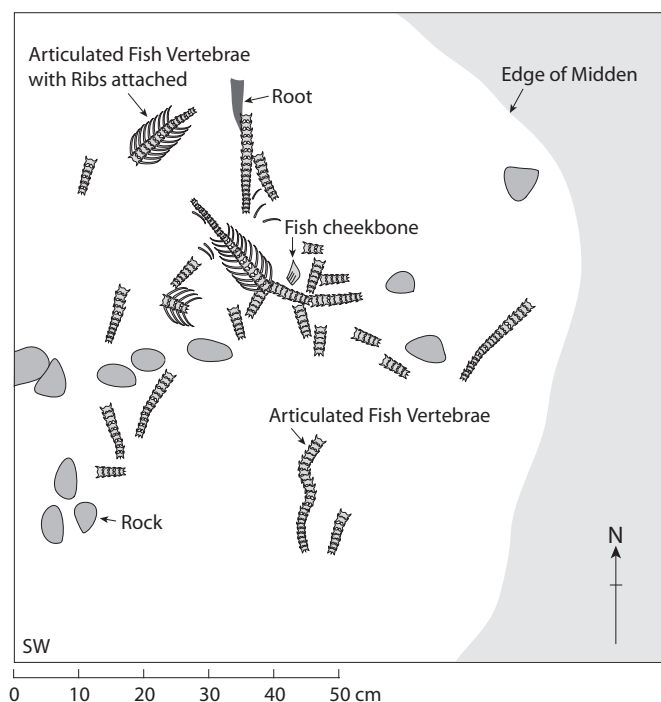


Figure VI-21. Articulated Salmon vertebrae in Unit Isw, Layer CM-2.

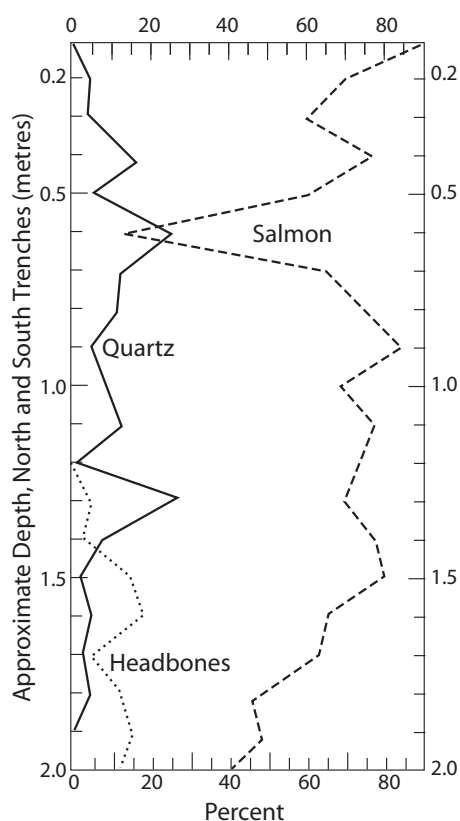


Figure VI-22. Salmon, headbones and Quartz.

what was later identified as the Old Musqueam component (Figure VI-21), we expected head bones, because we thought we had encountered a salmon processing layer. We were surprised to discover that no salmon headbones could be identified in this layer. Since, as they reported earlier in this chapter, Crockford and Wigen did find numerous headbones (although not as many as expected, based on number of skeletal elements) in the older deposits, beginning with Layer C-T (see Figure VI-22), this absence is significant as it can be explained as a preservation effect. Layer C-T is also the point when salmon begins to dominate the identified fish remains, showing that the increase in salmon remains correlates with a change in salmon processing. The relative absence – actually almost complete absence – of salmon headbones in the layers with the peak abundance of salmon (and their presence in earlier deposits) is very good evidence of storage. The Crescent Beach remains present multiple lines of evidence for the importance of stored salmon in the 3300–2000 RCYBP period there.

The seasonality of use at Crescent Beach during this Locarno Beach-Marpole period is not as firmly established as the use of stored salmon, but is still relatively certain. The absence of salmon headbones during most of the Locarno Beach-Marpole period at Crescent Beach indicates that late summer and fall was not the time of occupation. This inference follows from the expectation that, if live salmon were being procured (and) processed at a site, one would find headbones, as salmon heads are usually eaten but not stored. This expectation is met in Layers BC-H and BC-Hb, the Locarno Beach pithouse deposit described in some detail below, which do have salmon cranial parts and other evidence indicating that these two layers were occupied in the late fall and winter. Layers BC-H and BC-Hb, however, are almost the only layers during the Locarno Beach-Marpole period that have that seasonal pattern. Only Layer C-T, can be said to fit this pattern during this time, and that, only in part. Additionally, the presence of abundant flatfish remains in almost all Locarno Beach-Marpole layers at Crescent Beach (see Table VI-1 and Figure VI-23) points to a springtime use – when one would expect stored salmon to be important. The presence, but relatively low amounts, of Herring (see Figure VI-20), which is most abundant in February through early April, indicates springtime use. Ham (1982) had larger amounts of Herring present in the 1500-200 RCYBP deposits he analyzed from Crescent Beach, indicating an occupation during the herring season. The lesser amounts of Herring found in our excavations from the Locarno Beach-Marpole layers (3300-2000 RCYBP) probably indicate that these layers had a slightly later seasonality; April would be our best guess. The shellfish seasonality reported earlier is not inconsistent with this season. The presence of substantial amounts of *Clinocardium* in some layers is indicative of late spring, large amounts of *Tresus* spp. attests to spring or summer. The sectioned bivalves, however, show a pattern of spring, summer, and possibly fall in the post C-T layers. This information supports the spring season, but may also point to later seasons, not well represented by other seasonality indicators. The cluster of *Saxidomus* shells sectioned from Layer C-T point clearly to a winter-time collection of them. This layer also has large amounts of *Tresus* valves, showing that earlier seasons were involved in shellfish gathering as well.

The older parts of Crescent Beach (St. Mungo component, 4400-3300 RCYBP) have significantly lesser amounts of salmon (see Figure VI-23, Table VI-4), with flatfish being roughly equal in abundance. Headbones of salmon are present in these older layers, in contrast to their almost complete absence in the later, Locarno Beach-Marpole layers (Table VI-6). I see three alternative explanations for the presence of salmon cranial bones at Crescent Beach: (a) lack of salmon storage, (b) a function as large-scale processing site for storage (involving removal of the head), and, (c) use of the site only during minor salmon runs that were not worth processing for storage. I believe that the first alternative is by far the most likely. If salmon were being processed for storage at Crescent Beach during the St. Mungo Phase, we would expect large amounts of salmon bones including both post-cranial and cranial bones. Instead, we have modest amounts of both kinds of bones. The third alternative fails, I think, because of the presence of Herring in older

levels, indicating the use of this area during spring, when salmon cannot be easily obtained. I note that the fish analysts agree with this seasonality interpretation (Crockford and Wigen this chapter).

These lines of evidence demonstrate that stored salmon became important only after about 3300 RCYBP, a discovery, which fits well with other information that will be reviewed below. The advent of large-scale salmon storage is probably the single most important event in Northwest Coast prehistory. Although salmon remains appear in very old deposits, such as at the Dalles (Cressman 1960) and Glenrose (Matson 1976), it is at Crescent Beach that we have our first good, direct evidence of the time at which salmon began to be stored in large numbers.

The second most important fish at Crescent Beach is flatfish, almost all Starry Flounder (Crockford and Wigen this chapter). This fish is abundant in the area and most easily obtained in the spring, when it comes inshore. It is equal in abundance to salmon in the earlier, St. Mungo, layers. The St. Mungo Phase is a time of apparent broadscale fishing but not extensive storage. The variety of fish was notably broader (see Table VI-1) during this period than in later times. At no time do we see any change in the ratios of flatfish headbones to post-cranial parts, a pattern which is most simply interpreted as indicating that flatfish were never processed for storage at Crescent Beach.

Flatfish are also abundant, but usually only in the 20 to 30 percent range in the later layers of the 1989/90 excavations at Crescent Beach. This is what would be expected if the site was occupied during the spring as a limited-activity or short-time residential camp. Flatfish are very dominant, along with Midshipman, in the CN-3 layer reviewed above.

The broad spectrum adaptation seen in the earlier layers at Crescent Beach is also in accord with a more residential aspect of longer duration than seen in the later Locarno Beach-Marpole layers. It is notable that the layers from C-T to C-Y (see Figures III-6,7) do not show the sterile interlayers that are so evident from C-L0 to C-Q. The lack of relatively sterile intervening layers in the lower sediments is evidence of continuous occupation, or at least of abandonments that are not long enough to establish the intervening sterile natural layers.

