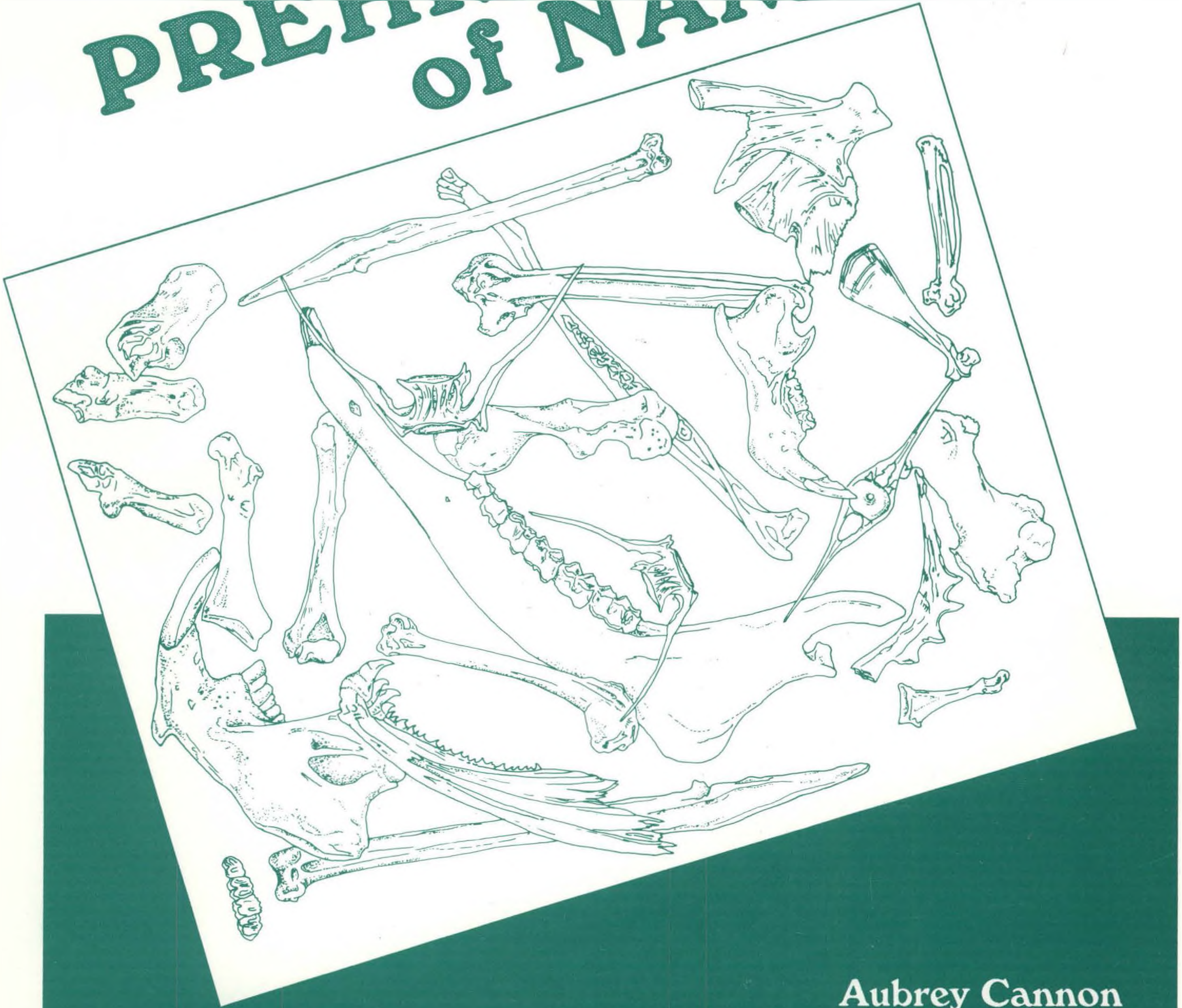
The ECONOMIC PREHISTORY of NAMU



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THE ECONOMIC PREHISTORY OF NAMU

Patterns in Vertebrate Fauna

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

PREFACE

This report by Aubrey Cannon presents the results of the analysis of faunal remains recovered from the 1977 and 1978 excavations at Namu. These excavations were funded by the Department of Archaeology, and the radiocarbon dates were obtained through a grant from the President's Research Grant Committee, Simon Fraser University. The Leon and Thea Koerner Foundation provided funds for the removal of a large section of the profile of the Main Trench, which is now on display in the Museum of Archaeology and Ethnology at Simon Fraser University. Ross Brand of what is now the Royal British Columbia Museum undertook the removal and preparation of the profile assisted by the staff and students of the Namu Project.

Many Simon Fraser University students worked in the Namu excavations as part of their participation in the Archaeological Field School in keeping with department policy that the best way to learn and understand field methods is by being part of a genuine research project. Aubrey Cannon participated in the excavations in 1977 as a student, and in 1978 as a research assistant responsible for cataloging the faunal remains and instructing field school students in their identification. Other research and teaching assistants were David Burley, Michael Deal, and Milton Wright. The following students worked on the excavations: Andrew Barton, David Black, Chuck Bollong, Marilyn Cairns, Helen Chambers, Susan Croll, David Falconer, Ingrid Fawcett, Melanie Gajkowski, Catherine Grieve, Steve Hopkins, Richard Lazenby, Jane Luke, Lynn McKitka, Robert Muckle, Rosemary Murphy, Wayne Nelles, and Ann Stevenson. Arne Carlson assisted substantially with the excavation, and Maureen Carlson with cataloging. Philip Hobler, who taught the students site survey and excavation methods at other sites in the vicinity, assisted the Namu Project in many ways.

The Namu Project was coordinated with the Bella Bella Band, and the material remains from the excavation are presently held in trust for them in the Museum of Archaeology and Ethnology at Simon Fraser University. Cecil Reid and Fred Carpenter of the Band Council, and Jennifer Carpenter and Evelyn Windsor of the Heiltsuk Cultural Education Center assisted with the project. Danny Windsor and Tommy Humchitt were employed as excavation assistants.

The Namu site is situated on property owned by B.C. Packers Ltd. who gave us permission to excavate and assisted in many, many ways including use of a well appointed bunk house for students and staff. Particular thanks go to Carl Skaaravik, Gunnar Toften, Peter Davis, and Mark and Darlene Jackson who extended many courtesies.

All of the above individuals and organizations contributed to the success of the Namu Project including the contents of this volume, which documents the economy of the site's prehistoric period.

Roy L. Carlson
Namu Project Director
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Simon Fraser University

ACKNOWLEDGEMENTS

In addition to the individuals mentioned in the preface, I would like to thank the following for their help and contributions in producing this volume. Foremost is Roy L. Carlson, who as director of the Namu Project has given me every opportunity and encouragement to undertake and report on the analysis of the faunal remains from the site. Without Roy Carlson's continuing support this report never could have been written.

I also want to thank my wife Debbi Yee Cannon for enduring my frustrations with the analysis and writing, for offering useful criticisms of earlier drafts, and for drafting the figures and cover illustration.

Two anonymous reviewers made very helpful criticisms of an earlier version of this report. Andrew Barton provided valuable comments, suggestions, and some key references during the course of the analysis. Diane Hanson helped with the identification of some of the more obscure bird specimens. All of my fellow 1977 field school students and the students from 1978 contributed to the initial sorting and identification of the faunal material. The initial writing of this report was undertaken with the financial support of a Social Sciences and Humanities Research Council of Canada Post-doctoral Fellowship. This financial assistance is gratefully acknowledged.

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CHAPTER 1

Introduction

The vertebrate faunal remains recovered from the Central Coast site of Namu (ElSx-1) (Fig. 1) are a rich source of information concerning the changing patterns of fauna utilization in the region. The descriptive data of taxonomic abundance and fauna characteristics presented in Chapter 2 are the basis for an interpretation of the prehistoric economy and settlement of the site over the period from 7000 cal. B.P. to approximately the time of European contact. The data indicate a long-term pattern of marine resource utilization, in which changes in the availability of salmon played a key role in the scale of site settlement and cultural activity (Chapter 4). The faunal data also make it possible to monitor long-term changes in minor resource utilization,

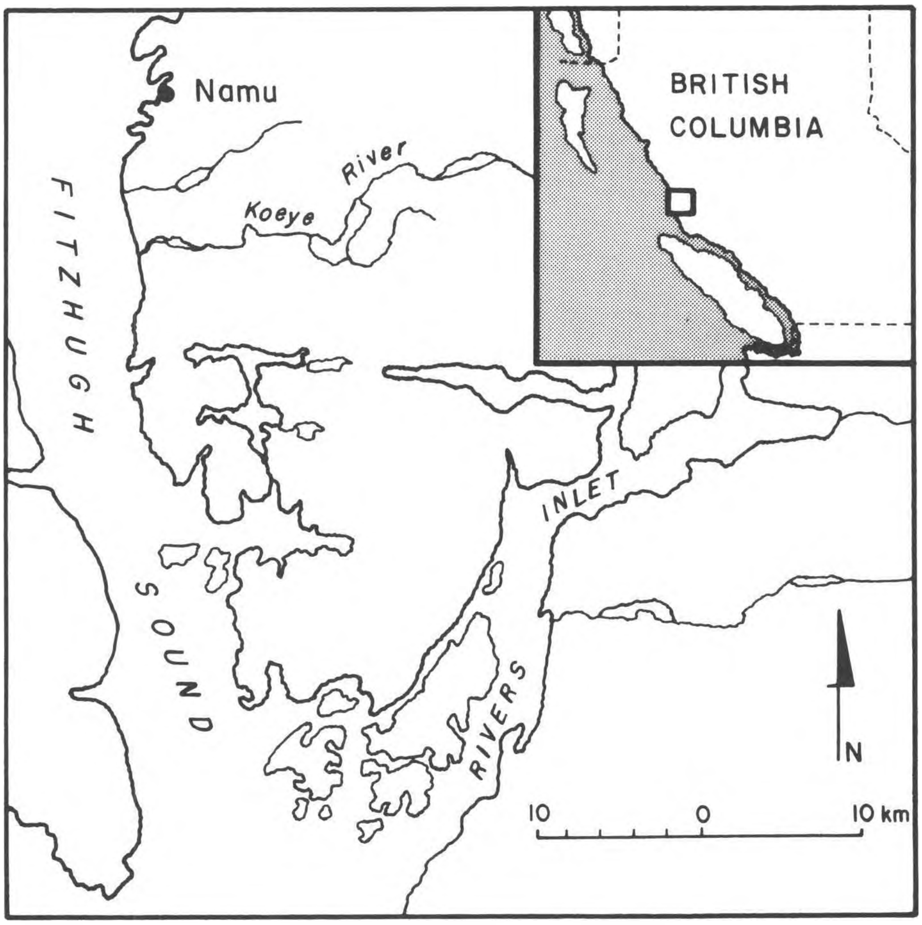


Figure 1. Map Showing the Location of Namu on the Central Coast of British Columbia.

which appear to reflect a combination of shifting cultural emphasis and fluctuations in resource availability in the site vicinity.

The interpretation of economic trends is based on the data generated from the recovered faunal remains, but the economic interpretation of faunal data requires more than the simple recovery and identification of faunal remains; it also requires the mutual resolution of three individually complex analytical problems, which include: 1) the quantification and comparison of zooarchaeological materials; 2) the determination of shell midden site formation processes; and 3) the explanation of culture change. In the chapters that follow, the evidence and procedures used to resolve these problems are discussed at length.

SITE EXCAVATION AND TEMPORAL UNITS

Faunal data are grouped and presented (Appendix A) according to the excavation units illustrated in Figure 2. The bulk of the faunal material was recovered from two main excavation units: the Central Main Trench excavated in 1977 and the Rivermouth Trench excavated in 1978. The data from the excavation units illustrated in Figure 2 are listed by unit in Appendix A; they are grouped by the major temporal divisions outlined below.

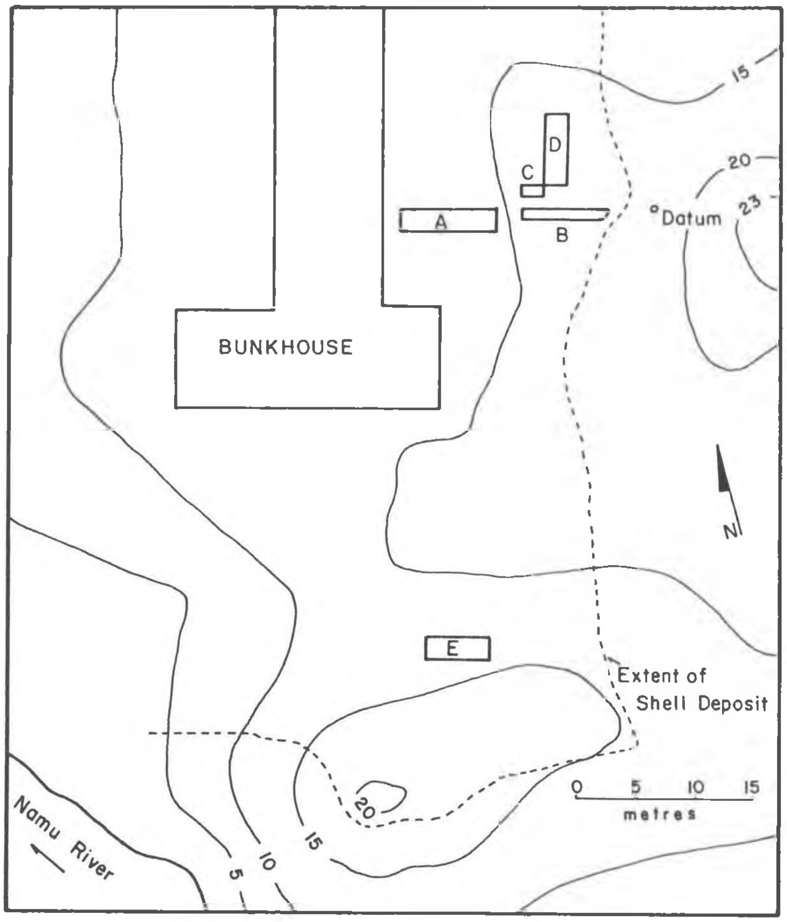


Figure 2. Site Map Showing the Location of Excavation Units. (See Table 1 for Unit Designations)

The simple description of faunal-class abundance by horizontal and vertical provenience units is an acceptable presentation format, but it provides a very limited basis for the discovery and interpretation of patterns and trends in faunal-resource utilization. Low per-unit frequencies and unknown sampling effects introduce too many extraneous sources of variability at this scale of analysis. The interpretation of changes in faunal abundance is greatly improved by grouping the materials within meaningful larger-scale temporal units. Ideally these would be based on the finest stratigraphic divisions for which accurate temporal resolution was available. Moderate to fine-scale stratigraphic divisions identified in the course of the Namu excavations cannot be assigned precise dates, but even if these micro-stratigraphic units could be dated they could not provide a clear picture of trends in faunal abundance. Variable deposition factors and low faunal frequencies within some strata would have obscured larger-scale patterning, especially among the less abundant faunal classes.

The aim of this study was to define and interpret larger-scale patterns and trends in fauna utilization. The analysis is based on major stratigraphic divisions, which can be placed within an absolute chronological framework, and which contain sufficient faunal material to allow for clear identification of within unit characteristics and between unit variations. Five major time periods are represented by the fauna-bearing deposits, which date between 7000 cal. B.P. and the period of European contact. For each of the excavation units shown in Figure 2, Table 1 lists the excavation levels associated with these major time periods. The lowermost fauna-bearing levels of the Rivermouth Trench represent intrusions of Period 2 shell and faunal remains into what are otherwise Period 1 levels. None of the Period 1 deposits yielded faunal remains. Table 2 is a summary listing of the stratigraphic designations and range of radiocarbon dates associated with each major time period.

(See Carlson: Appendix B for a full discussion of the dating and periodization of the deposits).

FAUNA RECOVERY AND ANALYSIS

Recovery

All excavated matrix was screened through 1/8 inch (3.2 mm) mesh screen, and all visible faunal material retained in the screens was recovered for later identification. Different screening techniques were used during the course of the site excavations. Much of the site matrix was dry-screened (the matrix was shaken through screens), but a significant proportion was wet-screened (water from a pressurized hose was used to wash the matrix through the screen). The humic portion of the matrix was black and sticky, and the visibility of faunal material varied according to the humic content of the deposits and the screening method used. Water-screening significantly increased the visibility and recovery of faunal remains, particularly the smaller remains such as fish.

A variable proportion of material from different periods was wet- or dry-screened (Tab. 3), which undoubtedly affected the quantity of identified fauna. Faunal abundance should be greater for periods in which a greater proportion of the matrix was water-screened. The potential for distortion is compounded by the likelihood that the recovery of faunal remains varied according to their size. Periods with a greater proportion of dry-screened matrix might exhibit an over-representation of larger fauna such as deer, and an under-representation of smaller fauna such as fish. Given this potential for distortion, and the implications for subsequent interpretation, it was necessary to gauge the impact of the water-screening effect.

Table 1. Temporal Periods and Associated Excavation Units.

Period	Unit	Levels
A - Central Main Trench 32-34S, 2-10W (1977)		
5	2-4W	30-90 cm. DBS
	4-6W	45-90 cm. DBS
	6-8W	60-130 cm. DBS
	8-10W	80-180 cm. DBS
4	2-4W	90-130 cm. DBS
	4-6W	90-(150-160)/(160-170) cm. DBS
	6-8W	130-(170-180) cm. DBS
	8-10W	180-193 cm. DBS
3	2-4W	130-170 cm. DBS
	4-6W	(150-160)/(160-170)-240 cm. DBS
	6-8W	(170-180)-280 cm. DBS
	8-10W	193-280 cm. DBS
2	2-4W	170-190 cm. DBS
	4-5W	190-220 cm. DBS
	6-8W	—
	8-10W	—
B - 32-33S, 0-7E (1977)		
6	0-2E	— 2-4E 40-120 cm. DBS
	4-6E	40-150 cm. DBS
	6-7E	40-140 cm. DBS (No Fauna)
5	0-2E	40-90 cm. DBS
	2-4E	120-160 cm. DBS
	4-6E	150-200 cm. DBS
	6-7E	140-190 cm. DBS
4	0-2E	90-110 cm. DBS
	2-4E	—
	4-6E	—
	6-7E	—
3	0-2E	110-120 cm. DBS
	2-4E	—
	4-6E	—
	6-7E	—
2	0-2E	120-170 cm. DBS
	2-4E	160-210 cm. DBS
	4-6E	200-230 cm. DBS
	6-7E	190-230 cm. DBS (No Fauna)

(Unit Designations in Metres from Site Datum; Levels in cm. DBS (Depth Below Surface)).

Continued...

Table 1. Continued

Period	Unit	Levels
C - 30-31S, 0-2E (1977)		
5	—	30-90 cm. DBS
4	—	90-120 cm. DBS
3	—	120-150 cm. DBS
2	—	150-180 cm. DBS
D - 24-30S, 2-4E (1977)		
6	24-26S	50-70 cm. DBS
	26-28S	50-(110-130) cm. DBS
	28-30S	40-130 cm. DBS
5	24-26S	70-130 cm. DBS
	26-28S	(110-130)-160 cm. DBS
	28-30S	130-160 cm. DBS
3	24-26S	130-180 cm. DBS
	26-28S	160-180 cm. DBS
	28-30S	160-190 cm. DBS
2	24-26S	180-210 cm. DBS
	26-28S	180-240 cm. DBS
	28-30S	190-250 cm. DBS
E - Rivermouth Trench 68-70S, 4-10W (1978)		
5	4-6W	30-(140-150) cm. DBS
	6-8W	50-160 cm. DBS
	8-10W	50-160 cm. DBS
4	4-6W	(140-150)-280 cm. DBS
	6-8W	160-280 cm. DBS
	8-10W	160-260 cm. DBS
3	4-6W	280-290 cm. DBS
	6-8W	280-290 cm. DBS
	8-10W	260-280 cm. DBS
2	4-6W	290-360 cm. DBS
	6-8W	290-370 cm. DBS
	8-10W	280-350 cm. DBS

A water-screening effect is evident in the frequency of bone recovered from individual excavation units. The effect is most evident in the Rivermouth Trench. In unit 68-70S, 6-8W the matrix was dry-screened to an excavated depth of 290 cm. DBS (Periods 3-5); the remainder of the unit (Periods 1-2) and the whole of the two adjacent units were wet-screened. Dry-screening resulted in a significantly lower rate of faunal recovery (Tab. 4). Given this absolute recovery effect, and its expected size bias, the problem was to determine the comparability of fauna recovered from different strata and different excavation units.

Table 2. Temporal Periods, Field Strata-Designations, and 14C Date Range.

1977 Excavations

Period	Strata	14C Range
6 - 2000 cal. B.P. - contact	7,8	1405±120 B.P.
5 - 4000-2000 cal. B.P.	5D,5E,6	3330±90 - 2185±85 B.P.
4 - 5000-4000 cal. B.P.	5B,5C 4	300±125 B.P.
3 - 6000-5000 cal. B.P.	4	4775±130 - 4700±125 B.P.
2 - 7000-6000 cal. B.P.	2B,4A	6060±100 - 5240±90 B.P.

1978 Excavations

Period	Strata	14C Range
5 - 4000-2000 cal. B.P.	IV,V	3500±100 - 2530±160 B.P.
4 - 5000-4000 cal. B.P.	IIIC,IIID	4390±160 -3825±105 B.P.
3 - 6000-5000 cal. B.P.	IIIB	4680±160 B.P.
2 - 7000-6000 cal. B.P.	IIB	5700±360 - 5170±90 B.P.

Table 3. Screening Methods Used for Each Excavation Unit and Temporal Period.

Water-Screened	Dry-Screened
	A - 32-34S, 2-10W (All Periods)
	B - 32-33S, 0-7W (All Periods)
C - 30-31S, 0-2E (Period 2)	C - 30-31S, 6-8W (Period 5)
D - 24-30S, 2-4E (All Periods)	
E - 68-70S, 4-6W (All Periods)	E - 68-70S, 6-8W (Periods 3,4,5)
6-8W (Periods 1,2)	
8-10W (All Periods)	

Although less bone was recovered from dry-screened deposits, the potential for distortion of temporal trends also depended on variation in the recovery of bone from different faunal classes and different period deposits. A recovery effect based on screening technique was likely to vary according to the humic content of the period matrix and the size of the faunal remains. Unfortunately it is difficult to compare wet- and dry-screen recovery because the abundance of faunal remains can vary as the result of a variety of deposition factors. It was only possible to gain a rough appreciation of the potential distortion of screening effects by comparing the recovery of fauna from adjacent units of the Rivermouth Trench.

Table 5 lists the quantities and unit percentages of selected faunal classes for each of the 2x2 metre excavation units of the Rivermouth Trench. The dry-screened unit (6-8W) produced much less fish bone than either of the two adjacent units. The quantity of mammal bone is also generally less in the dry-screened unit. To compare the recovery rates from the period deposits it was necessary to convert the faunal frequencies to percentages. The period frequency of each faunal class was divided by its total abundance in the excavation unit. The percentage figures then could be compared between units to determine whether the proportional recovery of fauna was consistent for each period within the wet- and dry-screened units.

Table 4. Frequencies of Identified Fauna from Units of the Rivermouth Trench

	Unit 6-8W	Unit 4-6W	Unit 8-10W
Identified Mammal			
Period 5	65	49	164
Period 4	283	384	456
Period 3	7	19	47
Identified Bird			
Period 5	9	6	30
Period 4	6	18	36
Period 3	10	2	9
Identified Fish			
Period 5	1179	1511	5085
Period 4	6159	29638	11891
Period 3	38	1283	5647

(Unit 6-8W - dry-screened, Units 4-6W, 8-10W - water-screened).

The figures in Table 5 indicate that the period proportions of deer *(Odocoileus hemionus)* and harbour seal *(Phoca vitulina)* are consistent for the wet- and dry-screened units. On this basis it would appear that the variable humic content of the deposits did not affect the proportionate recovery of large mammal bone. The absolute quantity of recovered mammal bone will vary according to the proportion of deposits that are wet- or dry-screened (Tab. 6), but the nature of the period matrix does not appear to introduce any additional distorting effect.