During our excavations at Crescent Beach, we noted that quartz crystal microliths were abundant in the middle of the deposit. We also noted that flatfish were more abundant in the lower levels. Given the Croes-Hackenberg model of flatfish being the first resource stored, Dale Croes and I developed the idea that quartz crystal microliths might have been used for processing flatfish for drying. Starry flounders (*Platichthys stellatus*) are named for the starry appearance of their very bony and tough scales. These fish are also known as "Grinders," "Emery Boards," and "Emery Wheels," in reference to their tough, abrasive skins, so a tough, durable cutting implement, such as a quartz crystal microlith, would be useful for butchering this fish. In other words, our hypothesis was that quartz crystal microliths were used in the processing of Starry Flounders for storage.

Figure VI-23 shows the percentages of salmon and flatfish, and raw abundance of quartz crystal microliths. Clearly, quartz appears in large quantities only after flatfish decline from about 50 percent to 20-30 percent of all identifiable fish. Thus, the behavior of quartz is exactly opposite to the expectations of the short-lived Matson/Croes hypothesis.

Figure VI-23 also demonstrates, however, that quartz first occurs with the initial increase in salmon. Accordingly, we now have a revised hypothesis, namely, that the quartz microliths were used to cut the skin of salmon. Actually, Croes suggested this idea earlier (Croes and Blinman 1980), when dealing with the slightly different microliths at Hoko River. Experiments by Flenniken (1981) with reproductions of hafted quartz microliths indicated that these tools were useful in all stages of salmon processing. More detailed, comparative experiments by Morin (2004), however, showed although microliths were ideal for cutting salmon skin, other tools were far more effective for other butchering steps. Quartz is also plotted on

Figure VI-21 and there it is most abundant when salmon headbones begin to disappear from the record. In Figure VI-21, salmon remains are plotted as percent of total fish against salmon cranial parts as percent of salmon and quartz as percent of debitage in the South Trench – and shows clearly the dramatic change in proportion of headbones and its relationship with the presence of quartz.

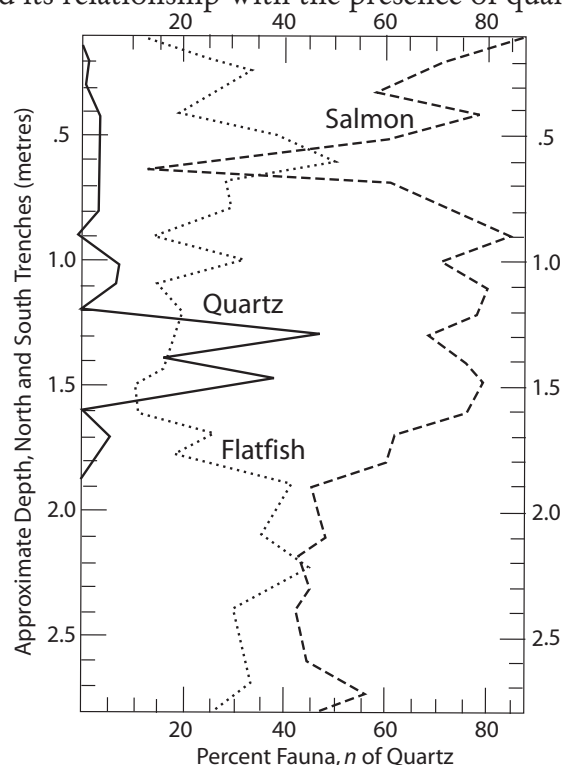


Figure VI-23. Proportion of salmon and flatfish (of fish) and abundance of quartz crystal plotted against depth, North and South Trenches.

A question that emerges is, why do quartz microliths decrease later? Two obvious answers exist for the Crescent Beach site. First, while we have lots of evidence (headbones) prior to 3300 RCYBP for the processing of live salmon, this evidence rapidly decreases after that, so that it appears that live salmon processing did not occur at Crescent Beach in later times. Second, we know that ground slate knives were later used for this purpose. Although microliths may be effective tools for cutting fish skins, the other butchering necessary to prepare the fish for drying probably requires a larger tool, such as a biface or a cortex spall, if not a ground slate knife, ideas that have since been confirmed by the experiments carried out by Morin (2004). Although we did not find any ground slate knives at Crescent Beach, they are known from the Locarno Beach type site and other Locarno components (Borden 1950a; Mitchell 1971; Matson and Coupland 1995:154-182; Chapter XI, this volume). In an earlier draft I had written “Microliths may have been replaced by ground slate knives during the later Locarno Beach period, as they could be used for both skin cutting and the other butchering aspects ..” but Morin’s (2004) experiments showed that ground slate was ineffective in this task. Curiously, Morin (2004) suggests that some sort of chipped stone tool must have been used for this step both where ground slate and ground mussel shell knives were used, yet the archaeological record for the Late Gulf of Georgia region (ground slate knives) and the west coast of Vancouver Island (ground mussel knives) show almost no chipped stone. Clearly, there is a gap in our understanding here.

Ground slate knives also have the advantages of ground stone tools referred to by Hayden (1977, 1989).

These include greater durability and the ability to quickly resharpen without removing the knife blade from the haft. In a situation where a lot of fish must be processed in a short period of time, these would be real advantages. Morin's (2004:305) analysis of his experiments gives qualified support to this position, in that he concludes that ground slate knives (and ground shell knives) would be easier to resharpen than chipped bifaces.

The Croes/Matson hypothesis which is predicated on large-scale use of flatfish is clearly rejected as an explanation for the occurrence of quartz, but nevertheless there may be some evidence of a short period that had abundant flatfish, just before salmon started to dominate the deposits. Level 200-210 of Unit F_{nw}, for example, has 251 identified flatfish remains but only 70 salmon remains, and dates between 3700 and 3000 RCYBP – and most likely the earlier date. If there was a period where flatfish were processed in large numbers before salmon at Crescent Beach, it was very short, and occurred before quartz appeared in large numbers. It should be remembered that, at Hoko River, where Croes and Hackenberger (1988) indicate that such a period occurred, the flatfish present are the much larger halibut which are known to be important stored foods for some ethnographic groups. The development of quartz crystal microliths then are hypothesized to have occurred in the context of large scale salmon processing for storage and are found at Crescent Beach because these extremely tough materials are ideal for making the initial incisions in the very tough starry flounders which were being caught while this site was being occupied.

No other fish comes close to the importance of either flatfish or salmon in the Crescent Beach deposits, except for Midshipman in Layer CN-3. Herring is found only in small quantities in most layers (Figure VI-20). Herring is usually thought to indicate a late winter, early springtime use, but Herring is not found in sufficient quantities in any layer to indicate specialization in its exploitation, except for Layers H and H_b, as reported below. Its presence, in low numbers, along with the abundant flatfish, suggests use of Crescent Beach in the spring for most Locarno Beach and Marpole layers.

Two features about Herring's distribution in Figure VI-20 are of interest. First, it is not found in the deepest St. Mungo layers (Table VI-2), indicating that it was not obtained prior to about 4000 RCYBP. This distribution suggests that Herring procurement, and perhaps Herring rakes, were developments that occurred within the St. Mungo period, 4400 -3300 RCYBP. The absence of Herring at Glenrose (Matson 1976) and their very low numbers at St. Mungo (Ham et al. 1986) for the St. Mungo layers at those sites may simply reflect the different settings, sampling error, or an incomplete adoption of Herring procurement at this time. Second, for much of the middle layers at Crescent Beach, Herring frequencies decline when flatfish increase, and vice versa. Percentages are a closed array, a class of statistics in which, when one item goes up in frequency, something else must go down. Thus, for example, salmon and flatfish are negatively correlated at Crescent Beach. Herring, though, occur in low frequencies and should not make that much of an impact on other fish percentages. I think that the layers in which Herring are more abundant (>7%) were occupied earlier in the year, and that layers with more flatfish and less Herring were occupied later in the springtime. This seasonal patterning is seen in microcosm in the Locarno Beach phase "pithouse," where Herring had its highest percentage in Layer BC-H_b of any layer analyzed.

Among the other, less important fish, sturgeon remains are found throughout the deposit in small amounts but only in quantity in the last two layers. This pattern may indicate that effective specialized sturgeon fishing techniques developed only in the Old Musqueam Marpole subphase. Barbara Lane kindly pointed out to me that Suttles (1951:118-123) has a good discussion about sturgeon fishing including in Boundary Bay. Sturgeon were hunted by harpoons in a canoe "from April through spring and summer, but especially in May" (Suttles 1951:119). They were hunted in the daytime during low tide, but at any tide night time in the dark of the moon, which appears to be the main procurement procedure. At night, the sturgeon swim about 7-8 feet deep, but can be seen some 30 feet ahead because of the phosphorescence. The

harpoon used was the same composite toggle form used for seals and porpoises, with a trident butt and two foreshafts each with harpoon heads at the front end, so that they formed a 'v'. Is it too much of a leap to suggest that the occurrence of large numbers of sturgeon remains in the upper most layers points to the introduction of the efficient night time sturgeon fishery?