The proportionate recovery of fish remains (salmon *(Oncorhynchus sp.)* and rockfish (*Sebastes sp.*)) also appears to be comparable between wet- and dry-screened units, at least for Periods 4 and 5. However, fish are proportionately under-represented in the dry-screened Period 3 deposits (Unit 6-8W). The Period 3 matrix has a greater humic content, and the absence of water-screening evidently decreased the visibility of fish remains in these deposits. The abundance of fish in Period 3 is probably greater than is indicated by the recovered and identified specimens. This problem is taken into account in the interpretation of temporal trends in fauna utilization (Chapter 4).

The most serious distortion of temporal trends is likely to result from differential screening of variable proportions of period deposits. As the figures in Table 6 indicate, the volume of water-screened matrix is roughly comparable for Periods 4, 5, and 6. Screening effects should have little affect on comparisons of faunal abundance between these periods. The most significant variation in water-screened volume is in Periods 2 and 3. Relatively little of the Period 3 matrix was water-screened, and an under-representation of fish, bird, and small mammal might be expected as a result. Taken as a percentage of period fauna, mammal remains will be somewhat over-represented in Period 3 (see Chapter 4). Eighty-five percent of the Period 2 matrix was water-screened, and some over-representation of small faunal remains might be expected as a result. However, because of the low shell content and higher acidity of the Period 2 deposits, the enhanced recovery of small bone is probably offset by poorer preservation.

It is impossible to quantify the effects of recovery and preservation. It is only possible to note where the effects are comparable between periods, and where significant differences exist that might affect interpretations. Taking these cautions into account, the recovered vertebrate faunal remains can still provide a sound basis for the interpretation of change in the site economy.

Table 5. Frequencies and Period Percentages of Selected Fauna within Dry- and Wet-Screened Units of the Rivermouth Trench (68-70S,4-10W).

	DRY-SCREENED				**WET-SCREENED**			
	Unit 6-8W		Unit 4-6W		Unit 8-10W		Units 4-6W, 8-10W	
	N	Unit %	N	Unit %	N	Unit %	N	Unit %
Oncorhynchus sp.								
Period 5	1099	15.3	1225	3.9	4263	20.3	5488	10.5
Period 4	6056	84.2	28714	92.1	11198	53.3	39912	76.4
Period 3	37	0.5	1241	4.0	5561	26.5	6803	13.0
Sebastes sp.								
Period 5	34	47.9	140	27.9	366	57.7	506	44.6
Period 4	37	52.1	347	69.3	238	37.5	585	51.5
Period 3	0	0.0	14	2.8	30	4.7	44	3.9
Odocoileus hemionus								
Period 5	27	18.2	23	11.7	106	40.2	129	28.0
Period 4	119	80.4	166	84.7	142	53.8	308	67.0
Period 3	2	1.4	7	3.6	16	6.1	23	5.0
Phoca vitulina								
Period 5	6	4.7	3	1.8	4	1.7	7	1.8
Period 4	123	95.3	162	98.2	213	93.0	375	95.2
Period 3	0	0.0	0	0.0	12	5.2	12	3.0

Table 6. Wet- and Dry-Screened Matrix Volume (m3) by Period.

Period	**Wet-Screened**		**Dry-Screened**	
	Volume	%	Volume	%
6	4.0	59.7	2.7	40.3
5	18.6	48.2	20.0	51.5
4	9.6	58.9	6.7	41.1
3	1.2	8.8	12.5	91.2
2	1.4	85.1	2.0	14.9

Identification

The precision of faunal identification is governed by: 1) the skills of the analyst; 2) the availability of a comprehensive comparative collection; 3) the preservation and condition of recovered faunal remains; and 4) the distinguishing morphological characteristics of skeletal elements. Each of these conditions plays some role in determining the faunal-class frequencies presented and discussed below.

All of the fish, bird, and mammal remains were identified by the author with the aid of the Simon Fraser University, Department of Archaeology zooarchaeology comparative collection. Fish and mammal remains were identified in 1977 and 1978; bird remains were identified in 1987. Some slight improvement in the analyst's ability to identify specimens did occur over the period of analysis between 1977 and 1978. Identification consistency was maintained through rechecks of material analyzed earlier. The one major inconsistency concerned the family Cottidae (sculpins), which was only identified in the 1978 assemblage. Although Cottidae was certainly present in the 1977 faunal assemblage, its under-representation is not significant given its low abundance and minimal economic value.

All potentially identifiable specimens of fish, bird, and mammal were catalogued, and only a small percentage remained unidentified at the end of the analysis. Given the fragmentary nature of most of the unidentified bone, it is unlikely that more thorough analysis would change the results appreciably. Certainly no significant classes of fauna have been overlooked. Most unidentified material can be expected to belong to one of the identified classes, while any additional classes would be represented by only a very small number of isolated elements.

The extent to which faunal remains could be dentified was largely a function of the availability of comparative specimens. Fortunately, the Simon Fraser University collection possessed a comprehensive range of specimens from all faunal classes likely to be encountered in a Northwest Coast shell midden. Nevertheless, there were specific collection-imposed limits to identification, particularly of species within families. For example, species within the families Mustelidae (mink, marten, weasel, etc.) and Otariidae (fur seal, sea lion) could not be consistently determined using the available comparative material. Most bird families were missing some member species, and some species were missing from virtually all fish families. Unless morphological distinctions are pronounced, species identification requires that all species be present, and often requires, in addition, that multiple specimens of each species be available in order to assess and account for intra-specific variation.

An additional problem was the partial state of some comparative specimens. In some cases partial specimens restricted identification to family (e.g. Otariidae, for which only a partial sea lion and an immature fur seal were available), while in other cases only a limited range of elements could be identified (e.g. *Enhydra lutris* (sea otter)). However, the restrictions imposed by the collection often were only minor. Even with a complete collection, the ability to identify elements to species often is restricted due to the morphological variation within species or the lack of morphological variation between species.

For many of the identified faunal classes, morphological similarities within families or genera made species distinctions difficult or impossible. Several classes of fish are affected by this problem. Salmon species *(Oncorhynchus sp.)* cannot be distinguished on the basis of morphological differences in most commonly preserved and recovered elements (D. Cannon 1987:5), though a technique for age determination from salmon vertebrae (discussed in detail in Chapter 5) provided some indication of probable salmon species (Cannon 1988). In addition, it is not generally possible to distinguish the many different species of the genus Sebastes (rockfish), or the individual species of Hexagrammidae (greenling) apart from *Ophiodon elongatus* (ling cod).

Among birds, there are a number of problems in distinguishing species within families, except in cases in which there are clear size differences. Ducks present a particular problem since they make up a large proportion of the recovered bird remains, and potentially represent a variety of species from a number of distinct habitats. The identification of duck remains was guided by an exhaustive study of the morphological variations in waterfowl skeletal elements (Woolfenden 1961). Woolfenden's (1961) study clearly indicates that the majority of waterfowl elements cannot be identified below the level of family or sub-family, even with the aid of a complete comparative collection, which has multiple specimens of individual species. This was the only case in which an authoritative guide could be used to help set the limits of taxonomic identification.

The significance of identification limitations depends on the application of the information. The aims of the present study are weighted toward the determination and interpretation of long-term patterns in faunal-resource utilization, environmental change, and the intensity and seasonality of site occupation. The differential condition and identifiability of remains from different species does not seriously impede these goals. Identification limits are comparable across temporal units, and it is temporal change rather than inter-specific comparisons within temporal units that is the main focus of this study. Comparison of taxonomic abundance on a crude ordinal scale also helps to minimize the effects of variable scales of identification.

In most cases, coarse levels of identification make little appreciable difference to interpretation. Unidentified species among the Mustelidae (mink, marten, etc.) and Aythyinae (diving ducks), for example, all share habitat, utilization, and seasonal characteristics. In contrast, the presence of constituent species of the family Otariidae (fur seal, sea lion) would indicate differences in habitat and exploitation technique, but the overall abundance of this class is so low that it is preferable to present the family frequency and acknowledge the presence of both constituent species than it is to present species frequencies when some identifications may be in doubt.

Preservation of faunal remains, particularly in the early deposits, in which the shell content is extremely low, also affected the frequency of recovered bone, though standardized comparison helped to compensate for variable bone preservation (see Chapter 4). Temporal trends indicate that differential preservation between classes is probably not a serious problem. Some classes of large mammal (e.g. harbour seal) are relatively infrequent in the early levels of the site, while some classes of fish (e.g. dogfish) are most abundant in these levels. The reverse is true for other classes of mammal and fish.

Additional Analysis

In addition to taxonomic identification, the side, portion, state of epiphyseal fusion, and other age characteristics were determined for each element. Although some of this information is used in the following analyses and discussions, many of these data were originally determined for the purpose of calculating minimum number of individuals (MNI) estimates. This particular quantitative measure of species abundance has been the subject of much criticism (see Grayson 1979, 1984), and it has been shown that MNI values vary widely according to a variety of different influences. Therefore, MNI is not used to assess relative faunal-class abundance; the number of identified specimens (NISP) is used as the basic measure of relative abundance. NISP also presents problems in interpretation; it varies as a function of the size of the animal and the survivability of its constituent elements, but it is possible to compensate for this problem by basing comparisons on ordinal scales of magnitude.

Shellfish

Although this report presents a comprehensive discussion of the palaeo-ecology and economy of Namu, the recovery and analysis of faunal material concentrated exclusively on mammal, bird, and fish remains. There was virtually no analysis of shell, which is by far the most abundant class of faunal remains within the midden deposit. This exclusion does not imply that shellfish are insignificant to the problems under consideration, but the sampling and analysis of shellfish remains was the major focus of earlier excavations at the site (Conover 1972, 1978), and the results of this earlier analysis are incorporated into the interpretations presented below. A detailed analysis of the shellfish remains from the 1977 and 1978 excavations would have provided little additional environmental or subsistence information.

CHAPTER 2

Faunal Data

Raw faunal frequencies do not provide an adequate basis for the analysis of economic and environmental trends, but their presentation is necessary to allow for the appreciation of subsequent data manipulation and interpretation. Tables 7 - 9 and Appendix A list the frequencies of identified fauna for each temporal period and major excavation unit. The figures give some impression of the relative importance of faunal classes at different periods in the site occupation. Information concerning the seasonality, habitat, and ethnographically-recorded uses of vertebrate fauna is summarized below. These data provide the basis for the analyses and interpretations presented in subsequent chapters. Ethnographic descriptions of fauna utilization on the Northwest Coast are scattered and sparse. For the Bella Bella region, in which the site is located, there is little available information regarding the Native economy. Therefore it is necessary to piece together a picture of fauna utilization from a variety of sources, which describe the Northwest Coast economy from the time of European contact to the present. The use of such wide-ranging information for the interpretation of specific archaeological data creates the potential for error in citing ethnographic practices that are neither culturally nor environmentally relevant. This same criticism can be made for any use of contemporary ethnographies for archaeological interpretation. Nevertheless, there is a Northwest Coast culture type, which accounts for cultural similarities among many different culture groups. The coastal environment also promoted a common subsistence strategy, which was based on the available marine resources. Detailed comparison might show differences in exploitation techniques, species emphasis, and the timing of subsistence activities among various culture groups, but the available ethnographic information still can provide guidelines for archaeological interpretation. Ultimately, any interpretation must be based on the evidence of the past and its correspondence with the available ethnographic information. The eclectic use of ethnographic sources also can be criticized for allowing the selection of data to fit a particular conclusion, but because there was so little information available there was no selection of some data over others. The data presentation below outlines the relative abundance and background information for the identified classes of mammal, bird, and fish; a brief review of shellfish data derived from previous excavations is presented at the end of this chapter.

MAMMAL

Table 7 lists the total frequency of identified mammalian fauna by temporal period, and the tables in Appendix A list the totals for the excavation areas described in Table 1. The three most common classes of mammal are deer *(Odocoileus hemionus)*, harbour seal *(Phoca vitulina)*, and dog *(Canis familiaris)*. None of the canid remains were identified as wolf, and the present range of coyote does not extend to the coast, which makes their presence in the midden unlikely. Therefore, all of the recovered canid remains are considered domestic dog. None of the dog remains show any obvious sign of human butchering, and they are not considered here as a significant food resource. Among subsistence resources, deer and harbour seal are by far the most common mammalian species, with deer somewhat more abundant according to the total number of identified specimens.

Four other categories of mammalian fauna, which are much less abundant than deer or harbour seal, but still relatively common in the Namu midden, include: Delphinidae (dolphins, porpoises, etc.), sea otter

(Enhydra lutris), smaller members of the family Mustelidae (weasels, martens, mink, etc.), and porcupine *(Erethizon dorsatum)*. Delphinidae are represented by a variety of elements, but these were not identified to species. Many of the remains identified simply as Mustelidae were tentatively identified as *Mustela vison* (mink), though some smaller fraction of the total may represent other small members of the family such as marten or ermine. Porcupine remains were easily identified to species.

Other identified mammals include river otter *(Lutra canadensis)*, Otariidae (sea lion *(Eumetopias jubata)* and northern fur seal *(Callorhinus ursinus)*), and beaver *(Castor canadensis)*, which are present in moderate to low abundance; black bear *(Ursus americanus)* and raccoon *(Procyon lotor)*, which are relatively rare; and finally mountain goat *(Oreamnos americanus)* and whale, which are represented by four and one identified elements respectively. The total frequency of bird (Aves) is also listed in Table 7.

Deer *(Odocoileus hemionus)*

Deer are the most abundant of the identified mammalian fauna, but their importance as a subsistence resource is open to some question. Conover (1978:91) suggests that deer were only important as food during times of starvation, and their procurement was motivated more by a desire for hides and bone and antler for tool-making. McIlwraith (1948:2) also states that though deer were killed whenever possible they were a negligible part of the Bella Coola diet. As is discussed in Chapter 3, there are indications that deer were returned to the site as whole carcasses, but there still may be some question as to the relative importance of deer as a food resource.

Deer were killed from canoe if they were encountered during channel crossings (Drucker 1955:51), and they were also actively hunted with the aid of dogs, which drove the animals from the tangled brush onto the beach (Krause 1979:125). Traps were also used in killing deer.

Table 7. Total Abundance of Recovered Mammal Bone by Period.

	Period				
Taxon	**2**	**3**	**4**	**5**	**6**
Castor canadensis	11	5	15	8	0
Erethizon dorsatum	9	22	33	18	3
Delphinidae	20	17	24	22	0
Canis familiaris	38	58	92	102	35
Ursus americanus	6	2	8	2	0
Procyon lotor	0	0	1	0	8
Mustelidae	45	47	47	31	4
Lutra canadensis	10	7	9	14	4
Enhydra lutris	4	5	47	4	0
Otariidae	6	11	7	9	3
Phoca vitulina	81	76	521	23	1
Odocoileus hemionus	191	236	519	235	61
Oreamnos americanus	0	1	2	1	0
Unidentified mammal	83	83	151	56	23
Aves	69	322	87	83	13

The coastal deer prefers a habitat of open coniferous forest and subclimax bush (Banfield 1974:390). Although the species is available year-round, some populations migrate to the mountain tops and high valleys in summer and return to the lower ranges in winter (Cowan and Guiget 1965:368). Boas (1895:319) places Kwakiutl deer hunting in winter, but contemporary Kwakiutl hunt deer year-round (Rohner 1967:59), albeit with vastly different techniques. Deer in the vicinity of Namu could well have been hunted year-round, but it is possible that there was a greater emphasis on deer during the winter, when other food resources were in shorter supply. This is also the season when deer are more gregarious and congregate in greater numbers.

Harbour Seal *(Phoca vitulina)*

This species is almost as abundant as deer, and was undoubtedly a food source, though the skin may have had important uses. Boas (1921:451-461) provides a detailed description of the Kwakiutl pattern of seal butchering and consumption, and the seal is described as a luxury food among the Bella Coola (McIlwraith 1948:2). The seal was hunted with harpoons, and was also taken when caught out on reefs or sandbars (Boas 1935:17). The harbour seal is common in the bays, harbours, and rivers of the coast (Banfield 1974:370), and isolated reefs and sandbars are used as pupping grounds. The peak of pupping season is during the first half of June; elements from neonatal pups were recovered from all levels of the site.

Delphinidae (dolphins and porpoises)

The most likely species within this family are the harbour porpoise *(Phocaena vermerina)*, which frequents bays, harbours, and inshore waters, and the dall porpoise *(Phocaenoides dalli)*, which is also common in coastal waters. Ethnographically, dolphins were used as food (Boas 1921:446-450), and were harpooned from canoes (Drucker 1955:42).

Otariidae (sea lion and northern fur seal)

The hunting of these species was not an important subsistence activity at Namu, but they were consistently taken, probably as opportunities presented themselves. In addition to its use as food, the fur seal also furnished a valuable skin (Boas 1895:318).

Sea Otter *(Enhydra lutris)*

The sea otter pelt was avidly sought by Europeans and was probably important to the coastal Natives as well. Prior to the European trade the sea otter was hunted in the same manner as the harbour seal (Drucker 1955:45). The habitat of the sea otter is the sea off rocky reefs, islets, and rocky coasts, and kelp beds, where it rests and sleeps (Banfield 1974:344). It feeds largely on sea urchin, which are common in kelp beds.

Mustelidae (mink, marten, etc.)

Mink and related species are common on stream banks and tidal flats. Ethnographically, they were caught in snares and used for their fur.

River Otter *(Lutra canadensis)*

The river otter is common in coastal streams and was exploited for its fur.

Porcupine *(Erethizon dorsatum)*

The porcupine is said to be rare in the coastal forest (Cowan and Guiget 1965:246), and this led Conover (1978:88) to suggest trade as a possible explanation for the animal's presence at Namu. A desire for incisors to use as tools was suggested as the reason for such trade, though it was acknowledged that other parts of the animal were present in the midden. Northern coastal groups practiced some porcupine quill embroidery (Drucker 1955:90), and porcupine was widely used by Natives in other areas as a source of decorative quills and tasty flesh (Banfield 1974:235). Nevertheless, it seems unlikely that the value of the animal would have warranted either trade with the interior or special hunting forays as Conover suggests, and there may be an alternative explanation for the consistent presence of porcupine in the Namu midden. Porcupines avidly chew bone and antler found on the ground, and they also have a craving for salt, which attracts them to any available source (Banfield 1974:234-235). Their craving for salt could have drawn them to the coastal margin, and the midden itself would have been a ready source of bone. Therefore, though porcupine are rare in the coastal forest, those that were present may have been attracted to human habitation sites, where they were occasionally killed and utilized by the inhabitants.

Beaver *(Castor canadensis)*

Beaver live in the vicinity of fresh-water bodies in forested country. The lake situated about a kilometre behind the site is a suitable habitat. Ethnographically, the beaver was exploited for its fur (Boas 1895:318) and prized for its flesh (McIlwraith 1948:2).

Black Bear *(Ursus americanus)*

Black bear live in the coastal forest and may have been attracted to the Namu River during the salmon spawning run. Although the flesh is edible and undoubtedly would have been used, it is likely that the skin of the animal would have been its greatest attraction. The Bella Coola killed bear for their skins (McIlwraith 1948:2), and the skin of the black bear was highly prized among the Tlingit (Krause 1979:125).

Raccoon *(Procyon lotor)*

Raccoon is not abundant, but it is of interest because raccoon is presently rare on the coast as far north as Namu, and because its presence is largely restricted to deposits that are more recent than 2000 cal. B.P. The limited temporal distribution of raccoon may indicate a change in either the environment or the mode of site occupation. These possibilities are considered in more detail in Chapter 4, which considers faunal patterns over time.

On the coast, the raccoon feeds almost entirely on the beach (Cowan and Guiget 1965:298), and it is something of a scavenger. Scavenging may have attracted raccoons to the midden site, but it is difficult to imagine a situation such as Conover (1978:86) suggests, in which the raccoon would be tolerated as a competitor with Native dogs.

Mountain Goat *(Oreamnos americanus)*

Mountain goat are widespread on the coast, and though they tend to inhabit rough terrain at high altitudes, they are occasionally forced to sea level by heavy snows during the winter months (Cowan and Guiget 1965:389). Goats were prized for their wool as well as for their flesh, which could be dried for winter use. Hunting goat in its normal habitat was a specialized activity on the Northwest Coast (Drucker 1955:52), but its rarity at Namu is more suggestive of fortuitous encounter than systematic hunting.

Whale (Cetacea)

This class of mammal is represented by a single identified element (the epiphysis of a vertebra centrum) recovered from a Period 5 deposit. The isolated occurrence of a single element cannot be taken as an indication of whale hunting at the site; its presence more likely represents the exploitation of a stranded individual. Northwest Coast groups are said to have enthusiastically utilized any whales that drifted ashore as a source of oil-rich blubber and meat (Drucker 1955:49).

BIRD

Table 8 lists the frequencies of bird remains. Most bird bone specimens were identified to at least the family level, and in many cases distinctions could be made within families. Some positive species identifications were made, but more commonly, because of collection restrictions or the inherent difficulty in differentiating between species, identification within families was restricted to the designation of size categories that have probable species referents.

Of the 110 unidentified elements, only 12 are relatively complete elements that are certain to represent species from outside the identified classes. The majority of unidentified elements are either: 1) very fragmentary elements for which further identification is unlikely; 2) elements for which identification is generally more difficult (e.g. vertebrae, sternum fragments, sacrum and pelvic fragments); or 3) elements for which corresponding elements in the comparative collection were unavailable, even though other elements of the probable species were present. Therefore it is likely that only a few additional species are represented by the unidentified elements, and it is likely that any additional species are represented by only one or a few elements. The bird-class frequencies presented in Table 8 give an almost complete picture of the range and relative frequency of the avian species in the Namu midden.

The most common classes of bird were Gavidae (loons) and Anatidae (geese, ducks, and merganzers). Ducks are most common among the Anatidae, and only three elements represent geese (Anserinae). Only a small proportion of the ducks could be identified to subfamily, but all of these were either diving ducks (Aythyinae) or merganzers (Merginae). Both groups are primarily ocean birds. It is likely that the majority of the other ducks are members of these subfamilies. Most species of sea ducks winter on the coast, though occasional specimens may be found in summer. Loons (Gavidae) were as common as ducks in the midden. Of the medium to large loons, most are likely to be common loons *(Gavia immer)*, a bird that winters on the coast, but there is also the remote possibility of a yellow-billed loon *(Gavia adamsii)*, which also winters on the coast but rarely extends south of southeastern Alaska. The smaller loons could be either the arctic loon *(Gavia arctica)*, which winters on the coast, or the red-throated loon *(Gavia stellata)*, which can be found at all times of the year.

Other common families of sea bird include: Phalacrocoracidae (cormorants), Podicipedidae (grebes), and Alcidae (auks). All are much less common than ducks or loons. Of the cormorants, the pelagic cormorant *(Phalacrocorax pelagicus)* is identified to species, and most of the elements identified as small Phalacrocoracidae are likely to be this species. Those elements identified as large Phalacrocoracidae could be either double-crested cormorants *(Phalacrocorax auritus)* or Brandt's cormorant *(Phalacrocorax penicillatus)*. The double-crested cormorant only winters on the coast, while the other species are available year-round. Some Podicipedidae (grebe) elements were identified as western grebe *(Aechmophorus occidentalis)*, and this species probably accounts for most of the other elements identified as large grebe, though the red-necked grebe *(Podiceps grisgera)* is another possibility. All species of grebe are most commonly found in coastal waters outside of the summer months. Of the identified Alcidae, most are common murre *(Uria aalge)*, a duck-sized sea-bird found on the coast year-round. The small Alcidae are probably one or a number of species of murrelet.

Table 8. Total Abundance of Recovered Bird Bone by Period.