Sucker/chub regularly occur only in the bottom two-thirds of the deposit, but are never really found in large numbers. Sculpin occurs in small amounts throughout the deposit but in larger amounts in the bottom third, as does Dogfish. In addition to these fish, there is a set of minor fish which occur only in the St. Mungo deposit – Skate, Perch, Eulachon, and Greenling – although some of these also occur in Layers BC-H and Hb. These figures support the idea that the earlier material is that of a broadscale fishing adaptation, in contrast to the more specialized salmon fishing adaptation seen in the more recent layers.

The increasing diversity of fish support a greater duration of occupation – longer seasonality – the further we go back in time. The general trend of increasing diversity with increasing age supports the idea of a broad-spectrum adaptation during St. Mungo times, as postulated by G. Fredericks (pers. comm.). This adaptation would be one in which locally abundant resources would dominate the faunal remains and would result in differences in faunal remains between contemporary sites, but without real intensification, such as specialized technologies, at any. The relative concentration on salmon and a relatively restricted range of fish found in the later Locarno Beach and Marpole layers stand in clear contrast to the material from the St. Mungo, as does the restrictive seasonality of at least some Marpole layers, such as Layer CN-3.

Christenson (1980) argues that one finds niche broadening prior to specialization and niche narrowing in subsistence evolution as shown in Figure VI-24. Although this was presented in terms of the origin of agriculture, it should also be true for the adoption of the stored salmon economy as presented by Coupland (1988:25-30). It is also axiomatic that with intensification (Matson 1983) diversity in terms of number of important resources declines. This change in niche breadth is also consistent with the pattern seen at Crescent Beach and other early sites. In effect, Frederick's model fits the broad-niche portion of the model, as does Croes' and Hackenberger's (1988) non-storage model, with salmon specialization fitting the narrow-niche-specialized portion. In view of Driver's (1993) critique of my presentation of decreasing fish diversity through time at Crescent Beach (Matson 1992:405), I develop this inference below (see also Matson 2006).

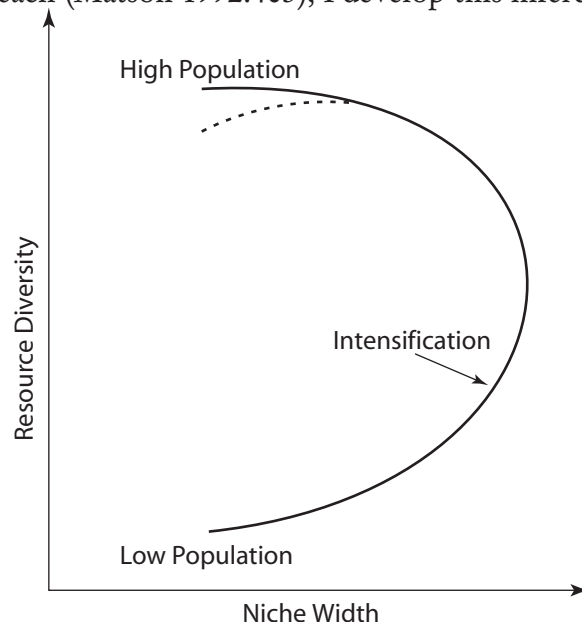


Figure VI-24. Intensification and Niche Width (after Christenson 1980).

In ecology there are three commonly seen three aspects to diversity: “richness” idea, “evenness” or “equability”, and “patchiness”. The first refers to the number of different sorts of things that are found in a sample. Thus, the number of species found in a set area (or set of traps) will vary and those “samples” with the greater number are those of greater “species richness” (Figure VI-25). This version of diversity has been applied to “tool kits” in archaeology, mainly the number of different types of lithic tools (Leonard and Jones 1989). Measurements of “richness” are known to be very sensitive to sample sizes, something that can be controlled to some degree in ecology – such as trapping a set number of animals, for instance (Southwood 1978)– but not something under control in archaeology. The second diversity idea is that of “evenness”, how equal is the abundance of different “species” if you will (Figure VI-25). At least some measures of this aspect are not sensitive to sample size. The third idea is that of “patchiness” in a geographical sense, such as

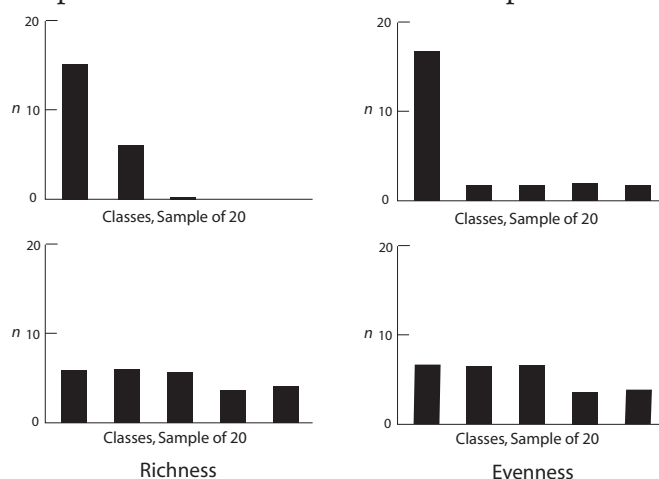


Figure VI-25. The Diversity Concepts of “Richness” and “Evenness”.

the environment being divided into a number of small “patches” or being the same over very large “patches”. I don’t see how the idea of patchiness applies to the current situation, and, indeed, it is essentially unused in archaeology. So the ideas of diversity that might be relevant in the current situation are that of “richness” and “evenness”.

In thinking about subsistence and diversity, one is indirectly thinking about the amount of calories that are contributed to the diet by each resource. What is important is how many resources are involved in producing the bulk of the diet, not how many produce the final 10 or 20 percent. So this is the “richness” idea, how many “important” resources there are. When we are comparing the fish profiles of St. Mungo and Locarno Beach deposits at Crescent Beach in terms of subsistence, “diversity” means “evenness”. In other words, when one enters the stored salmon economy, one gets a higher carrying capacity, but at the potential risk of depending on fewer resources for most of your diet.

Is this actually the case at Crescent Beach (Figure VI-26), or as J. Driver (1993) argues not the case? I used Southwood (1978) as a guide as I have in other cases (Matson et al. 1990) even though the similarity between archaeology and Southwood’s emphasis on insect ecology does sometimes seem limited. Southwood (1978:427) recommends the “Berger-Parker Dominance Index” for measuring evenness as it is not sensitive to sample size, or number of species, among other things. This index sounds complicated, but is simply the proportion of the total sample accounted by the most abundant species. On the face of it, it is hard to see how this is a good measure of “evenness”, but one can see if the most abundant taxon is very abundant there isn’t any room for other taxons to be very important, and thus that sample is not “diverse” (in the “evenness” sense). In the current case, the most important taxon would be either salmon or flatfish,

the two most important fish. But what are the appropriate units to compare? One could argue that one should use the layers, because the entire orientation of this project to get useful information for each natural layer. And, in fact, one can do that (Table VI-4 gives the appropriate values). But there is “bleed” between layers, and there is apt to be reuse of certain parts of the site for the same purpose, while other parts are used for different purposes. In this light, then each Trench should be used separately. One should also keep function and duration as close to the same, an issue I discuss in more detail below, which would eliminate the inferred winter Locarno domestic structure (BC-H and BC-Hb) as a point of comparison, because we have nothing we can compare it with from St. Mungo layers. So I chose to use three units, the St. Mungo from both trenches, and the Locarno from the South Trench.

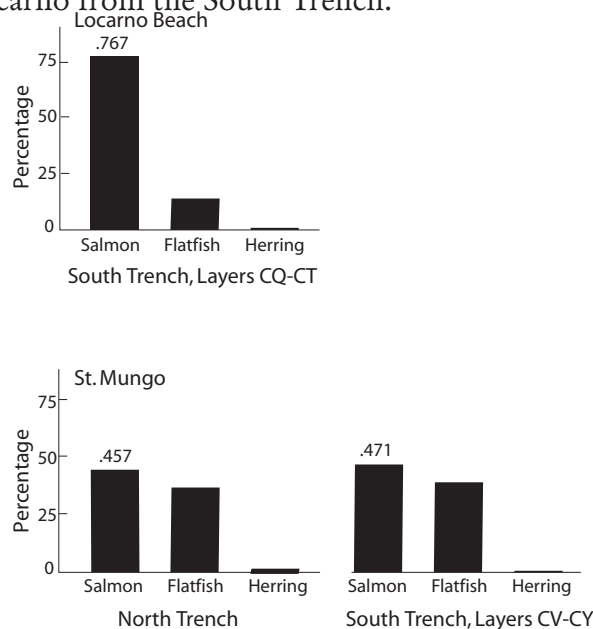


Figure VI-26. “Berger-Parker Dominance Index” for St. Mungo and Locarno Components.

Again, thinking of diet, such a comparison ideally should be of approximately equally sized “resource units”, and the two most abundant fish, Sockeye Salmon (assumed) and Starry Flounder are approximately the same with Sockeye weighing 2-4 kg and Starry Flounder, 1-9 kg. How this factor can lead one astray, is to think about Herring, the third most abundant fish, at 30g. So Locarno Beach (Figure VI-26) has a Berger-Parker Dominance Index of 0.767 and St. Mungo of 0.457 and 0.471, indicating the greater diversity base of St. Mungo diet. A quick look of the using layers (Figure VI-20 and Table VI-4) shows that the results are not based on the choice of units, as using the individual layers gives a similar result.

It is interesting that the importance of Starry Flounder is reduced even as the seasonality of the site shifts to the time of the year they are most available, spring. This gives one something of the scale of the shifts involved in this transformation. The decrease in “niche breadth” as the intensification of the stored salmon economy occurs as argued for by the presentations of Christenson (1980) and Coupland (1988) is supported by the evidence at Crescent Beach. It is notable that Wigen (1995) in a discussion comparing the fish remains from the West Point site and Crescent Beach (reviewed later) came to similar conclusions about the change in diversity of fish that I did.

Besides the statement about the change in diversity in the development of the stored salmon economy I also argued (Matson 1992:408) that the longer duration of occupation found in the Locarno winter domestic structure/layers resulted in greater variety of fish. This can be understood, in effect, as an example of the sampling issue discussed above. Clearly if one had a deposit that lasted a full year, one would have a sample

of all the fish used in a year, which would be a greater number of species than those found in any single season. (See also Matson 1992:408.) So a long seasonal layer should have greater species “richness” than a short one, in that a large sample of days of the year will have more species than a small sample of the days of the year. Evenness should also increase with longer duration of occupation, for a seasonally abundant resource will be extremely abundant in its season of availability, but less so when looked at in terms of the full year, including seasons when it was not available.

There are two layers involved in the domestic structure (Feature 9), with Berger-Parker indexes of 0.363, 0.440, or a combined 0.387, all much lower than the other Locarno layers supporting such a statement. Driver (1993) used the presence of this Locarno domestic structure to argue that the decreasing diversity through time that I argued for was invalid. One of Drivers’ (1993) main points in his discussion of

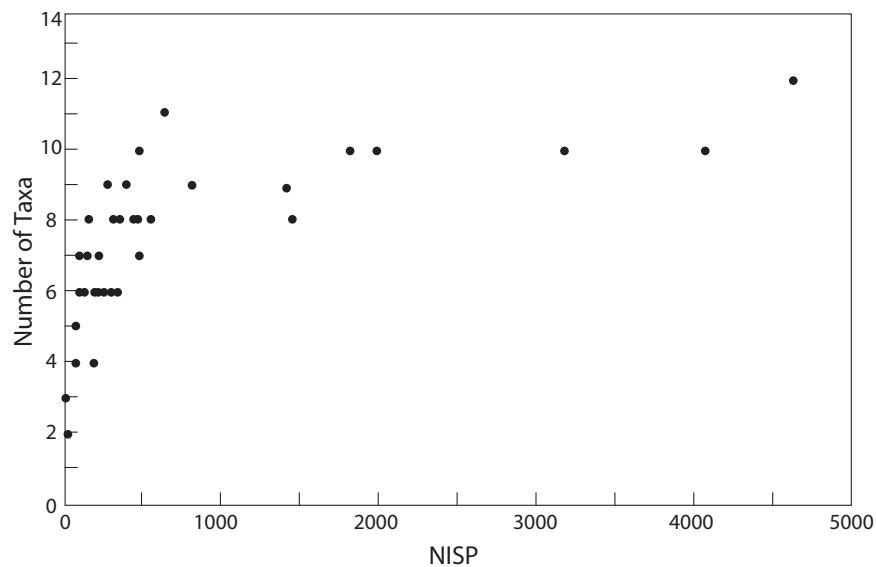


Figure VI-27. Richness and sample size, Crescent Beach (after Driver 1993).

Crescent Beach diversity was the effect of sample size on diversity (Figure VI-27), a point I think is always worth discussion, but his use of the Locarno winter domestic structure was inappropriate. To be fair, I did not specify that evenness was the aspect of diversity I meant for the overall trend, and clearly, I should have. For subsistence, as I have presented above, though, it is hard to see either of the other two aspects of diversity making sense in that context. In my discussion of the Locarno Pithouse (Matson 1992:408), it is less clear what is intended, and, in fact, I did not use the word “diversity”, but instead “wide variety”.

Shellfish

After the fish, the next most important resource is shellfish, which I argued prior to these Crescent Beach investigations (Matson 1976, 1981) was the basis of St. Mungo wintertime adaptation, and which Croes and Hackenberger (1988) have shown through economic modelling was likely the most critical wintertime resource in a pre-storage economy. There are several important features of the shellfish patterning. First, prior to 3500 RCYBP (Layer C-T) Bay Mussel dominates the remains (see Figure VI-28). In fact, it averages more than 70 percent by weight in the older layers. This confirms the pattern seen at other St. Mungo deposits (Calvert 1970; Boehm 1973; Matson 1976, 1981; Ham 1976; Ham et al. 1986). In the post-St. Mungo layers at Crescent Beach, clams increase in importance, although Bay Mussel may have remained the most important single shellfish species. Locarno components in general may have more Bay Mussel than Marpole, as we found at Crescent Beach, although with few other shellfish analyses of Locarno

Beach components this is difficult to substantiate fully. Still when the shellfish from the Locarno component at Decatur Island was analyzed it showed this trend (Walker 2003:137) and Mitchell (1971:57) suggests an emphasis on Bay Mussel is true for Locarno in general.

The older layers at Crescent Beach appear to have much more shellfish than the later layers. The interpretation of this difference is difficult, since the later layers are so clearly of limited activity (non-winter village) and include large amounts of material that was brought in by nonhuman, natural factors. At this point, whether or not shellfish decreased in importance through time is uncertain. Simply plotting analyzed shellfish weight totals by layers for the South Trench does not show this trend (Figure VI-29) as two peaks are shown for Layers CT and CN-3 in Locarno and Marpole times. Inspection of Figure III-6 shows that these two layers do not make up much of the sequence but since they were two of the shelliest

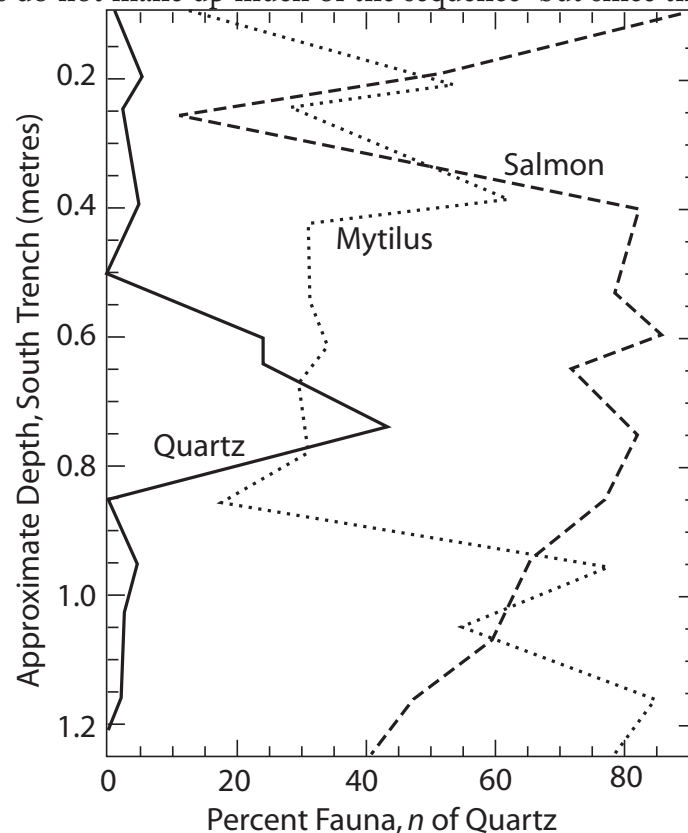


Figure V-28. Proportion of Salmon (of fish), *Mytilus* (of shellfish), and Abundance of Quartz.

layers they were a focus of attention for shellfish analysis. As examples of the size of these layers compared to neighbouring ones in Units Inw and Isw, Layer CT had volumes of 41 and 54 litres compared to Layer CS of 117 and 171; Layer CN-3 volumes of 122 and 72 litres compared to Layer CL-1 volumes of 112 and 143 litres. These layer volume figures are quite a contrast with Figure VI-29. The lower layers are dominated by Bay Mussel and much of that washes right through the 1/8 inch water screening process we used; therefore more shell is present in the site matrix of the lower layers than this figure shows.