	Period				
Taxon	**2**	**3**	**4**	**5**	**6**
Gavidae	0	15	2	1	1
small	0	21	2	3	0
small - medium	2	4	1	0	0
medium	3	15	1	1	0
large	2	59	4	4	0
Podicipedidae					
small	0	2	3	0	0
medium	0	3	0	1	0
large	1	8	1	3	1
Aechmophorus occidentalis	0	1	0	0	0
Procellariidae					
Puffinus sp.	0	0	1	0	0
Phalacrocoracidae	1	7	1	3	0
small	0	2	0	2	0
large	1	11	3	3	0
Phalacrocorax pelagicus	0	4	4	1	0
Ardeidae					
Ardea herodius	0	0	1	0	0
Anatidae					
Anserinae	1	1	0	1	0
Duck	20	66	26	23	0
Aythyinae/Merginae	1	5	2	0	1
Aythyinae	1	4	1	0	0
Merginae	2	0	0	0	0
Buteo jamaicensis	0	0	2	0	0
Haliaeetus leucocephalus	4	4	7	18	4
Charadriidae/Scolopacidae	0	0	0	3	0
Laridae					
very small	0	1	0	0	0
small	0	1	0	0	0
small - medium	1	0	0	0	0
medium - large	0	3	0	0	0
large	2	4	2	0	2
Alcidae					
small	0	7	1	0	0
Uria aalge	0	14	0	1	0
Tytonidae/Strigidae					
large	1	1	2	0	0
Corvidae					
Cyanocitta stelleri	0	1	1	0	0
Corvus corax	0	6	0	1	0
Corvus caurinus	0	1	0	0	2
Unidentified	26	51	19	14	2

The three next most common classes of birds can be roughly classed together as beach scavengers. These include: the bald eagle *(Haliaeetus leucocephalus)*; Laridae (gulls); and Corvidae (raven, crow, and Steller's jay). The bald eagle is relatively common in the midden. Corvidae occur only rarely in contrast to their present numbers in the site vicinity. Rare elements of raven *(Corvus corax)*, crow *(Corvus caurinus)*, and Steller's jay *(Cyanocitta stelleri)* are all represented. Based on size differences, several species of gull are represented, though the frequency of each is low. Only the largest specimens occur in any abundance, and all of these are probably glaucous-winged gull *(Larus glaucescens)*, the most common species on the coast.

A number of much less common bird families also were identified, including: two elements identified as probable red-tailed hawk *(Buteo jamaicensis)*, though they may represent other hawk species; one specimen identified as a shearwater *(Puffinus sp.)*; one great blue heron *(Ardea herodius)* specimen; three specimens of shorebird (Charadriidae/Scolopacidae), which were found together and probably represent a single individual; and four large owl bones (Tytonidae/Strigidae). These low-frequency bird classes are of some interest, but their presence is not significant for determining subsistence patterns or the seasonality of site occupation.

Drucker (1955:51) describes a number of methods used by various coastal groups for capturing waterfowl. These include: baited underwater traps for capturing diving waterfowl, the use of spears with multiple prong hardwood points, and the use of nets thrown over nondiving species or stretched across flyways used by ducks. Birds also could be shot with arrows, which were sometimes fitted with a thick blunt point (Boas 1895:319). The overwhelming majority of the birds recovered from the Namu midden are diving sea birds, and it is likely that they were principally captured in underwater traps fitted with baited gorges, as described by Drucker (1951:33-34) for the Nootka, but also said to be favoured by the Kwakiutl.

In archaeological analysis, birds are commonly used as seasonality indicators. Many of the Namu birds are species that winter on the coast, though this period actually stretches from early fall through to late spring for many species. There is only sparse ethnographic information concerning the timing of bird hunting, or the use of birds as food. The Haida hunt waterfowl in the late fall after salmon season, and eat the flesh fresh rather than preserved (Blackman 1981:15). Contemporary Kwakiutl concentrate on ducks during a part of the winter when certain varieties concentrate near shore to feed off rocks, making it easy to shoot them from shore.

The Kwakiutl make ducks into soup, though they are not a popular food because of their distinctive flavour, which many people do not enjoy (Rohner 1967:61). Bird feathers and down had decorative uses, which may have encouraged the hunting of some species. Eagle flesh was eaten by the Tlingit, who also used eagle feathers as decoration (Krause 1979:59). The identified species from Namu indicate that birds were primarily a food resource, which made up one small part of an overwhelmingly marine-based economy.

FISH

The total frequencies of identified fish classes are presented in Table 9.

Oncorhynchus sp. (Pacific salmon)

For all time periods, the most abundant fish remains are of the genus *Oncorhynchus*, which accounts for between 67.1 and 96.8 percent of the identified fish remains in each period. Although it is impossible to speciate members of this genus on the basis of most osteological morphology (D. Cannon 1987:5), there is evidence (discussed in more detail in Chapter 5) to indicate that the majority were either coho *(O. kisutch)* or chum *(Oncorhynchus keta)*, with a smaller proportion probably consisting of pink salmon *(O. gorbuscha)*. Today, these species predominate in the smaller coastal streams such as the Namu River. Although escapement figures were not obtained for the Namu River itself, the salmon that spawn in nearby Hooknose Creek (Hunter

Table 9. Total Abundance of Recovered Fish Bone by Period.

All elements

		Period			
Taxon	**2**	**3**	**4**	**5**	**6**
Rajidae	1	0	5	3	0
Squalus acanthias	74	37	49	73	17
Hydrolagus colliei	59	70	76	254	69
Clupea harengus pallasi	28	33	366	48	0
Oncorhynchus sp.	5720	17272	58940	9509	380
Gadidae	81	54	296	86	45
Sebastes sp.	318	210	755	815	41
Anoplopoma fimbria	4	16	19	48	1
Hexagrammidae	79	28	172	215	5
Cottidae	3	1	15	19	0
Pleuronectidae	48	58	185	147	9
Unidentified fish	53	73	64	110	18
Vertebra centra (* dental plates)					
Rajidae	1	0	5	3	0
Squalus acanthias	74	37	49	73	17
Hydrolagus colliei (*)	59	70	76	254	69
Clupea harengus pallasi	28	32	359	47	0
Oncorhynchus sp.	5633	17117	57525	9378	378
Gadidae	64	42	272	63	41
Sebastes sp.	202	135	474	466	35
Anoplopoma fimbria	4	16	18	46	1
Hexagrammidae	61	21	129	162	3
Cottidae	3	1	14	13	0
Pleuronectidae	45	56	166	129	9

1959) are predominantly pink and chum. Coho are also widely distributed among small coastal streams (Aro and Shepard 1967:261). Chinook are relatively scarce in the region (Rohner 1967:45; Pomeroy 1980:175), while sockeye tend to be restricted to a few major river systems.

Pink salmon spawn in late September or early October, chum spawn a little later (Hunter 1959:837), and coho are the latest of the Pacific salmon to spawn. Chum was the preferred species for smoking (Hart 1973:114) and for preservation for winter use because its low fat content allowed it to be kept longer (Romanoff 1985:154). Salmon were fished with a variety of techniques, including traps, nets, spears, and line fishing (Drucker 1955:35-39). The efficient exploitation of salmon during spawning runs required a large-scale communal effort using nets or fishtraps.

Herring *(Clupea harengus pallasi)*

The herring is the only other fish that was exploited on the same scale as salmon. Herring was heavily utilized throughout the period for which faunal data are available. The significance of herring is not conveyed by the figures in Table 9 because the vast majority of herring vertebrae were not retained in the 1/8 inch (3.2 mm) mesh of the screens. However, the frequency of herring bone in selected matrix samples from the 1977 and 1978 excavations (Fawcett: Appendix C) indicates that herring was intensively exploited, possibly to a greater extent than salmon. An isolated find of a dense mass of herring bone mash on the surface of the sterile subsoil in unit 32-33S, 4-6E, shows that herring was a major resource from at least as early as the 7000 cal. B.P. date for that deposit.

Ethnographically, herring was caught with rakes during the spawning season, when the fish gather in great numbers in shallow bays. Herring spawn was obtained by setting out evergreen boughs in the intertidal zone. The sticky eggs would be deposited on the boughs, which were then gathered. In British Columbia, herring spawn in late winter; heaviest concentrations are in March, though some herring spawn in February and April, and others occasionally spawn as late as early June or July (Hart 1973:97). The abundance of herring is a good indication of spring occupation of the site.

Pleuronectidae (flatfish)

Other fish species are much less abundant than salmon or herring. Halibut *(Hippoglossus stenolepis)* is relatively rare at Namu, though halibut was an economically important species in other areas of the coast, in part because of its large size. Halibut are included in the total frequency for the family Pleuronectidae (flatfish), but 135 halibut bones were identified from strata representing all time periods. Halibut are available year-round, and may have been fished, as among contemporary Kwakiutl, whenever there were signs they were present in the area. Halibut were normally taken singly using specialized fishing gear. The non-seasonal nature of halibut fishing probably holds for other members of the family Pleuronectidae, though it has been noted that the Tlingit fished for flatfish in the winter (Krause 1979:121). Drucker (1955:41) mentions a method of catching flatfish that involved individuals searching through the bottom mud with their feet and then attempting to hold the fish until it could be speared. The whole enterprise is described as something of a lark. Many Northwest Coast groups did not consider that most marine fish species were economically important. Unlike salmon, most other fish were eaten fresh to satisfy the needs of the moment (Krause 1979:121; Blackman 1976:3-4).

Sebastes sp. (rockfish)

The second most common class of identified fish was rockfish, though it is much less abundant than salmon. No attempt was made to determine which of thirty-seven possible species of rockfish found off the coast of British Columbia were represented in the midden. None of the species congregate in large numbers, and most were probably equally available at all times of the year. Among the Haida, species such as rockfish were only occasionally utilized, and were economically insignificant from the Native point of view (Blackman 1976:3). Although this family of fish was consistently utilized at Namu, there is no indication that it was ever the object of a specialized fishery.

Gadidae (cods)

Cod (Gadidae) is another category of fish that is not common enough to have been economically important. Most of the cod remains were not identified to species, but of the ninety-three elements identified to species as either Pacific cod *(Gadus macrocephalus)* or walleye pollack *(Theragra chalcogramma)* all but four are the larger Pacific cod. It is expected that the majority of the unidentified Gadidae are Pacific cod. This species moves into deep water in autumn and returns to shallow water in spring (Hart 1973:223). The presence of cod in archaeological sites has been interpreted as an indication of spring occupation (Pomeroy 1980:350).

Hexagrammidae (greenlings)

The Hexagrammidae are represented in numbers comparable to those of the Gadidae and Pleuronectidae. However, the recovered greenling remains probably under-represent their true abundance in the midden deposits. Many of the small vertebrae might have passed through the screens, but they were consistently present in small quantities in the matrix samples (Fawcett: Appendix C)

Only one separate species, the morphologically distinct and larger ling cod (Ophiodon elongatus), was identified from among this family. In total, only twenty-one elements were ling cod, the remainder were of one or another species of greenling (Hexagrammos sp.). Members of this genus are generally rather small, and though they are reputed to be of good flavour (Hart 1973:459), they cannot be considered an economically important species in the Namu fishery. Greenlings are common bottom fish in shallow water.

Cottidae (sculpins)

A few elements of sculpin (Cottidae) were identified among the fish remains. Species of sculpin may be abundant in the inter-tidal zone, but despite some problems in identification, it is certain that only a few elements were present in the Namu midden. There is no ethnographic evidence to suggest that sculpins were ever economically important on the coast.

Sablefish *(Anoplopoma fimbria)*

The sablefish or blackcod was another uncommon fish species. It has good flesh, which smokes well (Hart 1973:456), but it was obviously not of major importance at Namu, though it was fished during all time periods. The presence of this species in the matrix samples from the Rivermouth Trench (Fawcett: Appendix C) suggests that it might be under-represented in the overall fish assemblage. It is difficult to accurately project from the limited matrix samples, but it is unlikely that sablefish was ever economically important.

Dogfish *(Squalus acanthias)*

The dogfish is relatively common among the fish remains. Although never significant in absolute numbers, the dogfish is interesting because of its specialized ethnographic uses. Among the Haida the dogfish is processed for oil and eaten for medicinal purposes (Blackman 1976:7). Dogfish skin was also used as sandpaper to produce a fine finish on wooden articles (Drucker 1955:61). Historically, the Kwakiutl considered dogfish inedible, but they did resort to eating it during periods of famine or hunger in the region (Rohner 1967:17). Most of the recovered dogfish remains were relatively small and probably immature. Immature dogfish are available throughout the year in British Columbian waters (Hart 1973:46).

Ratfish *(Hydrolagus colliei)*

The ratfish is somewhat problematic because though it is relatively abundant, and is present among the earliest recovered faunal remains, there is almost no ethnographic information regarding its probable utilization. Boucher (1976:33) states that there is no report of the ratfish in ethnographies. Stewart (1977:17) makes a very brief mention of the use of ratfish oil as baby oil, but she does not provide a specific reference for this use. The flesh of the ratfish is very soft and the dorsal spine and reproductive organs are poisonous.

Therefore, it is unlikely that the ratfish would have been an important food resource. Ratfish oil is a fine lubricant, which some fishermen claim is useful in the treatment of arthritis (Carl 1973:20). Prehistorically, the ratfish may have been used exclusively as a source of oil. Ratfish are common in shallow water, particularly over muddy bottom (Carl 1973:20).

Rajidae (skate)

Nine specimens of skate were recovered from the site, but they are only significant as an indication of the wide-ranging utilization of available marine resources.

Bluefin tuna (*Thunnus thynnus)*

One specimen recovered from a Period 3 stratum was positively identified as bluefin tuna *(Thunnus thynnus).* Although no economic importance can be attached to this isolated specimen, its presence is interesting because bluefin tuna is presently considered rare north of California, and there are only a few records of its summer presence well off southern and central British Columbia. Bluefin tuna has been reported from archaeological sites on the west coast of Vancouver Island (McMillan 1979:118) and in the Queen Charlotte Islands (Geordie Howe, pers. comm.). The Namu tuna was an extremely large individual, judging from the size of the recovered vertebra. It undoubtedly represents a stray individual that was taken as the result of fortuitous encounter at sea or beach scavenging.

Although fish remains were not generally identified to species level, there are indications of a variety of species within each of the families of identified fish. A diverse array of marine resources were exploited throughout the economic prehistory of Namu. However, the abundance of identified salmon, and the abundance of herring, as inferred from matrix samples, make it equally evident that this variety of marine resources was at most a supplement to the mainstay subsistence economy.

SHELLFISH

All of the following information is summarized from Conover (1972, 1978), and her results are considered to hold equally well for the excavated units described in the present study. Four main categories of shellfish predominate at Namu: 1) clam *(Saxidomus/Schizothaeus sp.)*; 2) barnacle *(Balanus sp.)*; 3) mussel *(Mytilus sp.)*, primarily bay mussel (*Mytilus edulis)*; and 4) whelks *(Thais sp.)* (Conover 1978:78).

In Period 3, the early period of significant shell deposition, rock-dwelling species of barnacle, whelk, and mussel predominate. The trends for these species are similar, with all three achieving peak abundance by the early part of Period 5. Each of these groups exhibits declining abundance through Period 5 as larger clams become predominant; mussel show the sharpest decline (Conover 1972:291). Large clams are present from as early as the latter part of Period 3, but they are not abundant until the early part of Period 5. They increase in abundance until they reach their peak in the latter part of Period 5 and Period 6. The Period 6 strata exhibit the greatest shell content of any of the site strata (Conover 1978:78). Lesser shellfish species such as littleneck clam (*Protothaca staminea)* and cockle *(Clinocardium nuttali)* do not begin to appear in any abundance until the early part of Period 5, from which time they increase in abundance to a peak in Periods 5 and 6; this is the same trend exhibited by the larger clams (Conover 1972:292).

Although systematic investigation of the shell matrix was not undertaken for the 1977 and 1978 excavations, the units adjacent to those previously excavated naturally exhibit similar trends. Visual inspection of the 1978 Rivermouth Trench showed the greatest concentration of mussel shell in Period 3 and 4 deposits. Major deposits of whole clam shell occur in Period 6. The earliest small lenses of shell in the Period 2 deposits contain a relatively high proportion of mussel.

Although no estimate of relative contribution to diet has been made, it is clear that shellfish had become a major dietary component after ca. 6000 cal. B.P. Indications of a relative change in the dietary contribution of shellfish, and the environmental implications of the shift in the abundance of mussel and clam are considered in the Chapter 4 discussion of temporal trends.

SUMMARY

From the data presented in this chapter it is clear that throughout the period for which faunal data are available, the subsistence economy of the site was overwhelmingly marine oriented. Throughout this period, all varieties of marine mammals, birds, fish, and shellfish were exploited. There are changes in the relative abundance of faunal classes, but the primary focus was always toward the coast and the resources of the sea. This focus may have shifted or intensified at times, but it remained generally consistent. Therefore, it is inappropriate to consider a marine versus land orientation at the site; attention must instead focus on variation in emphasis within a specialized marine-based economy. Deer *(Odocoileus hemionus)* is the only land mammal species that can be considered an important subsistence resource. Other land mammals were undoubtedly more important as sources of fur and other raw materials. Even deer must be considered in this light, for they served as a major source of hide and bone for tool manufacture, though it is far from clear, as some suggest (e.g. Conover 1978:91), that this was the only economic importance of deer. The role of deer as a subsistence resource is considered in Chapter 3, but the faunal data suggest that the ethnographically-described emphasis on fish and other marine resources (McIlwraith 1948:3), in which land mammals were not essential as food but were hunted primarily for their fur or skins (Garfield 1945:628), extends well into the prehistoric past.

CHAPTER 3

Taphonomy and Spatial Distribution

Taphonomy literally means "the laws of burial", and this chapter examines a number of the site formation processes that have affected the frequency and distribution of faunal remains in the Namu midden. Of concern are the differential survival and spatial distributions of elements from particular faunal classes. A major aspect of taphonomy is the survival potential of different skeletal elements, and this problem is considered below as part of an effort to determine whether deer were a major food resource or were hunted more for their hide and bone. The discrete spatial distribution of fauna is examined in order to determine habitation and processing areas, and to provide a basis for interpreting temporal trends while controlling for variation between excavation units.

DEER TAPHONOMY

The utilization of deer on the Northwest Coast, and the particular significance of deer as a food resource are important problems in determining the degree of land-based orientation in the prehistoric subsistence economy. The abundance of deer relative to other mammalian remains indicates their potentially significant subsistence contribution, but ethnographic accounts tend to minimize the importance of deer as a food resource, and instead emphasize their value as a source of hides. Conover (1978:91) follows ethnographic sources in suggesting that deer were only important as food during times of starvation; she further stresses the importance of deer as a source of bone for tool manufacture. A cursory glance at the frequency of recovered deer elements (Tab. 10) supports the conclusion that deer were primarily used as a source of raw materials for tool-making. The emphasis on teeth and lower limbs is what would be expected if only select parts of the deer were returned to the site, specifically the head and limbs to supply bone and antler for tools, with the additional possibility that the hide was left attached to these elements and the whole package returned to the site as a unit (the so-called "schlepp effect" (Daly 1969:149)). If deer were taken at some distance from the site and bone and hides were the desired resources, then it would be expedient to butcher the animal at the kill site and only return select parts of the carcass. Most of the meat could be abandoned at the kill site.

Selective transport is one possible explanation for the Namu pattern of deer element recovery, but it is well known that skeletal elements are more or less resistant to destruction through the feeding actions of humans and dogs (e.g. Brain 1980). Such destruction could account for the observed element frequencies. In order to determine whether particular parts of the deer were selected for return to the Namu site, it was necessary to assess the probabilities of element survival and compare them with the relative frequencies of elements recovered from the site excavations.

Studies of the survival potential of deer elements have not been undertaken, but Brain (1980) has made detailed studies of Hottentot encampments in the Namib desert of southwestern Africa to determine the effects of human and canine attrition on the survival of goat elements. Goats have the same range of elements as deer; therefore Brain's results can be used as an indication of the relative probability of survival among deer elements subjected to similar destructive forces. The data sets can be compared by comparing the rank order of goat element survival to the rank order of deer elements in the Namu deer assemblage. Brain's data are ranked by

Table 10. Frequency of Recovered Deer *(Odocoileus hemionus)* Elements.

Element	Frequency
mandible	140
maxilla	115
distal humerus	27
distal tibia	44
proximal radius	30
scapula	18
proximal metapodial	33
innominate	30
axis	2
atlas	5
distal radius	12
distal metapodial	73
proximal femur	2
tarsal	114
proximal tibia	5
lumbar vertebra	23
distal femur	4
cervical vertebra	12
phalange	289
thoracic vertebra	23
sacrum	2
proximal humerus	1
carpal	100

the probability of element survival, and the Namu data can be similarly ranked according to the probability of element recovery. If the rank order of deer element frequency is equivalent to the rank order of goat element survival, then the relative frequency of deer elements is probably a function of preservation, and not human selection.

There are a number of potential problems with this approach to the question of deer utilization. If rank order comparison indicates that the probability of survival among individual goat elements is unrelated to the probability of recovery among the equivalent deer elements, then it is reasonable to conclude that the Namu deer bone assemblage was the result of element selection, and not differential bone destruction. Because non-meat-bearing elements predominate in the Namu collection, it could be concluded that there was a selection for tool-making raw materials. If there is a significant positive correlation between goat and deer element frequencies, it simply means that there was not a selective return of deer parts. A significant positive correlation indicates that the entire deer carcass was returned to the site, but how it was used once returned remains an open question. Deer could have been used as a source of bone, antler, and hide, while the meat was discarded or used as dog food. The assumption made here is that such outright discard of a meat resource was unlikely if the trouble had already been taken to transport the entire animal back to the site.

There are a number of specific problems to consider in comparing Brain's goat data to the frequencies of deer elements in the Namu midden. Although their elements are comparable, deer are larger than goats, which may affect rates of element attrition. Furthermore, a Northwest Coast shell midden is not a Hottentot

Table 11. Comparison of the Percentage Survival of Goat Elements (after Brain 1980:117) and the Recovery of Deer Elements (Element MNI).

Element	Goat Survival %	R1	MNI	R2	R1-R2
mandible	91.4	1	11.67	7	-6
maxilla	78.1	2	9.58	8	-6
distal humerus	64.0	3	13.5	6	-3
distal tibia	56.3	4	22.0	1	3
proximal radius	50.8	5	15.0	4	-1
proximal metapodial	27.7	6	8.5	11	-3
scapula	27.4	7	9.0	10	-5
innominate	26.6	8	15.5	5	-4
axis	21.9	9	2.0	18	-9
atlas	18.8	10	5.0	13	-3
distal radius	17.2	11	6.0	12	-1
distal metapodial	16.8	12	18.25	3	9
proximal femur	14.1	13	1.0	21	-8
tarsal	11.7	14	19.0	2	12
proximal tibia	10.1	15.5	2.5	15	0.5
lumbar vertebra	10.1	15.5	3.83	14	1.5
distal femur	7.0	17	2.0	18	1
cervical vertebra	3.8	18	2.4	16	2
phalange	2.7	19	9.03	9	10
thoracic vertebra	2.5	20	1.64	20	0
sacrum	1.6	21	2.0	18	3
proximal humerus	0.0	22	0.5	22	0
carpal	—	—	(8.33)	—	—

Rsc=.64

camp, and the cultural pattern of bone attrition and the effects of the physical environment on bone survival can be expected to vary substantially. If bone destruction is largely due to the chewing actions of dogs, then differences in the size and breed of dog also could have a significant effect on element survival. The validity of direct comparison can be questioned on all of these grounds. Although valid, such objections are only relevant if a correlation does not exist between the data sets. If a positive correlation is found, then it must exist for a reason, and the most parsimonious explanation is that similar element frequencies derive from similar taphonomic processes of human and canine consumption.

Brain's (1980:117) goat data are based on the percentage survival of elements from a known number of goats. For the Namu deer assemblage there is no way to determine the base number of deer that were brought to the site. Deer element recovery rates were determined by dividing recovered element frequencies by the number expected in a single individual. This calculation yields a rough minimum number of individuals (MNI) estimate based upon each element. This measure is not MNI as it is commonly used to measure species abundance. MNI is not used here to estimate the number of deer represented in the assemblage. It is an indication of the number of deer minimally required to produce the recovered frequency of each element. Given that all the deer elements were drawn from the same original population of deer, the relative magnitude of the element MNI is an indication of the relative survival of elements from the original deer assemblage. The MNI

Table 12. Comparison of the Percentage Survival of Goat Elements and the Recovery of Deer Elements (Element MNI) by Excavation Unit and Period.

		DEER ELEMENT MNI BY EXCAVATION UNIT AND PERIOD							
Element	**GOAT % SURVIVAL**	**68-70S 4-10W 32-34S 2-10W**	**32-34S 4-10W**	**68-70S 2-10W**	**Site Total**	**Period 5**	**Period 4**	**Period 3**	**Period 2**
mandible	91.4	8.42	2.83	5.58	11.67	3.08	5.25	1.08	1.83
maxilla	78.1	7.25	3.00	4.25	9.58	2.42	3.75	1.50	1.83
distal humerus	64.0	8.50	3.00	5.50	13.50	2.00	5.50	2.00	3.50
distal tibia	56.3	20.00	4.50	15.50	22.00	5.00	12.5	3.00	1.50
proximal radius	50.8	12.50	4.50	8.00	15.00	4.50	6.50	3.00	0.50
proximal metapodial	27.7	7.25	3.00	4.25	8.50	2.25	4.00	1.75	0.50
scapula	27.4	8.00	4.00	4.00	9.00	0.50	3.00	4.50	0.50
innominate	26.6	13.50	5.50	8.00	15.50	5.00	5.00	3.50	2.00
axis	21.9	2.00	1.00	1.00	2.00	0.00	1.00	1.00	0.00
atlas	18.8	4.00	1.00	3.00	5.00	0.00	2.00	1.00	2.00
distal radius	17.2	6.00	1.50	4.50	6.00	1.50	3.50	0.50	0.50
distal metapodial	16.8	15.75	5.25	10.50	18.25	5.00	7.50	2.50	2.50
proximal femur	14.1	1.00	0.50	0.50	1.00	0.50	0.50	0.00	0.00
tarsal	11.7	15.67	6.67	9.00	19.00	6.00	6.50	3.50	1.83
proximal tibia	10.1	2.00	0.50	1.50	2.50	1.00	0.50	0.50	0.50
lumbar vertebra	10.1	3.33	0.83	2.50	3.83	0.67	1.67	0.67	0.50
distal femur	7.0	1.50	0.50	1.00	2.00	0.50	0.50	0.00	0.50
cervical vertebra	3.8	1.40	0.20	1.20	2.40	1.00	0.60	0.20	0.60
phalanges	2.7	7.22	1.94	5.28	9.03	2.56	3.59	1.31	.91
thoracic vertebra	2.5	1.14	0.64	0.50	1.64	0.36	0.57	0.14	0.43
sacrum	1.6	2.00	1.0	1.00	2.00	0.00	0.00	0.00	2.00
proximal humerus	0.0	0.50	0.50	0.00	0.50	0.00	0.00	0.50	0.00
carpal	—	(7.00)	(2.50)	(4.50)	(8.33)	(2.42)	(3.83)	(0.92)	(1.08)

measure merely indicates the potential for element survival; for this purpose, it was not necessary to consider side, size, or age categories in the calculations. The element MNI was the basis for ranking deer element recovery rates. Brain's goat element survival percentages were similarly ranked, and a Spearman's rank order correlation coefficient (Marascuilo and McSweeney 1977:431-436) was calculated to determine the similarity of the two ranking orders. Table 11 gives a detailed presentation of the calculations used to determine the rank order correlation of goat element survival and deer element recovery.

The possibility that deer utilization varied through time or in reference to different site areas was assessed by calculating correlation coefficients for each temporal period, each main excavation trench, the combined main trenches, and the entire site. Table 12 presents the element MNI calculations for these separate units compared to the rankings for the percentage survival of goat elements. Table 13 lists the results of the Spearman's test of rank order correlation. All deer element distributions show a significant positive correlation with Brain's goat element survival data. The relative frequency of recovered deer elements is roughly equivalent to the relative percentages of goat elements that survived human and canine consumption in Hottentot encampments. It is reasonable to conclude that the frequency of deer elements in the Namu midden is the result of similar processes of attrition. The implication is that the Namu inhabitants were not selecting for the return of particular deer elements; the entire deer carcass was returned to the site.

Table 13. Spearman's Rank Order Correlation Coefficient (Rsc) for the Relationship Between the Recovered Frequencies of Deer Elements (MNI) and the Percentage Survival of Goat Elements.

Unit	Element Frequency	Rsc	p
68-70S,4-10W	583	.61	<.005
32-34S,2-10W	303	.61	<.005
68-70S,4-10W + 32-34S,2-10W	886	.68	<.005
Site Total	1106	.64	<.005
Period 5	297	.47	<.025
Period 4	453	.70	<.005
Period 3	166	.64	<.005
Period 2	144	.31	<.1

Although comparatively weak, the results for Period 2 do not necessarily indicate the selective return of deer elements to the site at that time. The largest Period 2 deviation from the survival ranking of goat elements is the high ranking for the sacrum. It is unlikely that the sacrum would be present unless the entire deer carcass was brought to the site.

In spite of the general agreement between the deer element frequencies and Brain's element rankings, there are some specific differences from Brain's element rankings that require explanation; these include:

1) mandibular and maxillary teeth - the Namu MNI values for these elements consistently rank lower than the ranks for goat mandibles and maxillae. This discrepancy is probably the result of MNI values that are based on the division of identified specimens by the total number of teeth expected in an individual, even though some of the identified archaeological specimens are maxilla or mandible fragments that contain more than one tooth. As a result, MNI values for teeth slightly under-represent their true relative frequency.

2) distal metapodials - these elements consistently rank higher for deer than for goat. In part, this pattern may be the result of specimen counts that included individual trochlea as single specimens; there are eight trochlea per individual (two on the end of each distal metapodial). MNI calculations are based upon complete distal ends, of which there are only four per individual. The result is a slight over-representation of distal metapodials, and a resulting higher than true ranking of their frequency.

3) phalanges and tarsals - these elements rank higher for deer than for goat, which may be partly because deer phalanges and tarsals are more robust and have greater survival potential. The reduction of other deer elements in tool manufacture also would result in relatively higher ratios of elements such as tarsals and phalanges, which were not reduced in the same way. It also is possible that there was some minor selection of lower limbs for tools, in addition to the general pattern of returning whole animals to the site.

The most likely explanations for the above deviations from expectation suggest that correlations with Brain's data are probably even stronger than indicated by the figures in Table 13. There is a correspondence between the goat elements that are most resistant to attrition and the deer elements that were most likely to be preserved in the Namu midden. The frequency of recovered deer elements therefore is consistent with a pattern of returning whole animal carcasses to the site for later processing. Given return of the entire animal, it is not unreasonable to assume that the meat was used for food. Although the Namu diet was overwhelmingly marine based, deer made at least some terrestrial based contribution to the diet. Deer was likely the major part of the small portion of the Namu protein intake that was derived from terrestrial sources (see Chisholm et al. 1983).

Table 14 - Distribution of Selected Fauna Abundance in the Rivermouth and Central Main Trenches.

	Period	**Rivermouth Trench**		**Central Main Trench**	
		Freq.	**% of Mammal**	**Freq.**	**% of Mammal**
Harbour Seal	5	13	4.7	7	5.1
	4	498	44.3	23	16.9
	3	12	16.4	53	17.9
	2	32	22.2	12	23.1
Sea Otter	5	4	1.4	0	0.0
	4	46	4.1	1	0.6
	3	1	1.4	3	1.0
	2	1	0.7	0	0.0
		Freq.	**% of Fish**	**Freq.**	**% of Fish**
Halibut	5	40	0.51	2	0.11
	4	86	0.18	0	0.00
	3	3	0.05	0	0.00
	2	2	0.13	0	0.00
Cod	5	31	0.40	38	2.03
	4	289	0.61	5	0.05
	3	25	0.38	19	0.26
	2	46	3.06	2	1.36
		Freq.	**% of Mammal+Bird**	**Freq.**	**% of Mammal+Bird**
Birds	5	45	13.9	33	19.5
	4	63	5.3	29	14.1
	3	22	23.2	294	49.8
	2	35	19.6	7	11.8

FAUNA DISTRIBUTION PATTERNS

The two major aspects of fauna distribution considered here are: 1) the deposition of faunal elements in primary butchering areas; and 2) faunal deposition in habitation areas, in which secondary butchering and consumption took place. Spatial patterning in shell deposition, and the effects of burials on the deposition and recovery of faunal material also are examined.

Sufficient material for comparing spatial distributions was only available for the two major excavation trenches, but these exhibit some interesting contrasts in faunal frequencies (Tab. 14). Five categories of fauna show variable distributions between the two trenches. These include halibut, cod, all bird species, sea otter, and harbour seal. Halibut, sea otter, and harbour seal generally were much more abundant in the Rivermouth Trench than in the Central Main Trench.

Halibut, Harbour seal, and Sea Otter

In Period 4, seal and sea otter remains are concentrated near the river/beach area of the site. Halibut remains are concentrated in this part of the site during all periods. Ethnographic sources indicate that primary butchering of halibut and harbour seal took place on the beach (Boas 1921:241,451-461), and it is reasonable to project the same pattern for sea otter, since they were hunted in the same manner as harbour seal (Drucker 1955:34). If canoes landed with their catches at the river's mouth, the most convenient area for initial processing would be in the vicinity of the rivermouth excavations. The area would provide for convenient disposal of unwanted viscera, etc. Boas (1921:242-248) describes the southern Kwakiutl technique of halibut butchering, in which the flesh was cut away from the backbone on the beach, while only the flesh was normally taken back to the habitation area.

Boas also describes the butchering of harbour seal on the beach, and the Kwakiutl pattern of body-part distribution can be traced in the spatial patterns of skeletal elements within the Namu midden. Boas' description of Kwakiutl seal butchering is more concerned with the ultimate distribution of body parts than with the actual butchering process. A clearer description of seal butchering is given in Boas' (1888:517) ethnography of the Central Eskimo. As described there:

> In dressing the animal [seal] the natives open the belly and first scoop out the blood, then the entrails are taken out, the ribs are separated from the breast bone and the vertebrae, the fore flippers (with the shoulder and the hind flippers) are taken out, the only part remaining being the head, the spinal column, and the rump bone. Generally these are not eaten, but are used for dog's food.

If the butchering technique at Namu approximated that of the Central Eskimo, then there should be a distinct pattern of element distribution, with the greatest proportion of head and vertebral elements deposited at the site of butchering, and a greater percentage of limb elements near habitation areas. Table 15 lists the frequency and percentage of major harbour seal elements relevant to this pattern. The figures in Table 15 clearly show that during Periods 3 and 4, harbour seal were butchered near the river in rough correspondence to the pattern described for the Central Eskimo. Vertebrae and temporals are much more abundant in this part of the site. There also is an indication that limb bones were more likely to be brought to the Central Main Trench area of the site during Period 3. Phalanges are more evenly distributed across both excavation areas. If the flippers were left attached to the limbs, then the bone elements of the flippers must have been dispersed after secondary butchering and consumption.

Conover (1972:171) also reports a high percentage of harbour seal limb bones in the central area of the site, which may indicate a main habitation area. Limb bones would be common among the meat-bearing portions of the seal, which were taken to habitation areas for secondary processing and consumption. The relative absence of limb elements in the Central Main Trench area during Period 4 may indicate that the main habitation area was located in another part of the site, though it could indicate a difference in butchering techniques, in which limbs were no longer removed as a unit to the habitation area. Nonetheless, a shift in habitation area is indicated by a difference in the overall proportion of limb bones in Periods 3 and 4 (Period 4 - 3.0%, Period 3 - 15.4% of the total seal elements recovered). Limb elements are under-represented in the Period 4 excavations, which indicates that they may have been removed to another part of the site at that time. The distribution of bird and shellfish remains also supports the conclusion that the main habitation area shifted over the course of time.

Table 15. Seal Element Distribution.

	Rivermouth Trench 68-70S,4-10W		Central Main Trench 32-34S,2-10W	
Period 4				
	Frequency	% of Total Seal Elements	Frequency	% of Total Seal Elements
vertebrae	45	9.5	0	0.0
temporal	31	6.5	0	0.0
femur/humerus	14	2.9	1	4.3
total seal elements	475		23	
Period 3				
	Frequency	% of Total Seal Elements	Frequency	% ofTotal Seal Elements
vertebrae	3	25.0	3	5.6
temporal	2	16.7	2	3.8
femur/humerus	1	8.3	9	18.9
total seal elements	12		53	

Bird

One of the clearest patterns in fauna distribution is the heavy concentration of bird bone in the Period 3 strata of the Central Main Trench. Bird species composition does not vary between locations and time periods, but the concentration of abundance is clear. Ethnographic accounts indicate that ducks were normally made into soup (Rohner 1967:61). This method of preparation would likely result in the disposal of all skeletal elements at or near the point of consumption. The Period 3 concentrations of bird bone and harbour seal limb bones in the Central Main Trench area suggest that this was a main habitation area. The comparative lack of bird remains in the Period 4 deposits might indicate some shift in the main habitation area at that time, likely more toward the front of the site.

Cod

There is a clear Period 4 concentration of cod (Gadidae) bones in the Rivermouth Trench. Supporting ethnographic information is lacking, but this pattern may indicate a beach area of cod processing similar to that for halibut in all periods. The concentration indicates primary processing of some form, but it is impossible to determine why it should be in the rivermouth area at this time and not others.

Burials

Burials from Periods 3 and 4 were concentrated in the area of the Central Main Trench. If the interpretation of fauna distribution patterns is correct, this would indicate a pattern of interment within or near dwellings in Period 3. The use of the same circumscribed burial area continues into Period 4, when according to the available faunal evidence the main habitation area was probably in another location. If Period 4 dwellings were located closer to the shoreline (i.e. westward), any evidence of their location would likely have been destroyed during construction of the modern bunkhouse structure (Fig. 2). An examination of the faunal remains from burial levels did not reveal any particular associations between burials and categories of fauna that could be construed as funeral offerings. The faunal material recovered from burial levels is of the same character as that found throughout the strata of these periods.

Shell

Conover (1972:290) observed that shell strata in the central area of the site, which date to later than 2900 cal B.P. (equivalent to Periods 5 and 6), were commonly composed of unbroken and unmixed shell, which would indicate less intensive use of this area at that time. The relatively light deposition of other fauna during this period suggests that the rivermouth and central areas were both peripheral at this time. In neither area is there any evidence of primary processing or habitation. If the excavation areas were peripheral during Periods 5 and 6, then there would be major ramifications for the interpretation of temporal trends in faunal-class abundance, but other indications suggest that site utilization was less intense overall during Periods 5 and 6. If this was the case, then the low degree of shell fragmentation and low faunal frequencies do not indicate particular areas of peripheral site use. This problem is considered in more detail in the Chapter 4 discussion of the Period 5 fauna.

SUMMARY AND IMPLICATIONS

The spatial distribution of certain faunal classes indicates the segregation of activity areas across the site. The primary processing of sea mammals and halibut took place in the area of the Rivermouth Trench. The Period 3 faunal assemblage from the central area of the site indicates the location of secondary processing and consumption of seal and birds, which suggests that this was a main habitation area at that time. It is impossible to trace the shifting focus of habitation in later periods from the available evidence. The presence of multiple burials in the Period 3 deposits of the central site area points to the likelihood of burial near habitation areas, though nothing in the character of the either the Period 3 or the Period 4 deposits suggests that this area was exclusively reserved for burial. The matrix and faunal remains from this part of the site are generally typical of the midden deposits.

The distribution of bird bone suggests that their Period 3 abundance is somewhat exaggerated. If the main habitation area and the location of bird bone deposition later shifted to areas that were not excavated, then the abundance of bird remains recovered from later deposits would not reflect the intensity of their utilization. However, the slightly greater abundance of bird bone in the limited Period 3 deposits in the Rivermouth Trench suggests that the peak abundance of bird might not be entirely a function of sampling effects.

A shift in habitation area also could be responsible for a slight under-representation of harbour seal in the excavated Period 4 deposits. However, the bulk of the harbour seal remains were recovered from the Rivermouth Trench, and it is unlikely that the pattern of harbour seal deposition would have had a significant effect on temporal trends in seal abundance.

Variation in the spatial distribution of fauna indicates the need for caution in interpreting temporal trends on the basis of limited samples of midden deposits. The distinctive fauna deposition patterns in the Central and Rivermouth Trench areas suggest that even large-scale, block excavations, if restricted to a particular area of the site, might yield misleading indications of changing faunal abundance. Samples drawn from across the site provide a greater opportunity for obtaining an accurate assessment of temporal trends in fauna utilization. It may never be possible to completely gauge the effects of partial sampling from complex midden deposits, but apart from the spatial patterns noted in this chapter there is an overall consistency in the period faunal assemblages obtained from different excavation areas. This basic consistency suggests that the large samples available for this study can provide an accurate measure of relative faunal-class abundance over time.

CHAPTER 4

Temporal Patterns

The Namu faunal data provide an unprecedented opportunity to monitor the economic prehistory of a Northwest Coast site over a period of almost 7000 years. The vertebrate faunal remains from the 1977 and 1978 excavations exhibit evidence of significant changes and striking continuities in fauna utilization over this long time span. When these data are combined with the shellfish and vertebrate fauna data recovered during the earlier University of Colorado excavations they produce an unusually clear picture of shifts in economic emphasis and site settlement.

The temporal trends in fauna utilization have significance for understanding the site's occupational history, but they also provide insight into wider economic transitions on the Northwest Coast. Temporal patterns in the abundance of fauna from Northwest Coast sites have been used to support a variety of interpretations of economic and cultural transitions in the region. The Namu fauna exhibit a very site-specific pattern, which reflects local environmental changes and cultural responses to the shifting availability of marine resources, but it is still possible to extrapolate from the Namu data without necessarily reading the Namu economy as a microcosm of changes that characterize the entire Northwest Coast.

QUANTIFYING CHANGE

To appreciate the changing emphases of the Namu economy and their implications for Northwest Coast prehistory, it is critical to understand the methods used to quantify and compare the relative abundance of faunal classes over time.

The analysis of the Namu fauna was not undertaken with the aim of establishing relative species contribution to diet. Therefore it was possible to avoid many of the problems associated with the quantification of faunal-class abundance (see Grayson 1984). Faunal-class abundance was determined as the number of identified specimens. On this basis, salmon and herring (see Appendix C) were the most significant fish resources, while deer and harbour seal were the most significant mammal species.

It is much more difficult to use the raw frequencies of recovered faunal remains to determine changes in resource emphasis over time. Apart from variation in the intensity of resource exploitation, the abundance of recovered faunal remains is a function of the volume of excavated material, the length and intensity of site occupation, and the consistency of bone preser-vation and recovery. Rates of resource utilization can only be determined if deposition, preservation, and recovery rates are standardized.

Conversion to unit percentages is a common method for standardizing frequencies to a comparable base, but though percentages provide satisfactory standardization it is often difficult to interpret the meaning of changes in percentage magnitude. For example, a percentage decrease may be due to decreased species utilization, but more intensive use of other species that contribute to the percentage calculation would have the same effect (Grayson 1984:19-20).

In an effort to avoid the inherent problems of percentages, an early attempt was made to standardize faunal-class abundance according to the frequency of certain index species. The abundance of these species

Table 16. Fauna Abundance Standardized by Period
(Figures represent percentage of total fish, bird, and mammal (excluding salmon)).

Taxon	**2**	**3**	**4**	**5**	**6**
Rajidae	0.08	0.00	0.14	0.21	0.00
Squalus acanthias	5.60	2.51	1.37	3.01	4.72
Hydrolagus colliei	4.47	4.76	2.13	10.47	19.17
Clupea harengus pallasi	2.12	2.24	10.27	1.98	0.00
Oncorhynchus sp.	433.00	1173.00	1653.00	392.00	105.00
Gadidae	6.13	3.67	8.30	3.54	12.50
Sebastes sp.	24.07	14.27	21.18	33.59	11.39
Anoplopoma fimbria	0.30	1.09	0.53	1.98	0.28
Hexagrammidae	5.98	1.90	4.82	8.86	1.39
Cottidae	0.23	0.07	0.42	0.78	0.00
Pleuronectidae	3.63	3.94	5.19	6.06	2.50
Unidentified fish	4.01	4.96	1.80	4.53	5.00
Aves	5.22	21.88	2.44	3.42	3.61
Castor canadensis	0.83	0.34	0.42	0.33	0.00
Erethizon dorsatum	0.68	1.49	0.93	0.74	0.83
Delphinidae	1.51	1.15	0.67	0.91	0.00
Canis familiaris	2.88	3.94	2.58	4.20	9.72
Ursus americanus	0.45	0.14	0.22	0.08	0.00
Procyon lotor	0.00	0.00	0.03	0.00	2.22
Mustelidae	3.41	3.19	1.32	1.28	1.11
Lutra canadensis	0.76	0.48	0.25	0.58	1.11
Enhydra lutris	0.30	0.27	1.32	0.16	0.00
Otariidae	0.45	0.75	0.20	0.37	0.83
Phoca vitulina	6.13	5.16	14.61	0.95	0.28
Odocoileus hemionus	14.46	16.03	14.56	9.69	16.94
Oreamnos americanus	0.00	0.07	0.06	0.04	0.00
Unidentified mammal	6.28	5.64	4.24	2.31	6.39

was used as a representative standard of faunal deposition and recovery rates (Cannon 1989). Unfortunately the method proved to be unacceptably sensitive to minor sampling variations. It also introduced unwarranted assumptions and undue complexity in the calculation of standardized abundance. In the end, the temporal trends exhibited by the indexed totals were very similar to the trends in percentage abundance. Given the problems and assumptions involved in indexing faunal deposition and recovery rates, the calculation of faunal-class percentages was a preferable method of standardization.

The standardized faunal-class figures (Tab. 16, Figs. 3, 4) are calculated as percentages of the non-salmon vertebrate fauna from each period. Salmon are so abundant that their inclusion in the percentage calculations would have obscured any variation in the representation of other classes. The variation in salmon over time is calculated according to a different scale. Salmon abundance was standardized by calculating its ratio abundance per one hundred specimens of non-salmon vertebrate fauna. The resulting ratio gives a better impression of changes in the emphasis on salmon, though it may exaggerate differences between periods. When the abundance of salmon is calculated as a percentage of all vertebrate faunal specimens the apparent change from period to period is less pronounced. This problem is considered below in the discussion of temporal trends in salmon utilization.

Although the percentage figures in Table 16 give some impression of the relative contribution of each class to the fauna-based economy, it is inappropriate to put much weight on this impression. The number of identified specimens varies according to individual species characteristics (e.g. the identifiability of elements, preservation, recovery etc.), and percentage comparisons should only be made within the groups of fish, bird, and mammal. All faunal classes have been combined to calculate the figures in Table 16; therefore comparisons of percentage abundance within periods should be made with great caution.

There are advantages in standardizing abundance relative to the combined total of non-salmon vertebrate fauna. Changes in the abundance of any one faunal class has less effect on the representation of other classes when the combined total is based on a greater number of classes. In this case there are no completely dominant classes, though a change in the abundance of deer would have a greater effect than would a change in one of the lesser classes. A percentage change among the more abundant fish species also could have a disproportionate effect on the percentages of mammals. Appropriate caution must be used when evaluating percentage changes over time.

Apart from the effects of percentage calculations, there is always the possibility of significant changes in abundance due to relatively minor sampling effects (e.g. the inclusion of an anomalous concentration of bone as part of the excavated period matrix). In most cases such distortions should not be a major problem because of the large volume of excavated material and the abundance of recovered faunal remains. Nevertheless, greater interpretative weight is given to systematic patterns of change, which are sustained over more than one period, and to coincident changes in the abundance of more than one class of fauna. With these cautions, the percentage totals in Table 16 provide a basis for measuring robust change in faunal-class abundance over time. The results are a valid basis for interpreting temporal trends in the fauna-based economy.

PERIOD CHARACTERISTICS

Each of the major periods of site occupation exhibits a somewhat distinctive pattern of resource utilization. The period-by-period utilization of each of the major classes of shellfish, fish, birds, and mammals is described below. Changes in the abundance of identified fauna within each group are assessed and compared to trends in other major classes, and an effort is made to explain the temporal patterns that emerge. A summary description of temporal trends provides an overview of major developments in the economic prehistory of the site. No faunal remains were found in Period 1 deposits (11,000 - 7,000 cal. B.P.)

Period 2 - 7000 - 6000 cal. B.P.

Period 2 is characterized by the virtual absence of shellfish, which do not become a significant subsistence resource until after 6000 cal. B.P. The presence of isolated lenses of shellfish remains in the lowest levels of Period 2, and the enhanced preservation of vertebrate fauna remains are the major characteristics of the Period 2 deposits that distinguish them from the earlier Period 1 deposits.

The significance of the Period 2 vertebrate fauna assemblage is its inclusion of nearly the entire range of species recovered from later periods. The earliest fauna-bearing levels indicate utilization of the range of fish resources represented throughout later periods. The variety of habitats and behaviours exhibited by these fish (e.g. isolated individuals, schools, or anadromous runs) is evidence of a well-developed early fishing technology.