We can, though, check the number of fish remains controlled for volume and see if this changes. Figure VI-30 shows the number of identified fish remains per litre of excavated material from three South Trench units. Here it is easy to see that this measure increases with depth, with layers CR and above ranging from 0.78 to 1.99, CS has two measures, both between 2 and 3 and the CT and below ranging from

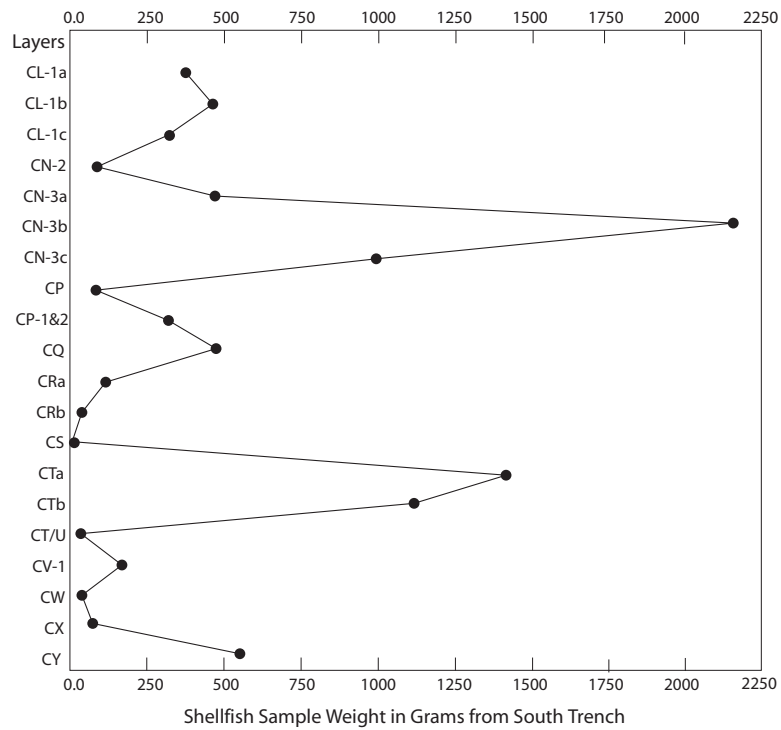


Figure VI-29. Shellfish Sample weights, Units Isw, Inw (CL-1-CW), and Ksw (CW-CY).

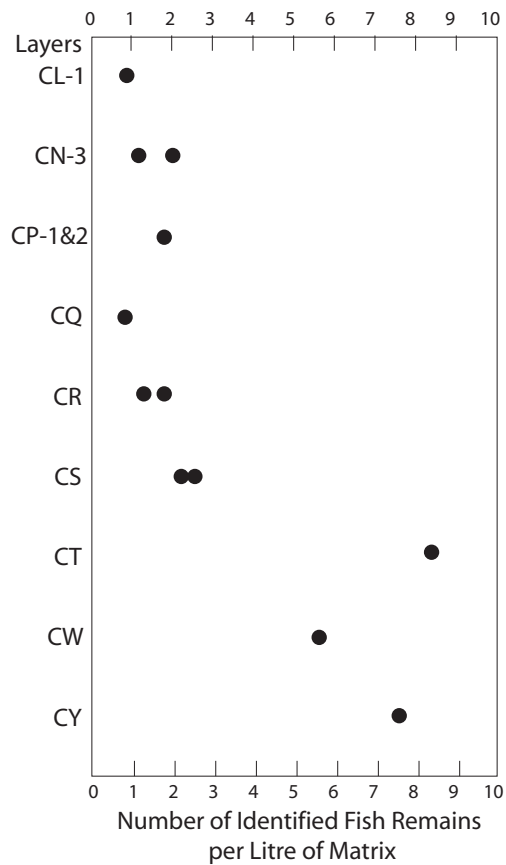


Figure VI-30. Identified Fish remains per litre of Matrix, South Trench.

5.48 to 8.32. If the density of identified fish remains is used as a measure of intensity of occupation, it clearly decreases through time. We have pointed out in Chapter III, though, that the relative sea level is higher in the upper layers, with a much larger amount of sand and small pebbles present in the later layers which we interpreted as the results of winter storms. Thus the percentage of the matrix that is anthropogenic is less in the upper layers. In general the changes in fish density agrees with both the changes in site matrix and our impressions in amount of cultural material, even though we were not able to demonstrate this change in terms of shellfish density.

If, as suggested above, stored salmon replaces Bay Mussel as the limiting winter resource, then plotted against each other they should replace each other. Figure VI-28 plots these two resources as percentage of each faunal category, along with raw numbers of quartz crystal microliths. This graph looks slightly different than either the fish or shellfish plots because the shellfish percentages are not available for some layers and, for others, sublayers were lumped together in order to correspond to the fish samples. The pattern, though, is clear. Through time, mussel decreases from 80 to 40 percent of the shellfish categories, while salmon increases from around 40 up to around 80 percent of the fish. This trend is exactly what was predicted above and, in general, by Croes and Hackenberger (1988). Since we are dealing with independent variables, i.e., not dealing with a closed array, both changes in abundance occurred.

The transition from mussel to salmon, though, was not smooth. Two notable dips occur, one in the lower layers for the mussel, and one high up for both mussel and salmon (see Figure VI-28). The higher-up one is the often-mentioned Layer CN-3. All three shellfish samples from this layer show less than 30 percent mussel. We have the results of the analysis of three separate excavation Units within this layer and none have more than 40 percent salmon. The other dip is within Layer C-T, which is the Horseclam deposit in early Locarno Beach times (ca. 3300 RCYBP) also referred to earlier.

Layer C-T was the first layer with substantial clams, and appears to have had an exceptional number of them for that time. Note that the relative amount of salmon in this layer, though, is in accord with surrounding layers. As noted earlier, there is good evidence of at least some winter season activities in this layer as well, with a cluster of *Saxidomus* samples showing that they were collected in the winter.

Mammals and Birds

At Crescent Beach the least important category in terms of caloric contribution is that of the mammals and birds. The summary of the analyses by Crockford and Stephen (this chapter) reported on the remains and concur on their relatively insignificant contributions, but they point out some significant seasonality information. These bird and mammal remains indicate a spring/early summer emphasis, although the majority of them are from the later portions of the site. This seasonality information agrees with, and is independent of, the fish and shellfish indicators.

Although the numbers of identified specimens are low, they are not inconsistent with other information about the most important mammals and birds. Starting with the Old Cordilleran (Imamoto 1976; Matson 1981), it is clear that in the Fraser Delta region, Elk, Deer, and Harbour Seal are the three most important mammals. For Crescent Beach as a whole, this is also clearly the case. For each component, however, the numbers are too small to confirm this, although all three are present in the Locarno and Old Musqueam components and Elk and Seal are present in the St. Mungo layers. Likewise, waterfowl are known to be the most important birds and are more abundant in Locarno and later periods and this appears to be the situation at Crescent Beach, although I would not like to make this statement on the basis of Crescent Beach alone.

Feature 9

An exception to the absence of significant numbers of salmon cranial remains between 3300 and 2000 RCYBP is found in the “pithouse” fill in the North Trench, layers BC-H and BC-Hb (see Table VI-3). In Unit Esw (the only Unit in this layer that we have this information tabulated) 108 of the 270 identified salmon remains found in layers BC-H and BC-Hb are “headbones” as defined in Tables VI-5 and VI-6. Fully 40% of the salmon bones are identified as cranial parts, with both layers having more than 35%. Thus, this deposit, radiocarbon dated to 3000 RCYBP, shows salmon was being procured and not just being introduced into the deposit after being stored. The presence of cranial bones in these two layers is substantial support for the notion that they are the result of a much longer duration of occupation than the layers elsewhere in the site in the 3500-2000 RCYBP period.