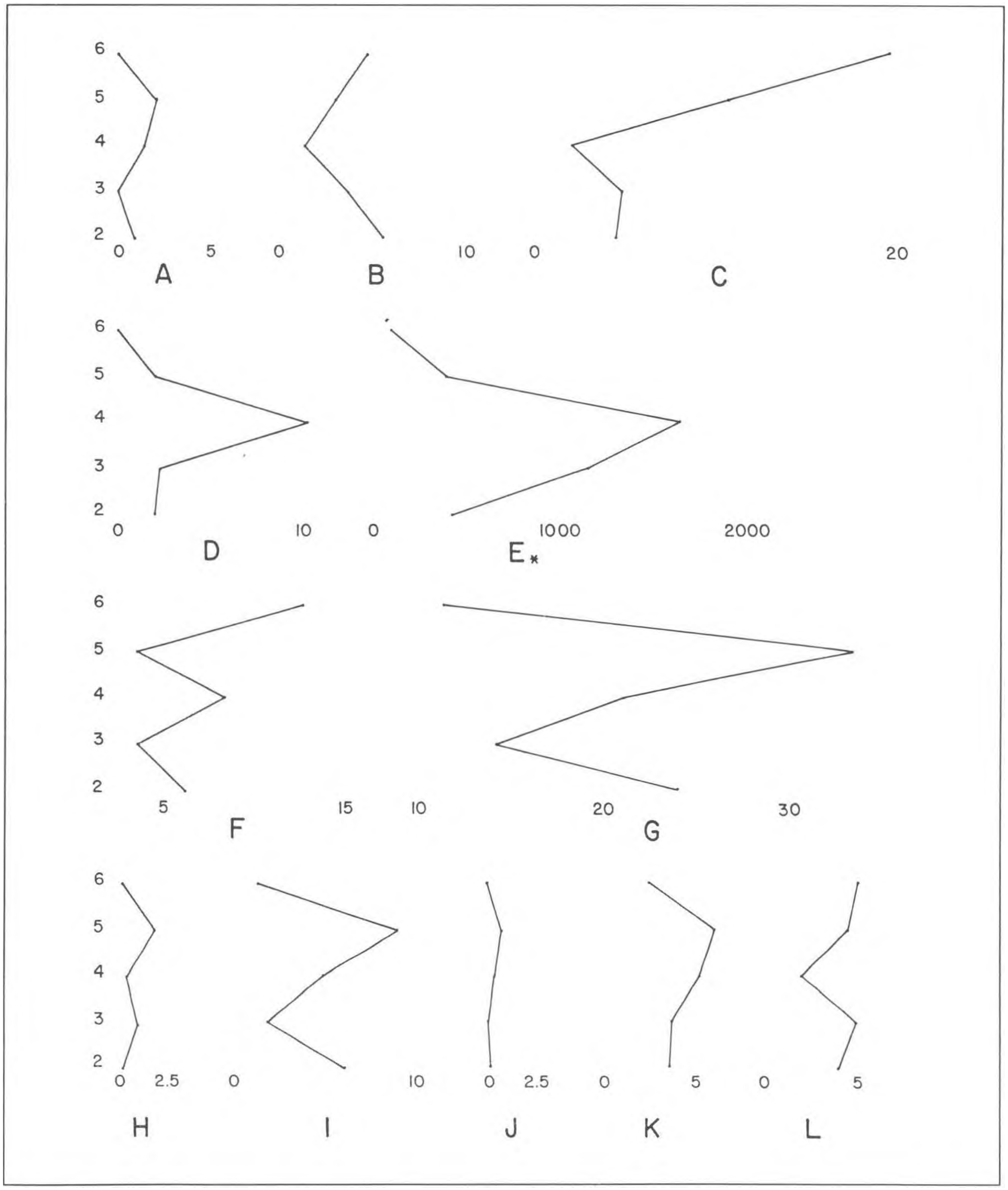


Figure 3. Temporal Trends in the Standardized Abundance of Fish (A - Rajidae, B - *Squalus acanthias*, C - *Hydrolagus colliei*, D - *Clupea harengus pallasi*, E - *Oncorhynchus sp.*, F - Gadidae, G - *Sebastes sp.*, H - *Anoplopoma fimbria*, I - Hexagrammidae, J - Cottidae, K - Pleuronectidae, L - Unidentified Fish) [Figures in % of non-salmon vertebrate fauna (* - Note scale change)].

The abundance of herring *(Clupea harengus pallasi)* and rockfish *(Sebastes sp.)* is comparable to later periods, as is the abundance of less common species. Only the dogfish *(Squalus acanthias)* is most abundant in this earliest time period, though it is not a major species at any time. Salmon is less abundant than in later periods, but it is still the dominant class of identified fish.

The below-peak abundance of salmon is probably a function of the failure of salmon streams to reach full productivity immediately following deglaciation. According to Fladmark (1975:207), full productivity was unlikely prior to 6000 cal. B.P. There are no obvious features of the environment that can explain the relative abundance of dogfish; it may reflect cultural preference. Given the historic use of dogfish as starvation food, and the almost complete lack of shellfish in the early deposits, it is reasonable to suggest that dogfish were exploited when other food was in short supply. Food shortages might have been particularly acute during Period 2, when salmon was less plentiful and shellfish were not yet exploited in appreciable quantities. Long-term trends show that the abundance of dogfish tends to vary inversely with the abundance of salmon.

The range of birds and mammals in the earliest fauna-bearing levels is virtually the same as throughout later periods; deer and harbour seal are the most abundant species. Period 2 exhibits the greatest percentage abundance of many mammalian species, though this may be partially due to slightly poorer preservation of fish remains in the early deposits, which would artificially inflate the percentage of mammals.

Period 2 exhibits the greatest abundance of many minor fur-bearing species such as beaver *(Castor canadensis)*, Mustelidae (mink, etc.), and black bear *(Ursus americanus)*. The abundance of fur-bearing species probably reflects their greater utilization in the early periods of site occupation. Long-term trends show a gradual reduction in the exploitation of fur-bearing animals.

The slightly higher percentage of Delphinidae in the Period 2 deposits is of interest in light of evidence from the Bear Cove site on Vancouver Island that shows an early emphasis on hunting dolphin and porpoise (C. Carlson 1979:188). However, the number of Delphinid remains from Namu is so low that little interpretative weight can be given to their percentage representation.

Period 3 - 6000 - 5000 cal. B.P.

Period 3 sees the first full development of shellfish gathering, with shellfish remains becoming the major component of the midden matrix. Detailed studies by Conover (1978) and visual assessment of the 1977 and 1978 excavations show a substantial increase in the use of shellfish, and a clear dominance of rock-dwelling species such as *Mytilus sp.* (mussel), *Balanus sp.* (barnacle), and *Thais sp.*(whelks). These are the species that would be expected to predominate as lower post-glacial sea levels exposed a rocky foreshore environment, which was still relatively unaffected by silt deposition from river estuary development.

The most significant change in the Period 3 fish assemblage is the sharp increase in salmon. During Periods 3 and 4, salmon completely dominate the recovered faunal assemblage. The increased emphasis on salmon is likely a function of their increased availability in the stabilized post-glacial environment (Fladmark 1975:207). During the period 6000-4000 cal. B.P., sea levels in the immediate site vicinity reached the limit of their post-glacial decline (Andrews and Retherford 1978:348). At this time, the Namu River, like other coastal streams, would have reached a stable gradient and downcut its bed sufficiently to reduce stream velocity and allow for peak salmon productivity (Fladmark 1975:204). Lower sea levels also would have increased the areal extent of the lower Namu River; studies of similar streams show the lower reaches to be the most productive spawning areas (Hunter 1959:854).

All other fish species were exploited to a degree roughly comparable to Period 2. The significant decline in rockfish *(Sebastes sp.)*, and to a lesser extent in greenlings (Hexagrammidae) is difficult to explain, but it may reflect lesser use of abundant but less predictable fish resources once salmon had become a reliable subsistence staple.

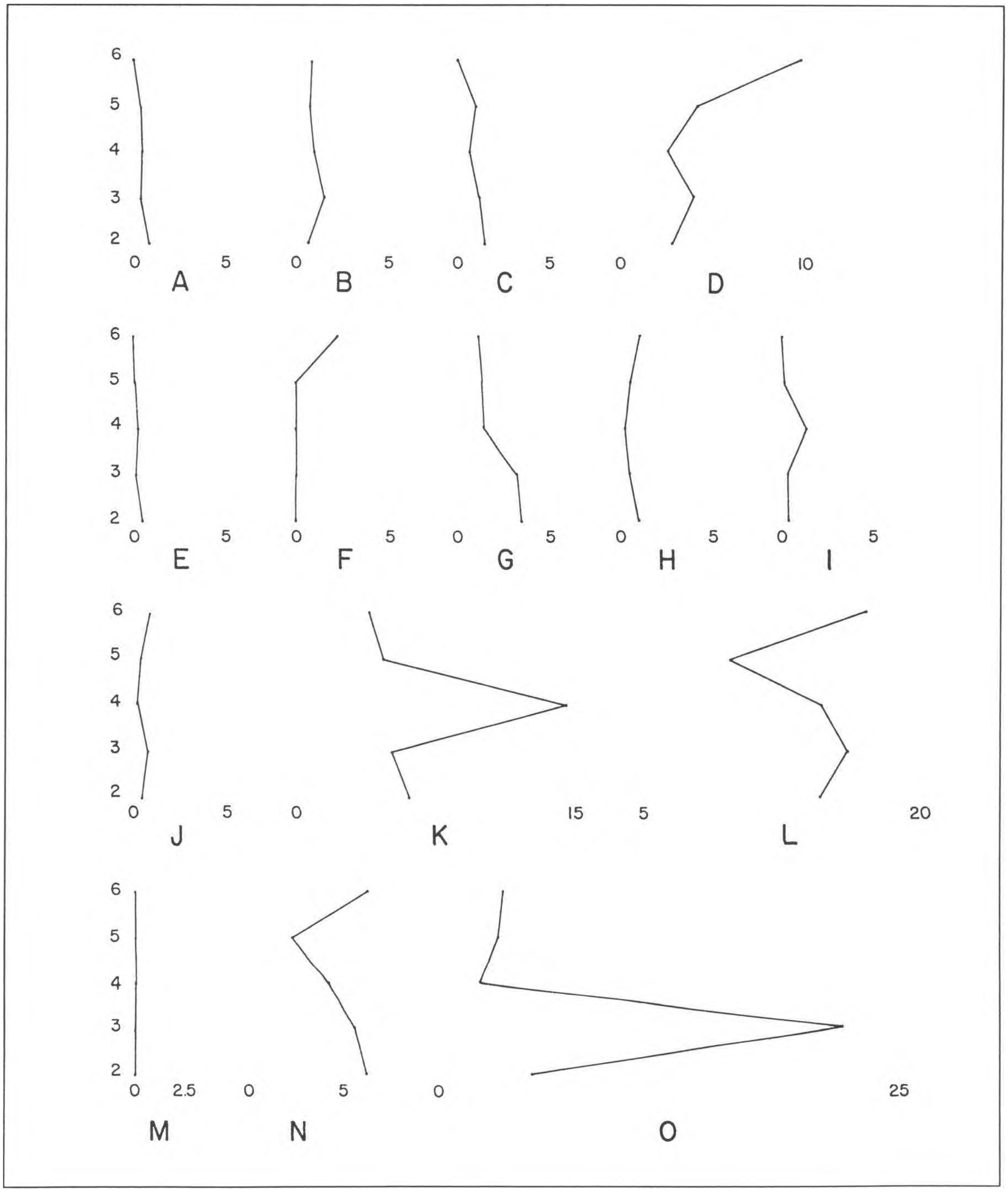


Figure 4. Temporal Trends in the Standardized Abundance of Mammal and Bird (A - *Castor canadensis*, B - *Erethizon dorsatum*, C - Delphinidae, D - *Canis familiaris*, E - *Ursus americanus*, F - *Procyon lotor*, G - Mustelidae, H - *Lutra Canadensis*, I - *Enhydra Lutris*, J - Otariidae, K - *Phoca vitulina*, L - *Odocoileus hemionus*, M - *Oreamnos americanus*, N - Unidentified Mammal, O - Aves) [Figures in % of non-salmon vertebrate fauna].

The Period 3 bird and mammal assemblage includes the same range of species exploited earlier. The abundance of most classes of mammal is little changed from Period 2. The only significant difference from Period 2 is the sharp increase in the number of birds. Nearly 60% of all the bird bones recovered from the site come from Period 3 deposits. As the graph of temporal trends reveals (Fig. 4), this increase in bird remains is out of line with their generally stable abundance throughout all other periods. The strong implication is that the Period 3 bird remains represent a sampling anomaly. It was suggested in Chapter 3 that the spatial concentration of bird bone in the vicinity of the Central Main Trench may indicate a habitation area, where the remains of birds that had been processed as soup were immediately deposited. Any alternative explanation based on changes in environmental conditions or cultural preference would have to explain the subsequent decline in birds in Period 4, when environmental conditions were roughly comparable. In the absence of a satisfactory alternative the peak in birds is best explained as the result of sampling effects.

Period 4 - 5000 - 4000 cal. B.P.

The range of shellfish is consistent with Period 3. The dominant species are whelks, barnacles, and mussel, but the frequency of clam increases toward its peak and dominance in Period 5.

The Period 4 vertebrate faunal assemblage exhibits a number of significant changes from earlier periods. Among the fish there is evidence of a further increase in the exploitation of salmon. This may reflect a real increase in salmon exploitation as the local population became further dependent on the large-scale catching, processing, and storage of salmon for winter use. Alternatively, the increase could be more apparent than real. One possibility is that the water-screening of Period 4 deposits (see Chapter 1) increased the recovery of salmon relative to their recovery from Period 3 deposits. The standardization of salmon abundance relative to other fauna also could have exaggerated their apparent increase in Period 4. In any case the dominant emphasis on salmon is consistent with that of Period 3, and any increase in emphasis would have to be viewed as a continuation of the trend that began earlier.

The Period 4 assemblage exhibits a significant increase in the abundance of herring *(Clupea harengus pallasi),* which far exceeds earlier or later levels. Low sea levels may have enhanced spawning conditions in the Namu Harbour, but the availability of herring should have been comparable in Period 3. Unless the increase is entirely due to the increase in water-screening, the increase in herring may reflect a response to population growth, which was predicated on the abundance of salmon. The predictable abundance of herring in the spring would have provided a significant food supply to a population dependent on dwindling supplies of winter salmon. The increased use of supplementary fish resources is seen to a much lesser extent in the increase in rockfish *(Sebastes sp.)* and cod (Gadidae), but trends in the utilization of these relatively minor fish resources are too erratic for substantive interpretation. Most other minor fish species show levels of abundance comparable to other periods, though the decline in some species can be taken as an indication that screening effects were not solely responsible for changes in the Period 4 fish assemblage.

Period 4 also sees a sharp increase in the abundance of harbour seal *(Phoca vitulina)* and sea otter (*Enhydra lutris).* Harbour seal are always much more abundant than sea otter, but the similarity in their temporal trends suggests that some common cause is at least partially responsible for their increase at this time. An expansion of their preferred habitat of rocky islets and reefs during the earlier decline in sea levels may have contributed to their increase in the area.

The dramatic increase in harbour seal also could be attributed to an increase in the availability of salmon and herring in the site vicinity, which would have provided food for a larger seal population. However, the consistency of environmental conditions between Periods 3 and 4 suggest that at least some of the increase in salmon, herring, and harbour seal was due to an enhanced cultural focus in Period 4.

Most of the rest of the Period 4 mammalian and avian assemblage is consistent with that of other periods.

Period 5 - 4000 - 2000 cal. B.P.

There are three major changes evident in the Period 5 shellfish remains: 1) an increase in shellfish volume (see Conover 1978:78); 2) a change in species composition from the primarily rock-dwelling species of mussel and barnacle to primarily silt- and sand-dwelling species of clam; and 3) a reduction in the degree of shell fragmentation and a consequent increase in the proportion of whole shell.

Many of the major changes in the Period 5 shellfish assemblage can be related to the conditions and consequences of the precipitous decline in the Namu salmon fishery, which is described below. The increase in shellfish volume likely represents an attempt to supplement food supplies in the face of declining salmon stocks. The maturation of the Namu River estuary (Conover 1978:82) and the buildup of fine-grain sediments in the site vicinity produced an ideal habitat for clam species, but it would have had a serious effect on salmon productivity. The rate of near-shore sedimentation likely increased after 4000 cal. B.P. when a moderate rise in sea level would have slowed the river outflow. The resulting increase in sedimentation appears to have been simultaneously responsible for an increase in the abundance of clam, a decrease in salmon productivity, and a possible reduction in the intensity of site occupation in Periods 5 and 6.

Conover (1978:98) noted a marked reduction in the degree of shell fragmentation in strata from the period between ca. 3000 and 1800 cal. B.P., as exhibited in the lower layers of the 1968 Front Trench. Many strata from this period are described as undisturbed layers of pure shell. Conover placed a narrow interpretation on these observations, describing them as evidence of reduced activity in this area of the site. An alternative explanation is that they reflect a reduction in the overall intensity of site settlement in Period 5. According to Conover (1978:98) this period represents a peak in site occupation, which was characterized by maximum shell deposition, increased variety of tool types, and proliferation of faunal species. However, as Conover suggests, the tool inventory may have been enhanced by the better preservation that resulted from the rapid buildup of untrodden shell. The proliferation of faunal species could represent an attempt to compensate for the loss of the salmon fishery and the decline in other important food resources. Failure to consider evidence of the salmon fishery seriously undermines Conover's interpretation of the site's economic prehistory.

The most significant change in the Period 5 fauna is the precipitous decline in the abundance of salmon. The decline is so abrupt and so complete that it suggests a near collapse of the Namu River salmon fishery. Around 3500 cal. B.P. the sea level on the Central Coast began to rise to its present level, which is at least three metres higher than the lowest post-glacial level (Andrews and Retherford 1978:348). This sea-level rise would have had a serious effect on the spawning beds of the Namu River. The lower reaches of coastal streams often provide the most productive chum and pink salmon spawning beds (Hunter 1959:854), and the lower sea levels of Periods 3 and 4 would have produced the maximum extent of these prime spawning areas. The subsequent rise in sea level would have greatly reduced the area of spawning beds.

A more damaging effect of a rise in sea level would have been the increase in sedimentation of the lower river. As the sea level rose, the river flow near the mouth would slow, causing the river to drop much more of its sediment load in its lower reaches. Sedimentation of spawning beds has an extremely deleterious effect on salmon-stream productivity (Hall and Lantz 1969:369; McNeil 1969:109), and the water flow in the upper Namu River is generally too swift to provide productive spawning areas. Contemporary escapement figures show the Namu River to be only low-to-moderately productive as a salmon stream (Pomeroy 1980:184).

Herring also exhibit a sharp decline in Period 5, which might be partially explained by changes in the foreshore environment. Sedimentation, rising sea levels, or both might have had some effect on the productivity of the herring fishery, but the evidence needed to assess the effects on herring is not available.

The ratfish *(Hydrolagus colliei)* exhibits a significant increase in Period 5. Although there is very little information concerning Native uses of this fish (see Chapter 2), its Period 5 abundance could be explained as the increased exploitation of a marginal marine resource at a time of need, though the lack of a general increase in other fish species and the unlikely use of ratfish as an important food resource argue against such an interpretation. The increase in ratfish is more important as an indication of the nature of environmental change in the site vicinity. The preference of ratfish for shallow water over a muddy bottom (Carl 1973:20) and its main diet of clam (Hart 1973:67) suggest that the increase in ratfish is further evidence of increasing sedimentation of the foreshore environment. The Period 5 fish assemblage exhibits increases in the abundance of several classes of fish that might have served to supplement the declining salmon and herring resources. Rockfish and greenlings show significant increases in Period 5. The abundance of dogfish also begins to increase at this time. Some Period 5 increase in the variety of marine species and the technologies used in their exploitation is supported by evidence from earlier site excavations (Hester 1978:102). It was suggested that this was an indication of a peak in the marine-fishing economy (Conover 1978:98; Luebbers 1978:62), but it is more suggestive of the need to expand the subsistence base in the face of a decline in the earlier economic mainstay.

The mammalian fauna provide further indications of a general economic decline in Period 5. The most significant decrease is in the number of harbour seal. The decline in harbour seal and sea otter may be partially due to the loss of an exposed rocky habitat due to the rise in sea level, though both species were more abundant in Period 2 when sea levels were as high or higher. Their decline in Period 5 must be due to more than the reduction of suitable habitat. Over-exploitation of harbour seal and sea otter during Period 4 might have contributed to their decline, and the loss of salmon and herring also could have contributed to the decline in harbour seal. In any case, the loss of harbour seal would have had a major impact on an already declining subsistence economy.

It might be expected that a reduction in harbour seal would result in increased emphasis on other mammalian species, but the Period 5 faunal assemblage indicates a decline in most categories of mammalian fauna. Even deer *(Odocoileus hemionus)* are reduced from their stable abundance in other periods. The implication is that there was a general reduction in sea- and land-based hunting. The further implication is that the loss of salmon did not simply encourage a shift to alternative resources, but instead encouraged the exploitation of resources such as fish and shellfish, which were most readily available and offered the surest return for labour invested. A smaller scale of site settlement may have discouraged greater investment in potentially low-return hunting expeditions.

Many of the characteristics of the Period 5 assemblage that indicate a decline in economic activity and a reduction in the scale of site settlement are more pronounced in Period 6.

Period 6 - 2000 cal. B.P. - Contact

Specific changes indicated in the Period 6 faunal assemblage must be viewed with caution since the assemblage size is very small and more subject to sampling distortion. The 1977 and 1978 excavations were also restricted to deposits dating to the early part of Period 6, and it is difficult to determine whether they fairly characterize later developments at the site. Nevertheless, the recovered Period 6 fauna indicate further decline in the scale of economic activity and site occupation

The Period 6 shellfish remains exhibit many of the characteristics evident in Period 5. Shell content is high, species of clams predominate, and many of the early Period 6 deposits consist of nearly pure lenses of whole shell. There is an overall decline in most classes of vertebrate fauna.

Salmon continues its decline to very low levels, and there is a decrease in the abundance of most other classes of fish. A notable exception is the continuing dramatic increase in the abundance of ratfish, which may reflect further sedimentation of the salmon spawning habitat. Dogfish also continue to increase, which probably indicates their increasing use as an emergency food supplement. The decline in groups such as rockfish is difficult to explain, but it seems to reflect a further reduction in economic activity.

Harbour seal are almost absent from the Period 6 mammalian assemblage. Only deer show a significant increase among potential food resources, and that increase may be exaggerated by the percentage decline in most other vertebrate fauna. A similar effect is probably responsible for the apparent increase in dog remains. There is a minor increase in the number of river otter *(Lutra canadensis)*, but it is difficult to account for this increase since there is a decrease in every other category of fur-bearing mammal. The increase in river otter may represent an attempt to replace the loss of sea otter, but there is no evidence to support this conclusion.

Although still rare, the number of raccoon *(Procyon lotor)* increases substantially. Raccoon is not a significant subsistence resource, but it may be evidence of less intense or more intermittent site occupation. The only other occurrence of raccoon in the 1977 and 1978 excavations is a single element from Period 3, and Conover (1978:86) also noted a lack of raccoon in the midden prior to ca. 2500 cal. B.P. Unless there was an unprecedented cultural focus on raccoon, there must have been either a general environmental change that extended their range to this area of the coast, or a specific change in the site environment that encouraged or at least allowed for the presence of raccoon. There was no change in climate or vegetation that would account for the increase in raccoon (Hebda and Mathewes 1984). It is more likely that their appearance indicates a specific change in the site environment. Rising sea levels are unlikely to have had a direct effect on raccoon, but smaller-scale or more intermittent human settlement might well have encouraged the encroachment of raccoon.

Conover's (1978:86) suggestion that raccoons were tolerated as scavenging competitors with Native dogs seems extremely unlikely unless the number of dogs in the settlement was greatly reduced from earlier periods. The consistent presence of dog remains argues in favour of periodic abandonment of the site as the reason for the raccoon encroachment. The occurrence of complete, articulated raccoon skeletons (Conover 1978:86) further suggests that the carcasses were left undisturbed during the periodic absence of the human residents.

The relative abundance of eagle *(Haliaeetus leucocephalus)* bones in Period 5 and 6 deposits (see Table 8) is further evidence of scavenger encroachment on the site. Eagles would be less likely to approach the immediate vicinity of a large and active settlement, but might be more common near a smaller or less continuously occupied settlement.

In contrast to earlier periods, Periods 5 and 6 saw increased exploitation of minor fish species and an increased emphasis on shellfish, particularly clams. This shift in economic focus probably represents an effort to compensate for the precipitous decline in salmon, herring, and harbour seal, which had been key resources in the earlier subsistence economy. However, these alternative resources certainly would not have been able to support the scale of earlier settlement. The subsistence economy underwent overall reduction from an earlier, large-scale, communally-based system to a smaller-scale, individually-based system. In terms of ethnographically-recorded settlement patterns, the shift was probably equivalent to a change from a large, multi-family village to a smaller band or extended family settlement.

Less intensive site occupation is indicated by the undisturbed deposits of whole shell, the low numbers of vertebrate fauna, and the increase in scavengers such as raccoon and eagle. A variety of evidence counters Conover's view that the late period fauna simply reflect a shift in activity focus to other parts of the site. Firstly, the character of the Periods 5 and 6 fauna is consistent in several different areas of the site, including the 1968 and 1977 Central Main Trenches, the 1977 Main North-South Trench, the 1978 Rivermouth Trench, and the basal levels of the 1968 Front Trench; in none of these excavations was there any indication of an alternate centre of more intense activity. Secondly, many fauna, particularly species of fish, are more abundant in these periods, which indicates that sampling effects are not responsible for the reduction in other classes. Finally, the characteristics of the late period fauna are consistent with an increase in the sedimentation of the site environment, which would have forced a shift in local economic emphasis.

All of the faunal changes could be explained as the result of culture change, but this is a particularly weak explanation given the complex of features involved. The reduced focus on previously important subsistence resources, the continued exploitation of the same range of species, with generally the same technological complex, and the increased emphasis on an unusual range of marginally important species including raccoon, eagle, and ratfish are unlikely to be due to any conceivable pattern of culture change. A pattern of resource decline and a consequent reduction in the scale of site settlement provides a better account of the available evidence.

TEMPORAL TRENDS

Temporal trends in faunal utilization must be set against the backdrop of continuity in resource range and emphasis. Against this backdrop dramatic fluctuation in minor resources such as rockfish *(Sebastes sp.)* are apparent but difficult to explain. Other sharp fluctuations, such as the Period 3 increase in birds can be explained away as the result of sampling effects. What remain are three classes of significant temporal change in the site economy, which include: gradual long-term shifts in species abundance (e.g. the increase in clam relative to mussel, and the gradual decline in fur-bearing mammals); major changes in economically important classes of fauna (e.g. the increase and subsequent decline in salmon, herring, and harbour seal); and coincident changes in faunal abundance that point to a single underlying set of environmental changes and cultural adjustments (e.g. the increase in silt-tolerant ratfish and clam, the decline in salmon, and the reduction in site settlement).

Most of the Namu faunal trends point to shifts in resource availability as the result of changes in the local site environment, though there are indications of cultural transitions that are more than a simple function of environmental conditions. In addition to the obvious implications for the site economy, these trends have wider implications for the interpretation of economic transitions on the Northwest Coast, though it would be a mistake to generalize too far on the basis of a single site.

The following discussion summarizes trends in the major taxonomic categories of shellfish, fish, and mammal, which taken together provide a summary overview of the prehistoric Namu economy.

Shellfish

A quantitative analysis of shellfish exploitation is not presented here, but there are obvious temporal trends in shellfish utilization, which are important to any discussion of the subsistence economy. The rarity of shellfish in Period 2; the increased utilization of shellfish after 6000 cal. B.P.; the changing species composition of shellfish remains, particularly after 4000 cal. B.P.; and the increase in whole, unmixed shell deposits in Period 6 are all trends that require further consideration and explanation.

Fladmark (1975:246-253) discusses a number of possible explanations for the scarcity of shellfish remains in Northwest Coast sites prior to ca. 6000 cal. B.P. He concludes that a lack of available shellfish resources was not responsible, since there is evidence that shellfish have been present in all coastal areas throughout the post-glacial period. Fladmark also dismisses suggestions that coastal inhabitants simply had not developed the cultural adaptation that would enable them to exploit shellfish resources. Fladmark (1975:253) explains the initiation of large-scale shell midden accumulation as "the result of a shift to the winter village settlement pattern following the development of peak salmon productivity". Once full reliance on salmon allowed large-scale population aggregates to become the prevalent settlement pattern, it was necessary to make use of shellfish in order to maintain large aggregates when preserved salmon were in short supply. Without salmon large aggregates would not be possible, and without large aggregates intensive exploitation of shellfish was not necessary. The fact that shellfish often were not collected in winter is not a relevant point against Fladmark's overall argument. Shellfish could be gathered in summer and preserved for winter use or gathered in the late winter and spring to extend the winter supply of preserved salmon until the first runs of the new season (see further discussion of this point in Chapter 6).

The subsistence value of shellfish and the conditions promoting their use following the end of the Pleistocene are subjects of world-wide debate (see Bailey and Parkington 1988). As generally documented on the Northwest Coast, the build-up of shell midden deposits is associated with the greater productivity and increased use of salmon (Fladmark 1975), though there are local exceptions (e.g. Mitchell 1988). At Namu the association between salmon and shellfish is clearly in evidence. Whether this is a simple function of population increase or the more subtle effects of an enhanced salmon fishery is a question that is considered below and in more detail in Chapter 7.

From the time that shellfish gathering was established as a major component of the Namu subsistence economy the most significant trend was the change in shellfish species composition from primarily rock-dwelling species such as mussel and whelk to primarily sand- and silt-tolerant species of clam. This transition in species composition is a pattern that is repeated at a number of localities on the Northwest Coast, including the Glenrose Cannery site in the Fraser Delta (Ham 1976:59) and sites on the Gulf Islands (Mitchell 1971:182). In all of these cases there is agreement with Conover (1978:82) that the explanation is stabilization of the marine/land interface and maturation of river and stream estuaries.

Wessen (1988:199-200) outlines a number of alternative explanations including human over-exploitation, which have been proposed to account for similar transitions in shellfish species at other Northwest Coast sites. Alternative explanations for the Namu transition have not been specifically evaluated, but the correspondence with changes in other fauna (e.g. the increase in ratfish and decrease in salmon) supports the interpretation of increased sedimentation of the near-shore environment. At Namu, it is likely that sedimentation of the inner harbour accelerated with the moderate rise in sea level after 4000 cal. B.P. The Period 5 increase in shell volume and the proportion of unbroken shell is likely the result of the precipitous decline in the salmon fishery, which would have increased demand for supplemental food resources such as shellfish. The rapid build-up of shell deposits, and a possible reduction in the scale of site settlement would have reduced the mixing and crushing of shell deposits.

Fish

Salmon dominates the identified fauna from every period of site occupation; its subsistence contribution was only rivaled by herring, and later shellfish. The importance of salmon in the ethnographically-recorded Northwest Coast economy was derived from its capacity for preservation and storage, which made it the economic mainstay that allowed for much of the elaboration of Northwest Coast culture and society. It is clear that salmon was equally important to the Namu subsistence economy, and variation in the local availability of salmon had a major impact on the entire course of prehistoric occupation of the site.

From the earliest period for which data are available, salmon and herring were the major subsistence resources, and their importance in Period 2 was enhanced by the low level of shellfish exploitation. The scale of salmon fishing increased dramatically around 6000 cal. B.P., when relatively stable sea levels allowed for full productivity of the Namu salmon fishery. This was also the initial period of full-scale shellfish exploitation. Salmon and shellfish appear to have been integral to the establishment of large-scale settlement at the site. During Period 4 the emphasis on salmon may have increased still further (Fig. 3), though the increase is insignificant if the abundance of salmon is taken as a percentage of all identified fauna (Period 3 - 92.15%, Period 4 - 94.43%). With the precipitous decline of the salmon fishery after 4000 cal. B.P. there was a reduction in the scale of site settlement and greater emphasis was placed on more readily available resources such as clam and minor fish species. The later Namu settlement may have been limited to a seasonal campsite (see Conover (1978:98-99) for a discussion of the latest periods of site occupation).

The initiation and collapse of the Namu salmon fishery is easily read as a function of changes in sea level and the consequent effects on salmon-stream productivity. The slight increase in salmon between Periods 3 and 4 is more difficult to explain. The implication is that there was increased cultural emphasis on salmon. Although quantitative assessments are lacking, there is comparable evidence for increasing utilization of salmon in the Fraser Delta (Boehm 1973:74; Matson 1976:96), as for example at the St. Mungo Cannery site, where the increase in salmon was matched by a decrease in the abundance of other fish species (Boehm 1973:74).

The other major food fish at Namu was herring, which is consistently abundant in Periods 2, 3, and 5. Its absence in Period 6 may be due to the low recovery of faunal remains from those deposits. The substantial increase in Period 4 stands out as an important development in the fishing economy of the site. It is difficult to estimate the abundance of herring, but based on the quantities of herring bone recovered from selected matrix samples (Fawcett: Appendix C) it is clear that herring was a major subsistence resource in all periods, with the possible exception of Period 6.

The five-fold increase in the percentage of herring bone in Period 4 suggests a substantial increase in the local reliance on herring as a food resource. However, several other considerations must be taken into account. More water-screening of Period 4 deposits relative to Period 3 (Tab. 6) may have increased the recovery of herring, though this would not account for the lower numbers of herring from Periods 2, 5, or 6. In addition, the use of pressurized water hoses to screen the material probably forced many herring bones through the 1/8 inch (3.2 mm.) screen, thereby reducing their recovery as much as it was enhanced by any greater visibility. The evidence from the matrix samples is inconclusive, but it also indicates a significant increase in herring in Period 4 (Fawcett: Appendix C). If the increased recovery of herring reflects its increased use, then this shift in economic emphasis must be explained.

The possibility of an enhanced Period 4 environment for spawning herring is not suggested by any of the available evidence. Sea level conditions were comparable to Period 3. The lack of a clear environmental explanation suggests the greater likelihood of an increased cultural focus on herring in Period 4. Although archaeological evidence is unavailable, one possibility is that an increase in settlement size put greater subsistence pressure on the local population by the late winter/early spring timing of the herring spawn. Such a situation might have forced greater investment in the herring fishery. A subsequent reduction in the scale of site settlement following the decline of the salmon fishery would then account for reduction of the Period 5 herring fishery to previous levels.

There are few clear trends in the use of other fish classes, with the exceptions of dogfish and ratfish. All species apart from salmon and herring make a relatively modest contribution to the local fishing economy, and it would be a mistake to accord too much significance to their variable abundance over time. The combined percentage of fish other than salmon, herring, and ratfish does not exhibit dramatic fluctuations over time (Period 2 - 46.0%, 3 - 27.4%, 4 - 41.9%, 5 - 58.0%, 6 - 32.8%), despite the sometimes significant variation in species composition. The decline in Period 3 may indicate less reliance on minor fish resources in the early stages of intensive salmon production. The slight increase in Period 5 may indicate an attempt to compensate for declining salmon stocks, while the decline in Period 6 marks the overall reduction in economic activity at the site. Beyond these observations there is little that can be inferred from the erratic changes in minor fish-class abundance. Dogfish are only notable for their tendency to occur in roughly inverse proportion to salmon, which may suggest their use as a food supplement during times of shortage, as suggested by recent Kwakiutl ethnography (Rohner 1967:17).

The substantial increase in ratfish in Periods 5 and 6 can be explained as part of the suite of faunal changes that indicate increasing sedimentation of the Namu River estuary and harbour area. However, despite the lack of ethnographic evidence to document its use as a food resource, it is still necessary to explain the presence of ratfish remains in the midden deposits. Ratfish were caught, kept, and used throughout the site occupation. Their increased abundance in Periods 5 and 6 may have been predicated on increased availability, but it also indicates that ratfish were increasingly utilized during this time period. One possible explanation is that ratfish were necessary to compensate for the reduction of fat in the diet due to the decline in salmon, herring, and harbour seal. The oil-rich ratfish could have become an increasingly important source of this critical dietary component.

Mammal

The utilization of most classes of mammalian fauna show little significant change over the entire period represented by the vertebrate fauna data. Deer is most common in all periods, and it was consistently exploited, with the exception of the anomalous decline in Period 5. The Period 5 decline may be a sampling effect, since it is followed by full recovery to earlier levels of exploitation. Alternatively, the decline in deer could be interpreted as consistent with an overall economic decline, possibly reflecting reduced demand for raw materials and reduced ability to mount high-risk, low-return hunting forays. The subsequent increase in deer in Period 6 can be explained as a result of the percentage decrease in most other classes of vertebrate fauna. The implication would be that deer hunting was still much below its earlier intensity.

The sharp Period 4 peak and subsequent decline in harbour seal would have had a profound effect on the subsistence economy. The increased exposure of reef habitats as the result of lower sea levels during Periods 3 and 4 could have contributed to a real increase in the local harbour seal population, though it is difficult to explain why the increase would not have occurred in Period 3. An increase in salmon in Period 4 could have attracted more seal to the site area, but the Period 3 salmon increase did not have a similar effect. The only possible environmental change specific to Period 4 that might be relevant is the increase in herring. If the herring increase reflects an actual increase in local availability, then it is conceivable that herring would attract larger populations of harbour seal to the site region. If the increase in herring is a function of cultural emphasis then the same explanation probably accounts for the greater exploitation of harbour seal.

If harbour seal hunting coincided with the pupping season in mid-June (see Chapter 6) then the Period 4 fauna indicate an increase in economic activity at strategic seasonal intervals – salmon in late fall, herring in early spring, and harbour seal in late spring. An increase in the scale of site occupation in Period 4 could have increased the demands on seasonally abundant resources. If so, then the Period 4 faunal assemblage points to a peak in site settlement between 5000 and 4000 cal. B.P.

Although it was less important to the site economy it is worth noting that sea otter also exhibit a peak in Period 4, though the increase and subsequent decline is far less dramatic. It is likely that this trend is more a simple function of increased availability at a time of minimum sea levels and maximum exposure of rocky islets and reefs in the immediate site vicinity, though the increase over Period 3 remains unexplained.

The only other noteworthy trend in the mammalian faunal assemblage is the gradual but steady decline in the abundance of fur-bearing species. Although their combined numbers are never very large there is a clear trend in the combined percentage abundance of beaver, bear, small mustelid, and river otter (Period 2 - 5.5%, 3 - 4.2%, 4 - 2.2%, 5 - 2.3%, 6 - 2.2%). Over-exploitation could be held responsible for some of this decline, though an increase in later periods might be expected if there was a decrease in the scale of site settlement. The fact that the decline in fur-bearing mammals occurs over such a long time span suggests that a gradual reduction in cultural demand is more likely than a decrease in species availability. Why such a reduction should have occurred is difficult to explain, and the significance of this trend will depend on similar findings from other sites and regions of the Northwest Coast.

Summary

A few major shifts in economic emphasis account for the bulk of the changes in the Namu fauna-based economy. From a well-established settlement dependent on a marine-based economy as early as 7000 cal. B.P., the settlement and its economy expanded with the enhancement of salmon productivity, which occurred between ca. 6000 and 4000 cal. B.P. This economic expansion put increased emphasis on the use of shellfish, and later contributed to the intensified exploitation of seasonally abundant salmon, herring, and harbour seal. Following a sharp decline in salmon after 4000 cal. B.P. the settlement and scale of economic activity was much reduced. After 4000 cal. B.P. there was a reduction in large-scale communal activity such as salmon fishing and processing, and some decline in high risk, low return activities such as large mammal hunting. With the reduction in economic activity and inferred reduction in site settlement, more marginal but predictably abundant resources such as clams became an increasingly important part of the subsistence economy.

All the major changes in the Namu economy were centred around one or another of the abundant resources of the marine environment. Given the consistent marine orientation of the economy, it seems hardly worth considering the question of a marine versus terrestrial economic focus. However this question has long played a key role in discussions of Northwest Coast culture history, and therefore the relevance of the Namu evidence for this question is briefly reviewed below.

ECONOMIC ORIENTATION

Interpretations of faunal transitions evident at other Northwest Coast sites present a common pattern of a terrestrial economic focus gradually giving way to an increasingly well-developed maritime adaptation. The implication is that a full maritime focus was a relatively late development in the region's culture history. The Namu data clearly do not support this pattern of shifting economic focus. The Namu economy was fully maritime from at least the time that faunal data are available at around 7000 cal. B.P. Nevertheless, it is still worth presenting the Namu data as a contrast to economic transitions in other areas of the coast.

Sea Mammal Versus Land Mammal

In relation to their subsistence contribution, mammalian remains have received an unwarranted amount of attention in the published reports of Northwest Coast site excavations. Fishing and shellfish gathering were the mainstays of the Northwest Coast subsistence economy in the ethnographic present and throughout most if not all of prehistory. Hunting was at most a supplementary subsistence activity, at least from the time that intensive salmon fishing was fully established. Nonetheless, the relative proportions of land and sea mammal remains in the faunal assemblages from Northwest Coast sites provide a source of interest and debate concerning regional cultural traditions.

In a survey of published reports from Northwest Coast sites, Boucher (1976:116-123) notes a tendency for land mammals to predominate over sea mammals in early periods, with the proportion of sea mammal gradually increasing over time. In a more recent survey of faunal data from sites in the Queen Charlotte Strait region of British Columbia, Mitchell (1988) describes an early emphasis on land-mammal species such as deer and elk, which was followed by a period that saw greatly increased ratios of sea- to land-mammal remains. Mixed trends or consistent species utilization over time is indicated for other regions of the Northwest Coast, but from the Queen Charlotte Strait evidence Mitchell infers a major cultural shift in the form of an intrusion of peoples adapted toward greater exploitation of salmon and sea mammals.

Borden's (1975) earlier reconstruction of prehistoric cultural affinities and transitions was also based in part on temporal and spatial variations in the relative emphasis on sea and land-mammal hunting. Following Conover's (1972:283) report of the early presence and increasing abundance of sea-mammal remains at Namu, Borden (1975:28-32) proposed an early Northern Boreal culture type on the northern coast, which had developed the beginnings of a maritime adaptation. In contrast, Borden (1975:39,84-85) proposed that the south coast was inhabited by an early Protowestern culture type, which had a subsistence focus centred on land-mammal hunting, as at the Glenrose Cannery site (Matson 1976:297). Croes and Hackenberger (1988:54) also note a common pattern of economic change on the southern Northwest Coast, in which an early (pre-5000 b.p.) emphasis on land mammals such as deer and elk is followed by decreased use of land mammals and increased use of shellfish, fish, and sea mammals.

In contrast to Borden's cultural explanation for an early land-mammal based economy on the south coast, and greater emphasis on sea mammals on the north coast, Fladmark (1975:260-262) proposed an environmental explanation, which focussed on the availability of species resulting from lower sea levels in the south and higher sea levels in the north. In short, lower sea levels expanded land-mammal habitat in the south, while higher sea levels diminished similar habitat in the north.

The Namu data do not provide a clear picture of shifting emphasis from land to sea mammal or vice versa; they indicate a consistent though minor focus on deer throughout the site's occupation. At no time in the site's economic prehistory was there a significant emphasis on hunting deer. Given the availability of marine resources and the successful adaptation to their use, the minor focus on deer is not surprising. In contrast to the consistency of deer, the abundance of harbour seal changes dramatically. However, the changes in sea mammal abundance, as represented primarily by harbour seal, are very specific and related to local environmental and economic conditions; they do not represent any long-term cultural or economic transitions in the region.

It is possible that the methods used to quantify faunal class abundance (e.g. minimum number of individuals, number of identified specimens, meat weight, species variety, etc.) have contributed to the varied interpretations of coastal economic orientations. Based on the number of identified specimens and the percentage abundance of identified fauna, there are no trends in economic orientation at Namu that are comparable to those reported from sites on the south coast.

Particular problems in comparing the proportions of sea and land mammal also may arise because the categories are too broad for meaningful comparison; they encompass a variety of different species from various habitats, including species that were ultimately used for many different purposes. However, even when comparisons are restricted to major food resources such as deer and harbour seal it is misleading to contrast the emphasis on mammalian resources in isolation from the overall subsistence economy, which was primarily based on fishing and shellfish gathering.

Marine Versus Terrestrial Focus

The problem of determining the degree to which the Northwest Coast economy was focussed on marine or terrestrial resources is more general than the problem of sea-mammal versus land-mammal exploitation. At issue is whether the overwhelming marine orientation recorded ethnographically developed in relatively recent times or was fully established from an early point in time. Recent analysis of Northwest Coast burial populations (including individuals from Namu) (Chisholm et al. 1983) shows that as early as 5000 cal. B.P., as much as 100%

of dietary protein was derived from marine resources. These results are consistent with the Namu faunal remains, which also indicate an overwhelming subsistence emphasis on marine resources.

All species of fish, especially salmon and herring, are important from the earliest time periods. Sea mammals and marine birds are also important from this time. From around 6000 cal. B.P., the focus on salmon, herring, and shellfish is fully developed, and accounts for the overwhelming majority of the fauna-based diet. The only significant source of terrestrial protein at any time is deer, but for most periods the number of deer, though relatively high for any single class of mammal, is insignificant in comparison to the dietary contribution of marine resources.

The results of carbon isotope analysis of 13 adult Namu burials, dating to between 5100 and 3000 cal. B.P., showed that marine-based sources accounted for 93-100% of total dietary protein intake (Chisholm et al. 1983:397). The 100% figures were all from Periods 3 and 4 burials, which is not surprising in light of faunal trends. Period 3 saw the inception of large-scale shellfish gathering and intensive salmon fishing. Period 4 saw the marine focus enhanced through increased use of salmon, herring, and harbour seal. Although deer was hunted in significant quantity throughout the site occupation, its potential dietary contribution was completely overshadowed by the contribution of the marine-based fauna. The Period 5 decline in salmon may account for the slightly lower percentages of marine-based dietary protein recorded for the later Namu burials.

Although species composition changed through time, the orientation of the Namu diet was always directed toward marine resources. Terrestrial sources of protein, principally deer, may have been slightly more important prior to 6000 cal. B.P., but from the time that the characteristic Northwest Coast subsistence economy based on salmon and shellfish was established terrestrial sources made little appreciable contribution to the diet. A well-established cultural orientation and adaptation to using the resources of the sea is evident from the beginning of the faunal record at 7000 cal. B.P.

CONCLUSIONS

Although Namu may have been occupied as early as 11,000 cal. B.P. (see R. Carlson: Appendix B), faunal data are only available for the period beginning about 7000 cal. B.P. These data show the full development of a marine-based economy, which possessed the technology and expertise necessary to exploit the widest range of marine and terrestrial resources. The earliest marine resources included the range of sea mammals (off- and near-shore), all varieties of fish (from a range of habitats), large numbers of salmon and herring, and limited quantities of shellfish. Despite exploitation of this full range of available resources, Period 2 can still be characterized as part of an initial phase in the development of the marine economy. There was less emphasis on the environmentally-restricted salmon resource and very little use of shellfish. Shellfish only became important once predictable supplies of salmon allowed for larger and possibly more permanent population aggregates at the site. The Period 2 occupation was probably below the peak intensity of later periods.

Periods 3 and 4 (6000-4000 cal. B.P.) exhibit the peak in economic activity, when salmon, herring, and shellfish became the dominant resources. The timing and the nature of this economic transition are in perfect agreement with Fladmark's (1975) suggestion of a palaeoenvironmental basis for changes in the Northwest Coast subsistence economy. Sea-level stabilization enhanced the productivity of salmon and allowed an increase in settlement size, and larger settlements made it necessary to meet shortfalls in salmon supplies through the increased exploitation of shellfish and other predictable and readily available marine resources.