In the field, the interpretation of Feature 9 was that this pithouse deposit was the result of a single season of occupation. If this was so, then the range of fish obtained would change with the seasons within this deposit. During excavation, this deposit was stratigraphically divided into two layers – BC-Hb, the material close to the floor, which was very finely broken-up *Mytilus* midden with lots of ash and firecracked rock; and, above that, BC-H, a less broken-up mussel deposit with a lower density of firecracked rock. If, in fact, these are sequential seasonal deposits, we would expect more salmon earlier, more Herring earlier, and more flatfish and fish related to shellfish gathering (Midshipman, sculpin) later.

Turning to Table VI-3, we can see that these expectations are largely met. Salmon (258, or 44% of 587 total identified fish bones) are more frequent in Layer BC-Hb than in BC-H (444/1228, or 36%). Herring likewise is definitely more common in BC-Hb (135/587, or 23%) than in BC-H (97/1228, or 8%). The 23 percent Herring in Layer BC-Hb is nearly twice the highest percentage found in any other layer elsewhere in the 1989/1990 excavations. Flatfish show a reverse trend (BC-Hb = 124/587, or 21% ; BC-H = 456/1228, or 37%). Flatfish, in fact, go from being half as abundant as salmon (124:258) to being more abundant (456:444), or from 21 to 37 percent of the total identified fish.

These three fish (salmon, flatfish, Herring) are by far the three most important categories; the others mentioned above occur only in low numbers in Feature 9. In terms of Midshipman remains, none were recovered from Layer BC-Hb, but four (4) were found in BC-H. Sculpin, of a variety of types, are found in modest numbers in both layers (24/587, or 4%, in BC-Hb; 86/1228, or 7%, in BC-H); the difference in their respective percentages, 4 and 7%, is slight but is in accord with the predicted seasonality. In summary, all five fish seasonal indicators are found in accord with their predicted abundance; Herring and salmon more common earlier, flatfish, sculpin, and Midshipman more abundant later. Note, that although we are dealing with a closed array, Herring, Midshipman, and sculpin are not abundant enough to effect the other percentages.

The fish remains, then, strongly support the notion that Feature 9 (see Figure III-4) is a winter “pithouse,” and that the sequential layers proceed from winter to early spring occupancy. The presence of salmon headbones indicates that these fragile bones can be recovered in dry middens, at least from *Mytilus* middens, given careful excavation (small units, layers and water screening) and proper analytical techniques (see Crockford and Wigen this chapter). The absence of these headbones, in other late deposits of this site can be attributed to their absence in the “systemic” (Schiffer 1976) context, and not to post-depositional processes.

In contrast with other Locarno Beach layers, BC-H and BC-Hb show a wider variety of fish remains, indicative of a broadscale adaptation, more in accord with what we have suggested for the Crescent Beach St. Mungo component, than with a specialized fishing activity. This is what we might expect if these layers are the result of a longer duration of occupation than other Locarno layers as discussed above. The longer the duration, the more activities that would be carried out and be incorporated into the layer. Furthermore, if Crescent Beach was a long duration wintering site during Layers BC-H and BC-Hb, with auxiliary

foraging also occurring, the results of a wide variety of minor subsistence activities would be incorporated into the archaeological deposits. Rankin's shellfish analysis (this chapter) of two samples (483 and 643 Figure VI-13) from these features shows that just such a pattern exists with regard to shellfish. As expected the Bay Mussel dominated the shell remains, but a wider, and more even distribution of shellfish are found in the larger screen sizes with *Clinocardium*, *Saxidomus*, and *Protothaca* are being evenly represented. As expected, the frequency of Horse Clam is very low, and Whelks are relatively abundant.

The fish and shellfish remains are in accord with the interpretation of Feature 9 as a winter-time habitation layer. The shellfish seasonality analyzed by sectioning (previous, this chapter) indicates a winter or very early spring for seven (7) and one (1) of spring for season of collection for the clams that could be read. These eight specimens do not inform us about the changes between Layers BC-H and Hb. Thus there appears to be no reason to doubt that aspect of this Feature's nature. The actually structural make-up of this winter-time habitation, however, is in more doubt as indicated in Chapter VIII. The architectural features are not as clear as the seasonal and subsistence information reported here.

Comparison with Ham's Crescent Beach Excavations

Since so much of our excavation methodology and analytical procedures were based on Ham's (1982) pioneering work on later deposits at Crescent Beach, it is useful to compare the two. Ham excavated a single large "block" ranging from 7 x 4 to 4 x 4m to a depth similar to our South Trench, and which dated between 200 and 1400 years ago. Thus it was laid down a few hundred years after the end of the 1989/1990 layers. One might think from this introduction that it would be easy to compare the results because of these similarities, but this is not the case.

First, Ham (1982:255,257, 285) saw the function of his deposit changing little over time and thus did not always report the differences between the layers in ways that are convenient for comparisons. Second, although mammal and avian remains were extracted from the midden as it was water-screened, only the shell samples that were selected for analysis had the fish remains removed. Ham (1982:194) indicates that about 13% of the shell samples were analyzed, but because of sample splitting for analysis of the smaller screen sizes (1982:193,254) slightly less than 1% of the total matrix was actually examined for fish remains, compared to our estimated 85% for the 1989-1990 intact deposits. On the other hand, Ham analyzed 124 shell samples, approximately 4 times the number we did for the 1989/1990 excavation. So although the recovery of mammal and bird remains and the shell should be broadly comparative, Ham's sample of fish is very different and much smaller.

Given these differences what can be said? Ham (1982:265-6) found that elk was the most common large mammal, with deer the second most common, a reverse of our findings and that these two occurred with about twice the density of what we found. Given that the higher layers of the 1989/1990 excavations had the large amounts of "natural" deposits, I doubt if the difference in density means anything, although the reverse in abundance of elk and deer may. Ham's (1982:265) third most common large mammal is sea mammals, of which only three are identified as to species, quite a bit lower than what we found, indicating that the use of sea mammals did decline. The other mammal of note is dog, which appears to occur in similar numbers in both deposits.

Ham (1982:259-264) was able to identify quite a number of birds and came to the conclusion that waterfowl (ducks and geese) were the only "birds consistently used as food" (1982:261) a conclusion that is valid for the 1989/1990 excavation as well. As near as I can estimate Ham identified about 400 out of some 2000 bird remains while we were only able to identify 25 out of 172 remains (Table VI- 9) for the South Trench. While the "profile" of species appears to be similar, the abundance of bird remains clearly increases through time.

Although the mammal and bird comparisons leads to some useful conclusions, albeit without any understanding of change through time within Ham's deposits, the fish raise more questions than answers. Remembering that only a very small amount of fish was analyzed, approximately 1%, and Ham did not give number of elements for each class or proportions for each layers, the very large differences between the two deposits may have a number of different origins. From Figure 5-32 (Ham 1982:258) one can estimate the number of identified elements in total found in his deposits for five of the most common fish. The most abundant is Herring at about 230 elements, followed by Midshipmen, with about 130, then flatfish at 70, sculpin with about 60, and salmon at 32.

In weight, Ham (1982:Figure 5-30) gives Herring 22%, flatfish 25%, Midshipmen 13%, salmon 13%, sculpin 8%, and Dogfish 11%. Not only is this pattern very different for the South Trench summary, it is not even very similar to any layer within South Trench. Perhaps the most similar layer is CN-3 with only 2 Herring, 181 flatfish, 134 Midshipman, 44 salmon and 16 sculpin elements. CN-3, it will be remembered, stood out among South Trench layers, and was interpreted as being later in the year than the others. The main difference between CN-3 and the summary of Ham's layer is in the abundance of Herring, which never rises to 10% in any South Trench layer. The largest difference between the two deposits is in the dominance of salmon in the South Trench, and the lack of this in Ham's. In both the later South Trench layers and in Ham's deposits, salmon cranial bones are absent (Ham 1982:256-259). It is unclear from the Ham's two layer distribution figures (Figures 5-31 and 5-43) how much variation occurs in his fish pattern. It is also unclear, given the very small numbers derived from his sampling scheme, that any such variation results from differences in use.

Ham focussed on the shellfish, and his investigation in many ways has yet to be matched. Particularly innovative is his model of midden development and how he "tested" it against the holistic data set from each layer (Ham 1982:343), including the faunal remains reviewed above. Although our excavations were on the same site, there were major differences in terms of shellfish, and we can be certain that these are not the result of different analytical processes. First the *Mytilus* dominated layers, so common in our deeper deposits, are absent in his. Second, in terms of identified shellfish, *Clinocardium* is the most important in Ham's, although *Tresus* may really be the most important when its prevalence in his Pelecypoda category and its higher meat : shell ratio (Ham 1982:256) are recognized. This pattern is only found in Layer CN-3 in our samples (Figure VI-6), although *Clinocardium* is also abundant in samples from layers CY and Hb (Figure VI-12 and VI-13). Ham's analyses were centred on the use of data sets that included a variety of archaeological remains, including shellfish, and so can not be easily compared with Rankin's, although they are not inconsistent, given the differences outlined in this paragraph.