The increased use of salmon and shellfish by around 6500 cal. B.P. also characterized economic transitions on the South Coast of British Columbia, as exhibited in the Fraser Delta in the transition between the Old Cordilleran and St. Mungo phases at the Glenrose Cannery site (Matson 1976:19,96). In contrast, Mitchell (1988) describes a much later (ca. 2500-1700 b.p.) transition to intensive salmon fishing in the Queen Charlotte Strait region of the southern Central Coast, which he ascribes to cultural intrusion. If his analysis and interpretation of these faunal shifts is correct, then it represents an interesting contrast to the apparent cultural and economic stability exhibited at Namu, which is only 150 km. to the north. It would imply that a significant cultural contrast had been maintained over this relatively short distance for a period of 3000 years. This scenario is not improbable, but more site data are needed, and alternative explanations focussing on site-specific environmental changes also should be explored. For example, at Mitchell's Hopetown and Echo Bay sites the lesser early-period abundance of salmon is matched by much greater abundance of ratfish. In later periods when salmon is more abundant ratfish is virtually absent. The Period 5 increase in ratfish at Namu is associated with the precipitous decline in salmon, which together with changes in shellfish composition indicates increasing sedimentation of the Namu River estuary. It is at least possible that there was significant environmental change in the vicinity of the Queen Charlotte Strait sites that reduced the sedimentation of the local environment and enhanced the productivity of salmon. Mitchell's cultural explanation would require the inhabitants of his sites to ignore salmon in favour of ratfish; this is certainly possible, but probably unlikely.

The economic trends at Namu are clearly defined. From an early well-established maritime orientation in Period 2 there is an increase to peak economic activity, which corresponds with the Periods 3 and 4 increase in salmon. Periods 5 and 6 represent a significant decline in economic activity. Salmon undergo precipitous decline due to increasing sedimentation of the river estuary, and minor fish and shellfish resources were more heavily utilized. Reduction in the degree of shell fragmentation, and a number of other indicators point to less intense and possibly more intermittent occupation of the site at this time.

Namu's economic prehistory can be characterized as a continuous process of economic transition involving progressively greater emphasis on smaller-scale, more localized, abundant, and predictable resources, such as salmon, herring, and finally shellfish. This overall pattern is typical of observed and modelled trends in resource utilization on the Northwest Coast and in coastal environments in other parts of the world; these trends have been attributed to one or a combination of: changes in environmental availability (e.g. Fladmark 1975; Pfeiffer 1978:197-199); population growth and resource depletion (e.g. Croes and Hackenberger 1988; Keeley 1988:393); and cultural innovation (e.g. Hayden 1981) and tradition (e.g. Mitchell 1988). The implications of the Namu faunal data for understanding these wider issues in economic prehistory are discussed more fully in Chapter 7.

Apart from the characterization of general economic and environmental transitions, interpretations of the faunal data also must acknowledge the specific pattern of the Namu economy, which was clearly a function of local micro-environmental circumstances and resource availability. The most significant changes in the local environment were those that affected the productivity of the salmon fishery. Most other major economic trends were affected directly or indirectly by the availability of salmon, and any interpretation of the site's economic prehistory must stress the character of the salmon resource and its utilization. To further characterize the nature of the Namu salmon fishery the following chapter presents a detailed analysis of the recovered salmon remains.

CHAPTER 5

Salmon Studies

Salmon was a key element in the Namu economy. Therefore, a study was undertaken to determine whether the salmon remains could provide any additional information concerning the nature of the salmon fishery. The initial study concentrated on variations in the size of salmon vertebrae, which would indicate changes in the average size of fish. There was visual evidence of size differences in the vertebrae from different excavation levels, which might have indicated changes in fishing techniques (e.g. from spear to net) or salmon species. Variation in salmon size also could have represented significant shifts in the contribution of salmon to the subsistence economy. Although systematic measurements did not reveal any long-term trends in salmon size, the effort to explain the observed variability in salmon size provided evidence of the probable species composition and timing of the Namu salmon fishery.

SIZE ESTIMATION

To obtain an accurate estimate of the variability in salmon size, it was necessary to obtain samples of vertebrae from discrete temporal units. The period assemblages were too large to be useful in monitoring systematic patterns of change. Therefore, arbitrary excavation levels were used as the sampling units. Arbitrary levels cannot be placed within an absolute chronometric framework, but they represent a chronological progression, and they were convenient analytical units since the initial recovery of salmon remains was by 10 cm. excavation levels and the major stratigraphic divisions within levels. The salmon vertebrae from each excavation level were considered representative of the vertebrae from an associated time period, which could be roughly scaled against the chronometric framework of the dated carbon samples. The absolute time depth represented by each level varied, but this was not important for the analysis of long-term trends.

Analysis was restricted to a single 2x2 metre excavation unit (68-70S, 4-6W) from the Rivermouth Trench; it represented a long time span and was water-screened, which allowed for the maximum recovery of salmon vertebrae. This unit yielded the largest number of vertebrae per excavation level, and the larger sample was considered more representative of the overall salmon catch for an associated time period.

The quantity of vertebrae recovered from each level ranged from less than one hundred to several thousand, but it was only necessary to measure a small sample of the recovered vertebrae. Only caudal vertebrae were used in the analysis to avoid the introduction of size variation associated with different vertebra types. Based on the number of caudal vertebrae recovered from each level, and an estimate of the coefficient of variation in vertebra diameter obtained from test samples, a sample size was chosen that would provide a mean diameter estimate that was accurate to within 5% of the true mean with a reliability of 99.7% (Yamane 1967:88). The required sample sizes for this estimate ranged to no more than 92 for any one level. The vertebrae sample was selected by using a standard two-way soil-sample splitter to repeatedly divide the vertebrae sample until a number close to the required number was obtained. In every case the actual sample size was equal to or greater than that required for the desired accuracy.

A transverse measurement to within .005 mm was made on each of the selected vertebrae, and the median vertebra width was determined for each level. The median width was converted to an estimate of median fish weight through application of a generalized regression formula for predicting fish weight from the width of Oncorhynchus sp. vertebrae (Casteel 1974:178). This generalized formula does not account for the many factors that might influence the vertebra width/fish weight relationship (e.g. slight species or population differences), but it provides a reasonably accurate scale for measuring the relative differences in fish weight between levels. Because the relationship between vertebra width and fish weight is exponential, a relatively minor difference in vertebra diameter represents a proportionately much greater difference in fish weight. The estimate of mean fish weight therefore gives a better impression of salmon size variation between levels. The median weight of salmon from each excavation level is listed in Table 17 and plotted in Figure 5.

Figure 5 shows considerable variation in the median weight of salmon from different levels, but except for a pattern of periodic rise and fall, there is little indication of any shift in size over time that might indicate a change in climate, species composition, or fishing techniques. There were significant fluctuations in fish size, but to account for these it was necessary to consider more specific and shorter-term causal factors.

AGE AND GROWTH STUDY

Having determined that there were fluctuations in the average weight of salmon from different excavation levels, the next step was to determine the specific causes of this variation. Any number of factors might have been responsible, but the first and most obvious possibility was that the variation in weight was due to variation in the ages of the salmon. Salmon spawn at different ages within and between species, and the weight of a spawning salmon is directly related to its age (Henry 1954:18-21). If the age structure of the Namu salmon was consistent over time, then some outside factor (i.e. some feature of the environment) would have to have been responsible for variation in salmon growth rates. It was therefore necessary to estimate the average age of salmon from each excavation level and compare the age and weight estimates.

The counting of annuli (annual growth rings) on scales is a standard method for determining the age of fish. The technique has been applied in a large number of studies of contemporary salmon populations. Fish are also aged by growth rings visible on otoliths and vertebrae (see Chugunova 1963; Casteel 1976). For the present study only vertebra centra were available, but the annuli on salmon vertebrae are not clearly visible unless the vertebra is sectioned or specially treated. It was not practical to apply these methods to obtain an accurate reading of several hundred vertebrae, so an experimental study was undertaken to view growth rings through radiographic analysis (Cannon 1988).

The portable x-ray unit (Fischer model FP200) at the Department of Archaeology, Simon Fraser University was used for this purpose. A number of power, distance, and exposure time combinations were tried, but the best results were obtained with a radiographic output setting of 70 KVP at 20 MA for a 0.5 second exposure, with the vertebrae set directly on the x-ray film plate at a distance of 64 mm. from the x-ray tube. The developed plates showed that each vertebra displayed a number of clear, bright concentric rings interspersed with wider dark bands (Fig. 6). The narrow bright bands were interpreted as winter growth in contrast to the wider, dark summer-growth bands. The denser winter slow-growth rings were more radiopaque than the broader less-dense summer bands.

From the radiographs it was relatively easy to count the winter growth rings to determine the age of the fish. However, because the method was new and experimental it was necessary to conduct a number of test studies to determine whether the radiographically visible rings were seasonal growth annuli. A number of specific tests and evaluations were conducted toward this end. The first was a comparison with written descriptions of growth annuli (Chugunova 1963; Casteel 1976:78-83); these described structures that were very similar to the radiographically-visible rings.

Table 17. Median Estimated Fish Weight (kg.) and Age Profile of Salmon for 10 cm. Excavation Levels (in cm. Depth Below Surface (DBS)) of Unit 68-70S,4-6W (weight estimate based on Casteel 1974).

Level (cm. DBS)	Sample Size	Median Weight	Age Profile (% per Age Category)		
			1 winter	2 winters	3 winters
40 - 50	2	-	0	100	0
	36	5.87	5.5	86.1	8.3
	32	5.41	0	84.4	15.6
	23	5.20	0	87.0	13.0
	52	4.625	6.3	89.6	4.2
90 - 100	30	3.925	10.0	83.8	6.7
	41	4.89	2.4	92.7	4.9
	32	5.725	3.1	87.5	9.4
	68	4.625	1.5	97.1	1.5
	68	3.89	0	98.5	1.5
140 - 150	95	3.32	3.2	86.3	10.5
	92	3.69	1.1	81.5	17.3
	97	3.95	3.1	85.6	11.3
	89	5.61	1.1	88.8	10.1
	92	5.655	0	90.5	9.5
190 - 200	85	6.22	1.1	86.3	12.7
	92	4.66	3.3	96.7	0
	80	4.02	0	91.5	8.5
	80	4.97	2.5	92.5	5.0
	106	5.01	2.8	85.8	11.3
240 - 250	65	5.61	0	87.7	12.4
	72	4.515	0	90.3	9.7
	78	3.79	6.4	88.5	5.1
	94	2.75	7.5	90.3	2.2
	80	3.08	1.1	92.4	6.5
290 - 300	62	3.56	1.6	95.2	3.2
	47	3.32	4.8	83.3	11.9
	68	3.56	0	100	0
	15	3.32	0	100	0
	1	-	0	100	0
340 - 350	1	-	0	100	0

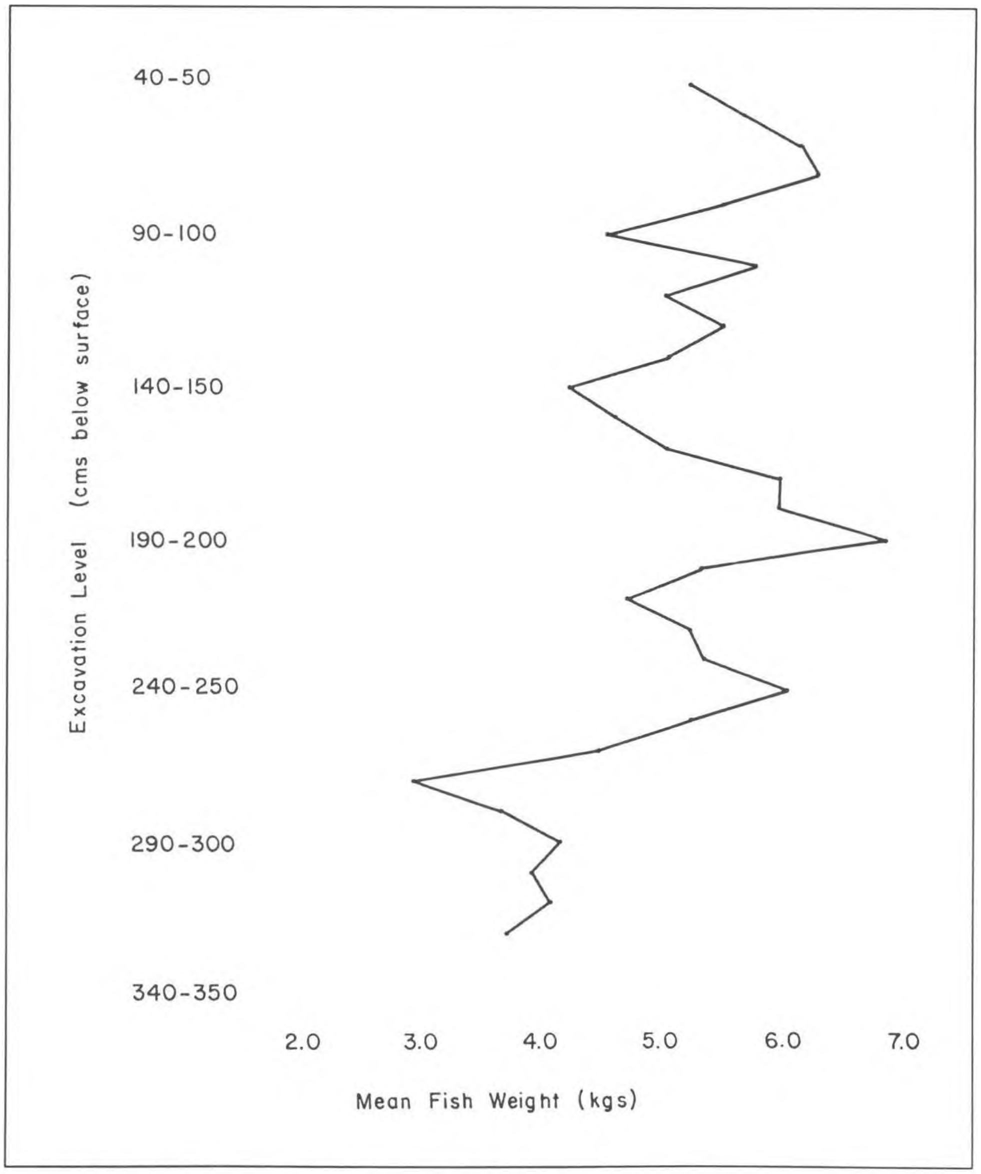


Figure 5. Variation in Median Salmon Weight by Excavation Level.

A number of comparative specimens of different salmon species were examined with the radiographic method; these included: 1) a specimen of chum salmon *(O. keta)*, which exhibited two winter-growth rings; 2) a specimen of pink salmon *(O. gorbuscha)*, which exhibited one winter-growth ring; and 3) a specimen of chinook salmon *(O. tschawytscha)*, which exhibited five winter rings. Each of these age determinations fell within the normal age range for mature individuals of these species. As a further test, two other specimens of chum salmon (*O. keta)* were aged by examining the winter growth checks on their scales. In both cases later radiographic age determination of the vertebrae agreed with the age estimate obtained from the majority of the readings from six different scales.

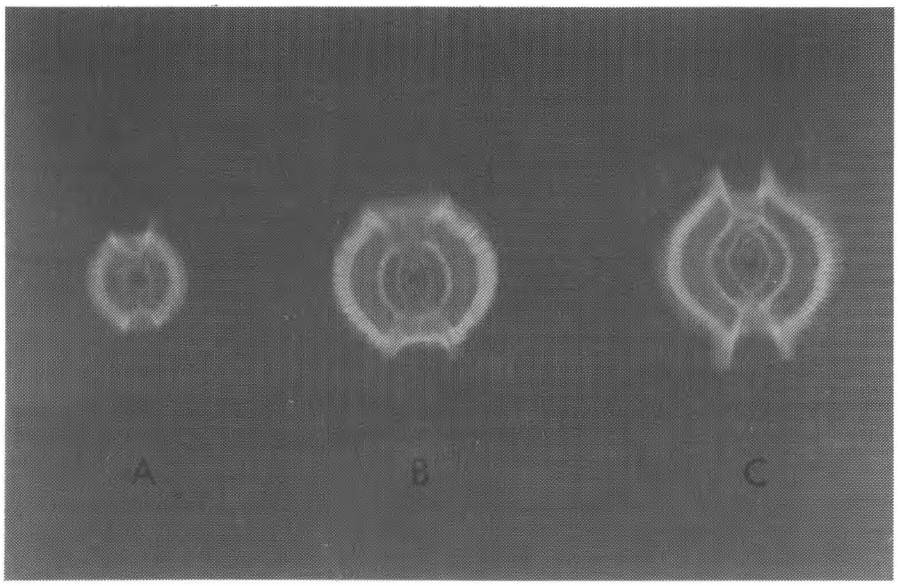


Figure 6. Radiograph of *Oncorhynchus sp.* Vertebrae Exhibiting: A - One Winter's Growth; B - Two Winter's Growth; C - Three Winter's Growth.

A final evaluation of the radiographically visible rings followed Chugunova's (1963:24) recommendation to estimate fish weight from the width of the first complete annulus. The generalized Oncorhynchus sp. vertebral width/fish weight regression formula (Casteel 1974:178) was used to convert the first annulus diameter to an estimate of fish weight. These weights were in complete agreement with observed average weights of Central Coast chum salmon at the end of their first winter's growth (Ricker 1964:917).

Although the radiographic method worked very well for salmon species, it was not at all successful when applied to other species of marine fish. Specimens of Gadidae (cod), Pleuronectidae (flatfish), Hexagrammidae (greenling), and *Sebastes sp.* (rockfish) were radiographically examined, but it was not possible to discern contrasting bands comparable to those visible in salmon. Without more detailed physical and chemical analysis it is impossible to determine why the method apparently only works for species of Oncorhynchus. It is possible that differences in bone density between salmon and other fish might in some way be responsible, but in the absence of further investigation this is only speculation.

Once it was determined that the rings visible on the Namu salmon radiographs were annual growth rings, the entire sampled and measured collection was radiographically examined. The winter-growth rings visible on each vertebra centrum were counted, and the age composition of each sample was determined. All of the Namu specimens were either two, three, or four years old. The percentages of age groups by excavation level are presented in Table 17. The majority of salmon were three years old, but the percentages of two and four year old salmon are more significant for explaining the observed variability in fish size. The variation in median salmon weight is clearly a function of the age composition of the sample. If there is a high percentage of two-year-old salmon and/or a low percentage of four-year-old salmon, then the median weight is low. If there is a low percentage of two-year-old salmon and/or a high percentage of four-year-old salmon, then the median weight is high. The strong association between the radiographically-determined age structure and the median weight estimates adds further credence to the interpretation of the rings as growth annuli.

SPECIES AND SEASONALITY

Based on the age composition of the recovered salmon, and data concerning the age at which different species of salmon mature and spawn, it is possible to determine the probable species composition and season of the Namu salmon fishery. The high percentage of salmon that exhibit two winter's growth were likely coho *(O. kisutch)*. At present, 95% of British Columbian coho salmon spawn at three years of age (i.e. after one winter of freshwater life and 1 winter of marine life) (Godfrey 1965:7). Coho are the most widespread of Pacific salmon in British Columbia, and they are common in small coastal streams like the Namu River (Aro and Shepard 1967:261).

Other species of Pacific salmon spawn at ages that do not closely match the Namu salmon age profile. Pink salmon *(O. gorbuscha)* almost invariably mature and spawn at two years of age (i.e. after one winter's growth period) (Hunter 1959:837; Hart 1973:110). The very small number of two-year-old salmon in the Namu midden indicates that very few pink salmon are represented. Sockeye salmon *(O. nerka)* normally spawn at four or five years of age (three or four winters' growth). The majority of sockeye spawn in only a few major river systems (Aro and Shepard 1967:232, 239); it is unlikely that they would be present in the Namu assemblage in appreciable numbers. Chinook salmon *(O. tschawytscha)* also tend to spawn in major rivers; they mature late in life, and normally spawn at between three and eight years (two - seven winters). The majority mature in their fourth or fifth years (Hart 1973:125). The absence of any salmon older than four years in the Namu midden means it is unlikely that chinook are present. At present chinook salmon are extremely rare in the small streams of the Central Coast region (Rohner 1967:45; Pomeroy 1980:175).

Chum salmon *(O. keta)* are a more likely component of the Namu salmon fishery. Although the majority of chum in contemporary populations mature and spawn at four years of age (Henry 1954:7-10; Hunter 1959:838), substantial numbers spawn at age three. Chum can mature at ages varying from two to seven years, but the numbers that mature at less than three or more than five years are insignificant (Neave et al. 1976:31). If chum salmon were exploited at Namu, there remains a serious problem in explaining the relative lack of four-year-old individuals among the salmon remains. This age group should have been a dominant portion of a normal chum spawning population. Nevertheless, there are good reasons for considering the possibility that chum salmon contributed to some portion of the Namu salmon fishery.

The Bella Bella area is currently the largest producer of chum salmon in northern British Columbia (Aro and Shepard 1967:286), and chum salmon commonly spawn in small coastal streams such as the Namu River. The potential for chum in the Namu collection is also given weight by ethnographic evidence that suggests a cultural preference for chum salmon. Chum salmon smoke well and are prized by contemporary Native fishermen for this reason (Hart 1973:114). In the past chum salmon were even more significant because they are the least fat of Pacific salmon species, and when dried for winter storage they last for the longest time without spoiling (see Romanoff (1985:154) for numerous ethnographic references concerning this point). Other species of salmon were more likely to be eaten fresh. Cultural preference and presumed availability argue in favour of the exploitation of significant numbers of chum salmon at Namu, and there should be evidence of this in the recovered salmon remains. In contrast, the absence of chinook and sockeye salmon at Namu is not difficult to explain; their spawning populations have a restricted distribution and they commonly spawn during the summer months, when Namu may have been unoccupied (see Chapter 6).

It is more difficult to explain the relative absence of pink and four-year-old chum salmon. Initial consideration was given to the possibility of systematic error in age determinations based on the experimental technique of radiographic analysis. Although tests confirmed that the radiographically-visible rings were annuli, it was still possible that systematic errors in counting the annuli resulted in either over-representation or under-representation of the number of fish in particular age categories. It is extremely unlikely that the number of annuli was overestimated, since in all but a few cases at least two bright winter-rings were clearly visible. Therefore, the low representation of pink salmon is not a function of observation errors. The distribution of pink salmon spawning populations is more restricted than that of chum and coho, though not as restricted as the distribution of sockeye or chinook. Pink salmon also run earlier in the year than chum or coho. The timing and restricted distribution of pink salmon may have been partly responsible for their under-representation in the Namu fishery.

There was a greater possibility of under-representing four-year-old chum through consistent under-counting of annuli. It was often difficult to determine the first true annulus. Many vertebrae counted as three years old had a very narrow and often irregular bright ring well inside the first counted annulus. If this inside ring was a true annulus then a much greater proportion of fish would have been four years old. This possibility was considered in the course of analysis.

Examinations of fish-scale annuli have shown the common presence of a juvenile ring not far from the focus, but well inside the first annual zone. This is often confused with the first annulus (Chugunova 1963:23-24). Juvenile rings often could be distinguished on the radiographs because they were narrow, irregular, and sometimes discontinuous. Following Chugunova (1963:24), a further check was made by estimating the weight of the salmon from the width of the suspected juvenile ring. In each of the test cases the estimated weight was far below the normal weight at the time of the first annulus formation. Weights estimated on the basis of the first clear annulus corresponded closely with the weight expected by the end of the first winter's growth. It is unlikely that the first annulus was mistaken for a juvenile ring in any appreciable number of cases, and as analysis progressed it became easier to distinguish between the juvenile ring and the first annulus. The correspondence with age determinations from scale readings and the consistency of counts from unintentional repeat readings of samples provided further support for the accuracy of annuli counts.

The discrepancy between the proportion of three-year-old fish in the Namu assemblage and the normal age composition of contemporary chum spawning runs could mean that: 1) the majority of the fish were coho, and only a small number were pink or chum; or 2) environmental or biological factors in the past restricted the number of four-year-old chum in the spawning population; or 3) there was a cultural selection factor that prevented inclusion of four-year-old chum salmon, either because they were not caught or because their remains were not preserved. The most parsimonious explanation is to assume that the majority of the Namu salmon were coho and that other species were simply not fished in appreciable quantities. However, chum should have been available, and the small but significant percentage of four-year-old salmon in the assemblage indicates that they were caught in limited quantities. Although pinks are less widely distributed, they also should have been more strongly represented in the Namu fishery.