In summary, the mammal and bird remains appear to be similar between Ham's excavations and ours, but the fish and shellfish very different. Layer CN-3 does have the same shellfish profile and fish pattern, except for the Herring as the summary pattern for Ham's material. Since Herring can occur in very large numbers (Monks 1977), Ham's summary may be misleading in that Herring may occur only in a few layers of his excavation yet appear to be important in the summary. Since there are a number of grounds to infer that CN-3 is later in the season than most other 1989/1990 layers, an obvious inference is that Ham's deposit is also later in the year. In this case the low numbers of salmon in both CN-3 and Ham's is because stored salmon of the previous year are no longer used by late May or June. Layer CN-3 was dominated by flatfish, Midshipman, and *Clinocardium*, all resources obtained easiest in the middle spring. Midshipman, it will be recalled, are fish which build nests under rocks in the intertidal zone in the spring and thus are easily "collected" during shellfish gathering, as we demonstrated on several occasions at Crescent Beach. The higher numbers of Herring in Ham's deposit is the leading discordant factor in such a comparison.

Comparison with the West Point Site.

Perhaps the most similar faunal remains to Crescent Beach are found from the West Point site, near Seattle (Larson and Lewarch 1995). This site includes a number of components ranging in age from about 3700 RCYBP to about 500 RCYBP. The oldest, Component 1 dates between 3700 and 3300 RCYBP and if it is not St. Mungo, is very similar to St. Mungo. Component 2 dates from 3300 to 2800 RCYBP, Component 3 is very small and probably dates to about 2400 RCYBP. Although Component 2 is very similar in age to Locarno Beach, and shows some general similarities, the similarities are not as strong as those between Component 1 and St. Mungo (see Chapter XI). Although only about 1% of the fish remains were analyzed, we are fortunate that these were also classified by Pacific Identification, and that the analyst, R. Wigen, also analyzed part of the Crescent Beach material and provided us with a careful comparison of the two fish samples (Wigen 1995:A5-51-56), which I summarize below.

Wigen (1995:55) reworks the data from both sites to provide comparable component summaries and finds that the two oldest components show similarities in abundance of flatfish (Crescent Beach 37.3%, West Point 35.7%) and that both sites' oldest component show that "the resource use is spread evenly among a variety of resources" supporting the conclusions discussed earlier in this chapter. The two components differ though, in that at Crescent Beach Salmon remains are more abundant at 46.7%, but only 11.3% at West Point, which also has large amounts of Staghorn Sculpin (20.7%) compared with a total sculpin percentage of only 4.4% at Crescent Beach. Crescent Beach has 6.4% Herring, while this is only about 3% at West Point (my estimate, Wigen does not provide this figure). West Point also has more perches and ratfish, but similar amounts of freshwater fish and Dogfish as Crescent Beach. Wigen (1995:55) suggests that the broad base of resource use that I infer for the Crescent Beach St. Mungo component is even more so for this component, a tentative conclusion that is certainly warranted by the summary and comparison she presents. The broad spectrum adaptation for St. Mungo, as mentioned earlier, was first posited by Gay Boehm, another principal of Pacific Identification.

In Wigen's tabulation Salmon dominates the Locarno component at Crescent Beach with fully 76.7% identified as such, compared with 60.8% at Component 2 of West Point. The presence of a common dominant fish is followed by flatfish being the second most abundant in both components, 17.6% at Crescent Beach, and about 13 percent (my estimate) at West Point. Thus there is a broader range of fish at West Point and less focus on Salmon.

The greater dominance of Salmon at the Crescent Beach Locarno component is associated with better evidence of salmon storage. It was only in the North Trench habitation that any significant salmon cranial bones were found in the Crescent Beach Locarno component, although about 25% were in the St. Mungo component (Wigen 1995:55). At West Point the figures are 88.7% vertebrae in Component 1 and 97.8% in Component 2 (Wigen 1995:55,56). This pattern is certainly supportive of a change from mainly non-storage to one of storage, but is not as clear or as definite as at Crescent Beach, nor is it based on anything like the same sample size or control over context. The last statement is by no means a critique of the important and fully reported West Point investigations, but in this C.R.M. project they did not have the flexibility, as we did at Crescent Beach, to focus on this particular issue.

In summary, the West Point site shows convincing similarities in patterns and developments with the Crescent Beach site. In both sites one goes from a broadscale emphasis on locally available fish, to one where stored salmon is the inferred dominant subsistence activity, a change which occurs at the same time in both places. The differences between the sites are greater in the earliest time period which one would expect if the main subsistence activity is obtaining the locally available fish and the environments differ, as they do at Crescent Beach and West Point. We are fortunate that both fish collections were not only analyzed by the same people and that excavation methods were similar, but that Wigen did her careful

comparison so that the differences and similarities can be seen not to be the results of such “external” factors.

Summary of adaptations

To summarize, Crescent Beach shows three successive adaptations: (1) a long-duration broad-spectrum fishing basecamp use, in which a variety of fish, including approximately equal amounts of flatfish and salmon, were obtained along with Bay Mussel; (2) a winter-time residential adaptation, where salmon was being stored and a wide variety of resources were collected; and (3) a limited-activity adaptation, a location where processed salmon was bought and where flatfish, Midshipman, mussels, and a variety of clams were processed during the spring. The first two are paralleled by developments at the coeval West Point sites. Our most important finding is the development of salmon storage at 3500-3300 RCYBP, as shown by its overall increase, by the decrease in proportion of headbones, and by the introduction of quartz crystal microliths. I doubt that it is merely a coincidence that this is also the time when the St. Mungo Phase is replaced by the Locarno Beach Phase (Croes 1989).

Other Evidence for the Beginnings of Salmon Storage

Although there is convincing evidence of the implementation of large-scale salmon processing and storage at 3500-3000 RCYBP at Crescent Beach, which is well supported by the West Point site evidence, we cannot assume that large-scale salmon processing occurred everywhere – or anywhere else – at that time. In this section, I refer to other evidence for the initiation of large-scale salmon processing – most of which that was published prior to 1991 is also found in Matson (1992) – in order to see how it fits in with the Crescent Beach evidence.

Perhaps the best demonstration of the beginnings of salmon storage outside of Crescent Beach and West Point is the dating of weirs reported by Moss (1989) and Moss et al. 1990) in the Alaskan Panhandle. It is difficult to understand why a weir of the size, more than 100 m long, that she reports would exist unless salmon was very important. Favorite Bay, in which the weir was found, today has runs of pink and chum salmon. Salmon would be that important only if it spawned for a long period or if they could be stored in large quantities. The weir dates to 3000 RCYBP show a close correspondence in timing with the beginnings of large-scale salmon processing and storage at Crescent Beach.

Mitchell (1988a) indicates a dependence on salmon developing in the Queen Charlotte Strait off Vancouver Island in his Queen Charlotte culture type, but this culture is tentatively dated to A.D. 300, well after the time period indicated by Crescent Beach. Further investigations may show that the development of large-scale salmon processing and storage should be pushed significantly back in time, as the dating of the Queen Charlotte Strait complexes is just beginning (Mitchell 1988a, 1990).

Coupland's (1985, 1988a, b) investigations on the Skeena River has only indirect evidence of the beginnings of large-scale salmon processing but supports the pattern inferred from Crescent Beach. The very important Paul Mason phase, which includes two rows of rectangular houses, is dated to 3000 RCYBP. It is difficult to see how “permanent” house structures so far up the Skeena River (near Terrace, B.C.) could exist unless salmon was stored in quantity. This locality on the first constriction of the Skeena River is a very important historical fishing location. Furthermore, the very limited faunal remains found in the Paul Mason component included salmon remains. Thus, this site—between the Alaskan Panhandle and the Fraser Delta—supports the inference of large-scale stored salmon by about 3000 RCYBP.

Moving away from the coast and upstream along the salmon rivers of the Northwest Coast, one finds widespread winter pithouses occurring just before 3000 RCYBP (Matson 1988b). Although the conditions here are not identical to the coast, as interior groups had a much lower population density and a general

lack of cultural complexity during ethnographic times, the interior area also fits within Wissler's Salmon Area (1917), sharing large-scale use of stored salmon with the coast. I have presented arguments (Matson 1983,1985) explaining why cultural complexity did not occur in the interior, primarily based on the relative abundance of fishing places in the interior as opposed to the coast. What is relevant in this context is that evidence in the form of widespread pithouse villages develops at the approximately the same time as evidence of salmon storage at Crescent Beach. We should note that fish are easier to preserve upstream, for two reasons: (1) better, drier weather and (2) loss of oil content as the fish move upstream.

Elsewhere, there are other indications of Locarno Beach as having a stored salmon economy. S. Steifel (1985) analyzed a variety of faunal remains from all three Locarno Beach components excavated by Borden (1950a,1951b,1976), Locarno Beach, Whalen Farm I, and Musqueam NE (DhRt 4) (see Figure II-1). Although there are questions about the representativeness of the samples from Locarno Beach and Whalen Farm, since they were excavated more than 50 years ago, the general pattern found agrees with that found at DhRt 4 which was excavated in 1972/73 (Borden 1976).

In all three sites, salmon remains dominated the large fish, ranging from 66 to 78 percent at the two earlier excavated sites, to 59 percent at DhRt 4. Since the screen size used in these earlier excavations were quite large, Steifel's exclusion of small fish in these tabulations is appropriate. At all three sites, the only other common large fish is flatfish, mostly Starry Flounder.

Steifel (1985:153-155) points out that no salmon head parts were found in any of these three collections, indicating that the salmon were bought back to the site as preserved salmon backs. Since Steifel's research indicated that the Locarno Beach site was occupied in the spring, the lack of salmon cranial parts would be in accord with large scale salmon storage, since this well after most salmon would have been procured.

Besides the questions about the representativeness of these "old" collections, the numbers of salmon bones identified from the Locarno Beach site (281) and the Whalen Farm site (446) in the samples Steifel (1985) examined do not leave one with much confidence about this last inference. DhRt 4, however, was excavated using more modern field procedures and Steifel identified a much larger number of salmon bones (2470) in her samples, putting this conclusion on firmer grounds for this site.

Wigen (1980) also reports on two sites near Buckley Bay, on the east side of Vancouver Island, which have components attributed to the Locarno Beach Phase. Excavations in 1973 and 1974 resulted in modest numbers of salmon remains being recovered but no salmon cranial bones (Wigen 1980:107). Although Wigen interprets the lack of cranial bones indicating that the salmon remains recovered from stored rather than freshly obtained fish, the modest numbers (471 and 25 identified salmon remains) and field techniques not directed toward recovery of this material qualify her interpretations, as she acknowledges.

Wigen (2003) has also analyzed the fish remains from the Decatur Island sites (Walker 2003), which includes a Locarno component with a small pitstructure very similar to Feature 9 at site 45SJ169 which is dated to 2700 RCYBP (See Chapter VIII for a further discussion of this feature). The floor of this feature produced 600 identified fish remains, of which 218 were salmon, making it the most common fish (Wigen 2003:283). As is the case with Feature 9 at Crescent Beach, one would expect a long duration occupation when a dwelling structure is present and a broad range of fish, and that is what is found here. Since many of the fish types at this feature are small (Herring is the second most common at 82) Salmon clearly provides the greatest weight, followed by Starry Flounder with 42 NISP (Wigen 2003:283). Wigen is cautious about her interpretation stating the salmon "bones in the housefloor sediments were mainly vertebra fragments and could have come from dried stored salmon." (Wigen 2003:289).

Another site that with remains of this time period indicating large scale use of salmon is the Puddleduck site, located near Campbell River (Mitchell 1988b). Both Mitchell's analysis and the ones presented in Chapter XI, indicate that the largest component, II, is best thought of as a Locarno Beach

component, although it probably has an admixture of later material as well. Some 4400 salmon remains were recovered from the excavation units for this component, compared to 1800 Herring, 300 Dogfish, 300 Starry Flounder, and 300 Staghorn Sculpin. A column sample recovered some 3500 Herring, 600 salmon, 39 Dogfish and 39 Staghorn Sculpin remains. Clearly, this component is dominated by Salmon, with Herring also being important. A date from the bottom of this component is 2800 RCYBP (Mitchell 1988b:16).

Component I, undated, although stratigraphically earlier than II, indicates that intensive salmon use may have developed prior to 2800 RCYBP. About 700 salmon remains were recovered from the excavation units, with 62 Dogfish, and 94 Herring, and 46 Starry Flounder. The column analysis shows 38 salmon, 37 Herring, 5 Dogfish, and 4 Staghorn Sculpin. The affinities of this component are not clear although Locarno Beach is certainly one possibility, as it links to the Crescent Beach Locarno Beach component in a cluster analysis (Mitchell 1988b:19). The evidence from the Puddleduck site supports the occurrence of the Stored Salmon Economy co-occurring with the Locarno Beach phase, but does not preclude it developing earlier.

Although these corroborating studies for the initiation of large-scale salmon processing and storage at 3500-3000 RCYBP are not as strong as one might like, particularly outside of Locarno Beach components, none points to another time period as initiating salmon storage on a large scale. The sites on Decatur island and West Point, which both had their fish identified by Pacific Identification, do provide important modern information since our 1989-90 excavations and support the pattern and interpretations we found at Crescent Beach. Additional detailed fish analyses of the 4000-3000 RCYBP transitional time period are needed to corroborate this transition in the Fraser Delta and elsewhere.

It is important to consider whether the archaeological cultures were as dependent on maritime resources as the above discussions assume. Although the ethnographic people were clearly dependent on fish, the subsistence reliance of the cultures of, say, 4000 RCYBP is not that clear. One way to look at this is to examine the results of stable carbon isotope analysis.

In that kind of analysis, one measures the ratio of carbon-13 to carbon-12 from the collagen of human skeletons. Most terrestrial sources have a carbon-13 to carbon-12 ratio—as measured against the standard—of approximately -26 parts per thousand (δ), in contrast to marine animal values of about -18 δ . Eating exclusively terrestrial animals would lead to a human bone collagen ratio of -21 δ ; an exclusively marine diet (fish and shellfish), produces a ratio of -13 δ (Chisholm 1986, 2008).

Chisholm (1986, 2008) has analyzed a number of samples from Northwest Coast human skeletons dating from the last 4500 years, and almost all fall within the -13 and -14 δ range, indicating a reliance on marine sources of proteins. This evidence supports the inferences based on the more traditional styles of faunal analysis, which also point to the overwhelming importance of marine resources in the diet for the last 4500 years. Salmon, spending most of their life in the ocean, have carbon isotope values similar to those of other marine resources.

The stable carbon isotope analysis does not, however, distinguish among marine resources in the diet. Thus, a shift from shellfish to roundfish or flatfish would not show up in this kind of analysis. If Croes and Hackenberger's (1988) specific model findings can be generalized to the Northwest Coast as a whole, as assumed here, their six fold increase in population and the shift from pre-storage to storage would not be detected with this technique. Chisholm (pers. comm.) and others, though, are working on the idea that other stable isotopes, such as nitrogen, may show a difference between diets based on shellfish and those on fish (Tuross et al. 1994; Jones 1996).

Conclusion

The most important subsistence analysis result from Crescent Beach is the determination of the time of the introduction of the stored salmon economy (Croes and Hackenberger 1988). This appears in early Locarno Beach times, between 3500-3000 BP, between Layers C-V and C-R in the South Trench. It is clear that this did not appear all at once, as layers such as C-T are definitely transitional. It is not surprising that these developments co-occur with the growth of evidence for a new cultural tradition, Locarno Beach. Croes (1989) has suggested the these cultural traditions should be thought of as economic adaptations or plateaus which the Crescent Beach evidence supports. In the review immediately above, and earlier in Matson (1992) and Matson and Coupland (1995:165-177) the strong Crescent Beach evidence is in accord with weaker evidence elsewhere in the Gulf of Georgia and further afield in the Northwest Coast.

After the salmon storage economy is introduced, Crescent Beach is used primarily as a spring season, shellfish gathering site, with flatfish procuring and the use of salmon acquired at other seasons being other important aspects. This Locarno Beach cultural pattern continues into the early Marpole culture with the introduction of more effective sturgeon fishing. In the North Trench, and exception to this spring time patter in seen in Feature 9 which is clearly a winter habitation feature, used about 3000 years ago, immediately after the salmon storage economy is put in place. This feature appears to be the remains of a small, not very permanent, shallow, pithouse as described in more detail in the Chapter VIII.

The lower layers, representing the St. Mungo component, appear to fit well with the evidence from the Glenrose and the St. Mungo sites (and West Point), about the adaptation of this culture (Matson 1976; Calvert 1970, Boehm 1973; Ham et. al. 1986). In general, the evidence of this broad-spectrum adaptation along the coast noted for the large amounts of bay mussel shell-middens, and a broad range of other subsistence remains, fits the pattern presented by Frederick (pers. comm.).