There are alternative explanations for the Namu salmon age profile, but most are more complex than one that assumes predominance of coho. The proportion of three-year-old chum in contemporary spawning populations varies, and the possibility of long-term change in the normal age-profile was considered as a potential explanation for the Namu findings. Researchers have noted a tendency for a north-to-south gradient in the age of chum salmon, with younger fish occurring in greater percentages in the south, but this gradient does not hold for every locality, and three-year-old fish remain a minority in every location (Henry 1954:24). Although there is considerable annual variation in the proportion of three-year-old chum in the spawning population at a single locality (Henry 1954:9), four-year-old fish almost always predominate. The reasons for variation in age composition are unknown, but there is nothing in contemporary observations that would suggest environmental or biological reasons for the long and consistent lack of four-year-old chum salmon in the Namu population. Cultural factors remain as the only probable explanation.

If the past spawning population of Namu chum salmon contained a large proportion of four-year-old fish, then there are few probable causes that would account for their absence from the midden deposits. It is unlikely that there was a deliberate selection of three-year-old salmon from among the entire spawning run. Four-year-old chum are larger and represent a food resource that would not have been ignored had it been available to the Native population. Salmon fishing techniques also would not select against larger fish. Therefore, either the prehistoric residents were unable to catch four-year-old fish or the older and larger fish were prepared in a way that destroyed their vertebrae.

An explanation based on differential preservation requires that one method have been used for the preparation of pink and older chum salmon, while a second method, which did not involve destruction or loss of vertebrae, was used for the preparation of smaller chum and coho. Scattered ethnographic information does indicate differential treatment of the higher-fat-content backbone of salmon (Romanoff 1985:154). The Kwakiutl sometimes consumed the backbone immediately rather than preserve it (Boas (1921) cited in Romanoff (1985)). Therefore, preservation of larger, older chum and fatter pink salmon may have involved removal of the high-fat backbone, while this was unnecessary for the preservation of smaller chum, but there is no specific ethnographic record of such a practice. Without detailed comparison of the fat content and preservation qualities of pink salmon and different age and size categories of chum salmon, it is impossible to evaluate the likelihood that different preparation techniques were responsible for the age composition of the Namu salmon remains.

The more likely explanation is that pink and four-year-old chum salmon were unavailable because the site was unoccupied at the time these fish entered the river to spawn. In a long-term study of salmon spawning in Hooknose Creek, a nearby coastal stream, which is very similar to the Namu River, it was observed that pink salmon were the earliest to spawn, followed by older chum, and finally younger chum salmon (Hunter 1959:837,849). In the Bella Bella region, most pinks presently spawn in September, chum follow in September and October, and coho, the latest-spawning Pacific species, reach their peak spawning in October (Aro and Shepard 1967:282,286,289).

If the Namu residents consistently arrived at the site late in the salmon fishing season they only would have had the younger chum and coho available to them in large numbers. Late arrival also would account for the general lack of pink salmon in the midden. Any fluctuation in the arrival time of either the residents or the salmon would increase or decrease the relative proportion of two-year-old (pink) salmon and four-year-old (older chum) salmon in the assemblage. It is possible that the seasonal round of subsistence activities placed the Native population at other locations up until the latter part of the chum salmon run. Better fishing for pink salmon at other locations would be sufficient reason to delay arrival at Namu.

A variety of seasonal indicators show that the site was consistently occupied from early autumn through spring (see Chapter 6); it is likely that Namu was occupied autumn, winter, and spring throughout the period from 7000 to 1800 cal. B.P. The seasonal interpretation of the salmon age profile ties the autumn arrival to a very precise date in late September or early October. This pattern shows remarkable consistency over the economic prehistory of Namu. It extends from before the establishment of peak salmon productivity (prior to 6000 cal B.P.) to well after the peak in local productivity between 6000 and 4000 cal. B.P.

The age and growth study of salmon vertebrae gives a reasonably precise reckoning of the species composition of the Namu salmon fishery, and it provides a good indication of the probable timing of site occupation. The presence of chum and/or coho salmon indicates an autumn presence at the site, and if the recovered remains are representative of the salmon that were caught, then the more precise indication is of consistent arrival at the site sometime in late September or early October. The problem with seasonal indicators is that they only indicate the seasons of definite site occupation. Inferences of seasonal absence must be based on negative evidence such as the lack of pink salmon and four-year-old chum salmon. As is discussed in the following chapter, these are problems that are common to all seasonal inferences from faunal remains.

CHAPTER 6

Seasonality

The characterization of the Namu economy and the explanation of its transitions over time depend in part on the inferred scheduling of economic activity and the potential for changes in the seasonal duration of site occupation. The faunal data can indicate at least a minimal seasonal range of economic activity. The available evidence includes: 1) seasonally limited species of fish and bird; 2) seasonally specific neonatal harbour seal elements; and 3) seasonal growth increments in shell (Stevenson 1977). The relative abundance of seasonally available species also provides some indication of variation in the intensity of economic activity.

SPECIES AVAILABILITY

The study of the salmon age profile (Chapter 5) provided a very precise late September/early October date for the minimum season of site occupation. This inference is based on the conclusion that the majority of recovered salmon were either young chum *(O. keta)* or coho *(O. kisutch)*, and the further assumption that the recovered remains are representative of the fish that were caught in the site vicinity. A possible variation in the timing of salmon fishing is indicated by the slight increase in the percentages of two- and four-year-old fish in the Period 5 assemblage (Tab. 17), which probably represent a greater proportion of pink and older chum in the salmon assemblage. These fish spawn during the early part of the late summer/early fall salmon fishery, and their greater abundance could indicate a slightly earlier arrival at the site (mid-to-late September), possibly to increase access to salmon at a time of declining stocks.

The utilization of seasonally restricted salmon runs defines seasonality much more precisely than is normally possible. Migratory bird species often are used as seasonal indicators despite the fact that most species are available over a broad time span. Almost all of the identified birds from Namu are either available year-round or are species that "winter" on the coast and migrate to the interior in the summer. For many species, a winter presence can range from September to March (see McAllister 1980:169). Therefore it is more accurate to speak of summer absence than winter presence. Only the shearwater *(Puffinus sp.)*, which is represented by a single element, is present in summer only, but because it can be present in late spring its isolated occurrence cannot be taken as an indication of summer occupation.

Very little seasonal information is provided by the Namu bird specimens. The large number of birds in Period 3 could be taken as an indication of more intensive winter occupation, but the temporal trends for winter birds generally correspond to the trends for species such as the common murre *(Uria aalge)*, which are available year-round. The Period 3 abundance of bird remains is probably a function of intra-site deposition patterns (see Chapter 3).

Herring *(Clupea harengus pallasi)* remains probably indicate fishing at the time of spawning in late winter or early spring (Hart 1973:97). Cod are also said to provide an indication of spring or summer occupation because they move into deep water in autumn and return to shallow water in spring (Hart 1973:223). The abundance of cod in certain periods could be taken as an indication of more intense fishing in spring or summer, but there is no other evidence of significant variation in the scale of seasonal occupation. Fluctuations in the abundance of cod are difficult to interpret.

The least ambiguous of the seasonal evidence indicates consistent autumn (coho and/or chum salmon) and spring (herring) fishing. It is reasonable to infer continuous winter occupation on this basis since there are few reasons for catching and preserving winter salmon supplies at one location, moving to another site for a brief winter stay, only to return to the original site in early spring for the herring season. The lack of pink salmon and older chum salmon, and the lack of summer-specific species among the recovered fauna suggests that the site was probably unoccupied for most of the summer. The age determination of harbour seal provides further evidence that the site was temporarily abandoned in summer.

Neonatal or juvenile specimens, which might provide a very specific indication of seasonal occupation, are generally rare in the Namu assemblage. Apart from a few remains of dog *(Canis familiaris)*, only harbour seal were identified as neonatal specimens. Harbour seal pups are generally born between mid-May and mid-June; the peak of the pupping season is in early June (Banfield 1974:370). A neonatal harbour seal specimen obtained in mid-June was available in the Simon Fraser University comparative zooarchaeology collection. Size and morphological correspondence between this specimen and many of the recovered seal bones indicated that a relatively large number of neonatal specimens were present in the Namu assemblage. Table 18 lists the frequency of neonatal elements; these represent every major occupation period between 7000 and 2000 cal. B.P., and they are included within the very oldest fauna-bearing deposits.

The Namu seal-pup bones exhibit minimal size and morphological variation, which indicates that all were either neonatal or very near neonatal in age. One archaeological specimen that is somewhat smaller than the comparative specimen may have been foetal. Another inferred neonatal specimen is slightly larger than the comparative specimen, but given the rapid growth of seal pups and the duration of the pupping season, it is likely that it was killed at about the same time of year. The seal-pup remains probably all derive from a very narrow seasonal time frame around the mid-June peak in the pupping season. The presence of adult or near-adult specimens in the rest of the Namu harbour seal assemblage, and the absence of any specimens of

Table 18. Neonatal Harbour Seal (Phoca vitulina) Elements by Temporal Period.

	Period			
Element	**2**	**3**	**4**	**5**
Vertebral arch	5	28	-	1
Vertebra centra	4	14	2	-
Innominate	-	2	1	-
Sternum	-	1	-	-
Femur	5	1	3	-
Tibia	-	-	1	-
Calcaneous	-	-	1	-
Metapodials	-	2	-	-
Humerus	1	1	2	-
Radius	-	-	1	-
Total	**15**	**49**	**11**	**1**

intermediate age, is a good indication that the site was probably not occupied for the period immediately following the pupping season. There is no explanation involving seasonal seal migration or Native hunting patterns that can otherwise account for the absence of intermediate-age harbour seal.

The Namu faunal collection also does not contain any specimens of foetal or neonatal deer, which would indicate summer occupation. The interpretation of this and the harbour seal remains as an indication of summer absence implies the consistent maintenance of a very precise seasonal schedule of economic activity, which dates to at least 7000 years ago. The regular pattern of summer absence could be explained by the exploitation of seasonally abundant resources at another locality. Contemporary ethnographic accounts indicate that the first of the major sockeye runs at Rivers Inlet in July is a major attraction for Native groups on the Central Coast. Every year in early July, contemporary Kwakiutl villages are partially abandoned as families travel to Rivers Inlet to mark the beginning of the salmon-fishing season (Rohner 1967:24). Rivers and Smith Inlets presently account for 16% of the total British Columbia and Washington State sockeye salmon fishery (Aro and Shepard 1967:239), and this is the only major sockeye spawning area on the Central Coast. Sockeye salmon become available when winter salmon supplies would have been exhausted and the spring harvest of herring was long past. Therefore, the attraction of the sockeye salmon run in the past probably would have been even greater than it is today.

If Namu was consistently abandoned near the end of the late spring seal pupping season, then it was likely in order to take advantage of the sockeye salmon fishing season at Rivers Inlet. Summer movement to take advantage of seasonally abundant resources was a well-established ethnographic pattern on the Northwest Coast. The seasonal interpretation of the Namu fauna suggests that this pattern was established by 7000 cal. B.P. Once the salmon runs were established following deglaciation, it is likely that Native fishing would assume a pattern that would take maximum advantage of the timing of specific spawning runs.

SHELLFISH GROWTH INCREMENTS

Stevenson (1977) conducted a limited study of seasonal growth increments on shell samples taken from the 1977 excavations. As with other seasonal indicators, the results of the shellfish study are ambiguous in establishing the presence or absence of seasonal occupation, but the results do provide an interesting indication of the seasonal pattern of gathering butter clams *(Saxidomus giganteus)*, the one species examined in Stevenson's study. Based on growth increments, four seasons were defined, including: 1) early spring, 2) late spring/summer, 3) late summer/fall, and 4) winter. The majority (73-92%) of shells in samples taken from strata deposited in Periods 3, 4, 5, and 6 were gathered in late spring/summer. The only significant departure from this pattern were shells from Period 5 strata. A larger percentage of Period 5 clams (20% as compared to 10% for Periods 3 and 4) were gathered in late summer/fall, though the majority were still gathered in late spring/summer. As Stevenson (1977:10) notes, this spring/summer, summer/fall utilization is in keeping with ethnographic information regarding the seasonality of shellfish gathering (see Ham 1976:74). If shellfish supplemented winter supplies of dried salmon, then the greatest demand would be in late spring when salmon stores were likely to be exhausted. The Period 5 increase in clams gathered in late summer/autumn might indicate greater need for winter supplies of preserved shellfish at a time when the local salmon fishery was in decline. However, the late summer/early autumn pattern of shellfish collection is not sustained in the one sample of 15 shells from a Period 6 deposit.

The inability to distinguish summer growth from late spring or autumn growth made it impossible to use the shellfish study results to resolve the question of whether the site was occupied during the summer. The possibility of late spring (i.e. May and June) and autumn (i.e. September and October) utilization of shellfish (Ham 1976:74) is not inconsistent with a pattern of summer abandonment.

SUMMARY

Despite the serious limitations of seasonality data, they demonstrate with certainty: 1) an early autumn presence, based on the presence of coho and/or chum salmon, 2) an early spring presence, based on the presence of herring, and 3) a late spring presence, based on the presence of neonatal harbour seal. Working from this information, it is possible to infer that Namu was a winter village site, which was probably unoccupied July through September. Winter occupation is assumed on the basis of a fall and early spring presence, and the lack of any economic reason to leave the site between the times of the last salmon runs in October and November and the herring spawning in February or March. Summer absence is inferred from: 1) the lack of harbour seal older than neonatal and younger than young adult, 2) the absence of summer-spawning salmon species such as chinook and sockeye, and 3) the relative absence of pink salmon and four-year-old chum salmon, which would run in early September.

The ethnographic Northwest Coast settlement pattern was based on major winter villages and smaller summer campsites established to take advantage of seasonally-available resources. If Namu was a major winter village during the last 7000 years of its occupation, then a series of corresponding summer activity sites should be located nearby. A resource based survey of the Central Coast region, along the lines suggested by Pomeroy (1980), might yield evidence of summer activity sites fitting within the time frame of the present study. A search for evidence of prehistoric sockeye fishing at Rivers Inlet is one of several lines of further investigation. Other summer resource extraction sites might be based on berries, trout, or pink salmon.

The faunal data indicate long-term consistency in seasonal activities. From the time of the earliest fauna-bearing levels, there is evidence of herring, neonatal seal, and a predominance of coho and/or three-year-old chum among the recovered salmon remains. The seasonal pattern extends at least 7000 years into the past and was maintained throughout later occupations. The available evidence also indicates long-term consistency in the seasonal pattern of shellfish collection. Only the Period 5 assemblage exhibits any slight deviation from the general pattern of seasonal resource utilization. In Period 5 there is a slight increase in two and four-year-old salmon, and a possible increase in shellfish collection in the fall. Each of these minor variations could be explained as a response to the decline of the Namu salmon fishery, but they do not indicate a significant change from earlier seasonal patterns.

The salmon fishery and timing of salmon runs were probably the major determinants of the Namu seasonal round. Spawning runs of sockeye salmon provided incentive to leave Namu in summer, while chum and coho salmon runs provided incentive for return in early autumn. Other resources that became available between these times were exploited as need required and opportunity allowed, but the subsistence economy represented a primary adaptation to the availability of salmon.

Beyond the evidence of long-term consistency in seasonal economic activity, the faunal data indicate that Namu was a winter village site for at least the last 7000 years. From the earliest date for which faunal evidence is available, seasonally abundant resources sustained a continuous resident population for nine months of the year. The ethnographic pattern of permanent winter settlement is therefore evident at Namu from at least 7000 cal. B.P. This essentially sedentary pattern of settlement was established prior to the peak in salmon productivity, and was sustained for 1000 years before the intensive exploitation of shellfish began.

Given the intensive use of salmon and the sustained winter occupation of the site, it is reasonable to infer that salmon were preserved and stored for winter use, though there is no definitive evidence of storage at the site. If the early Namu settlement was a permanent winter village sustained on the basis of stored salmon, then it is necessary to re-evaluate many of the proposals that have been made regarding the causes of economic transitions on the Northwest Coast. The Namu winter village settlement did not depend on peak salmon productivity, and it was not initially sustained through intensive exploitation of shellfish. Larger aggregates, which may have followed the peak in salmon productivity, are associated with the increased use of shellfish, but these developments were neither necessary for, nor the outcome of semi-sedentary settlement. The implication is that semi-sedentary settlement was not a sufficient basis for sustained population growth. If population growth was a later development associated with greater salmon productivity and the increased use of shellfish, then it must have been due to more than the establishment of semi-sedentary village settlement.

The results of the seasonality studies indicate long-term use of seasonally-abundant resources. The establishment of this pattern from the time of the earliest shell deposition and bone preservation suggests that it likely extends still further back in time. The only subsequent change in economic activity is the intensification of seasonal resource use, which begins with greater exploitation of salmon in Period 3 and culminates in the peak exploitation of salmon, herring, and harbour seal in Period 4. The seasonal pattern of economic activity also continues through the inferred decline in site occupation in Periods 5 and 6. The scale of the occupation may have been reduced, but the pattern of site settlement remained essentially unchanged. When combined with evidence of temporal change in vertebrate fauna abundance, the seasonality evidence allows for a remarkably complete reconstruction of Namu's economic prehistory.

CHAPTER 7

Summary and Conclusions

When all of the faunal analyses and data manipulations are completed, and appropriate cautions taken into account, it can seem as if there is very little that can be concluded from faunal evidence with any degree of certainty. Variability in the recovery, analysis, and quantification of vertebrate faunal remains can be responsible for much of the apparent variation in faunal-class abundance over time. Some part of the debates concerning economic transitions on the Northwest Coast undoubtedly reflects the methodological problems of zooarchaeology. Nevertheless, general economic patterns have been established on the basis of robust faunal data from other Northwest Coast sites, and the Namu data offer further insight into the causes of economic change and intensification in the region. The patterns of change evident in the Namu economy also have implications for understanding similar economic transitions in other regions of the world.

Namu is a unique site because of its long and continuous occupational history (R. Carlson 1979). The economic prehistory of the last 7000 years, which is documented in the surviving faunal record, also provides a unique chronicle of long-term economic transition. The maritime orientation of the economy is evident from the beginning of the faunal record, and it is reasonable to project a fishing-based economy well into the earlier period of site occupation, possibly to as early as the 11,000 cal. B.P. date of initial human habitation. Based on the faunal data, a period of transition to a maritime economy is not in evidence. The fishing economy of 7000 cal. B.P. includes a well developed emphasis on the abundant and predictable salmon and herring fisheries, which were key elements of the later subsistence economy. The seasonal salmon and herring fisheries also indicate an early pattern of semi-sedentary settlement, though it is impossible to say whether this was a function of or the reason for the intensive fishing economy. Available evidence suggests that intensive salmon and herring fishing and winter settlement pre-date the post-glacial peak in salmon productivity (Fladmark 1975) and the beginning of major shell midden accumulation by as much as 1000 years.

The beginning of intensive shellfish exploitation ca. 6000 cal. B.P. is the clearest change in the site's economy. The correspondence with a major increase in the abundance of salmon in the site deposits provides support for Fladmark's contention that environmentally enhanced salmon productivity and shellfish utilization are inter-related. The association at Namu is clear, and it marks the most significant change in what is otherwise a consistent maritime economy. The peak productivity of the Namu salmon fishery lasts for a period of 2000 years. The only changes in the subsistence economy during this time are the apparent intensification of salmon and herring fishing and the major increase in seal hunting.

The peak in economic productivity between 5000 and 4000 cal. B.P. ends with the precipitous decline of the local salmon fishery. Environmental indicators point to estuary development and increasing sedimentation as the reason for the decline in local salmon productivity. With the decline in salmon, the overall scale of site settlement and economic activity is reduced. Although the occupation and maritime economy of the site continue for another 4000 years, it appears that Namu was never again a major winter village, though it was continuously used as a minor winter settlement. The decline in salmon fishing is associated with further reliance on shellfish and an increase in the use of certain minor fish resources.

The faunal record provides a clear overview of Namu's economic prehistory. A marine-based economy including intensive use of salmon and herring and the incipient use of shellfish was well established by 7000 cal. B.P. The seasonality of faunal resources indicates the establishment of winter village settlement by that date as well. Although not evident in the archaeological record, it is likely that salmon was being processed and stored for winter use, thereby sustaining the settlement until the time of the herring spawn in late winter/ early spring. Salmon were caught in large quantities, and given the short spawning season it is probable that the catch exceeded the capacity for immediate consumption. Given the need to sustain winter settlement, and given the opportunity afforded by a surplus catch of salmon, it is reasonable to conclude that some part of the salmon catch was being stored, at least by the date of the earliest faunal record.

If there had been no further transition in the prehistoric Namu economy, the pattern of resource use would be essentially that of the ethnographic present. The one necessary additional element was the intensive exploitation of shellfish, which began at around 6000 cal. B.P. and continued throughout the rest of the site's history. Intensification in shellfishing is associated with clear evidence of intensification in local salmon fishing, and the reliable salmon and shellfish resources supported an increased scale of site settlement. Further economic intensification is evident after ca. 5000 cal. B.P., with the increasing use of the strategic seasonal abundance of salmon, herring, and harbour seal; all of which suggests further increase in the scale of site settlement.

The decline of the salmon fishery after 4000 B.P. is associated with an apparent reduction in the scale of site settlement and the intensity of most forms of economic activity. Only shellfishing continues to increase in intensity. The site economy does not appear to have undergone any further change in orientation or emphasis after 4000 B.P.

The faunal record indicates four major transitions in Namu's economic prehistory. The first was the initial intensive use of the fall salmon spawning runs, which occurred sometime before the faunal record begins. The second was the intensification of salmon fishing and shellfish gathering. The third was the further intensification of salmon fishing, and the associated increase in late winter herring fishing and late spring seal hunting. The final transition was the economic contraction associated with the decline of the local salmon fishery. The reasons for the first of these transitions cannot be addressed on the basis of the Namu faunal data, but given 4000 years of site occupation prior to the beginning of the faunal record there was ample opportunity for the transition to intensive salmon fishing. The other economic transitions can be well documented and should be explicable in relation to changes in local environmental and cultural conditions.

CAUSES OF ECONOMIC TRANSITION

The process of economic intensification is one of the major areas of archaeological inquiry, and there are several major causal factors that are commonly cited to explain the economic transitions evident in the course of world prehistory. These include changes in the availability of resources, local culture change and technological development, population growth, and social demand. Each of these factors has some potential bearing on the economic developments at Namu, and the Namu evidence can contribute to a general understanding of the causes of economic change on the Northwest Coast and elsewhere. Given the initial need for resources capable of supporting economic intensification it is appropriate to begin by examining the role of environmental availability on the changing pattern of resource use.

Environmental Change

The global environmental changes associated with the end of the Pleistocene are commonly cited as the preconditions for an increasing economic emphasis on marine resources (Binford 1968, Pfeiffer 1978).

Stabilization of the marine/shore interface is linked to the enhanced productivity of shellfish and anadromous fish resources and the establishment of permanent settlement to take advantage of local maritime abundance.

Fladmark (1975) combined archaeological evidence for the onset of shell midden formation with evidence of sea level changes to argue that stabilization of the marine shore environment was the key factor in development of Northwest Coast economic and settlement patterns. The critical variable in Fladmark's palaeo-ecological model is the enhanced productivity of salmon at around 6000 cal. B.P. The increased availability of salmon encouraged its utilization and allowed for larger and more permanent settlements. The increased use of shellfish was due to the greater demands of larger population aggregates. According to the available archaeological evidence, the shellfish resource had been little used prior to establishment of these conditions.

The enhanced production of salmon at Namu at 6000 B.P., which coincides with the build-up of shell midden deposits, provides substantial support for Fladmark's model. The apparent decline in economic activity and site settlement associated with estuary development and its negative effect on salmon productivity is further evidence of the economic significance of environmental availability.

The Namu evidence supports a central role for salmon in the local site economy, but the overall importance of salmon on the Northwest Coast has been questioned recently (Croes 1988, Mitchell 1988). Detailed faunal analysis from sites on the south (Croes and Hackenberger 1988) and south-central (Mitchell 1988) coasts have indicated long-term site settlement and extensive shell midden formation without any indication of intensive salmon fishing. As suggested in Chapter 4, the evidence from these sites does not necessarily contradict an early Northwest Coast pattern of economic dependence on salmon. Local environmental changes could adversely affect the salmon productivity of a particular site, and site economies could be expected to take advantage of whatever resources were in greatest local abundance. The economic focus of an individual site would have been based on its local micro-environment, which might not have been representative of a broader regional pattern in which salmon was a priority resource.

The intensive exploitation of resources other than salmon at some sites could indicate a broadening intensification of regional economies as a result of population expansion initially predicated on the regional intensification of salmon fishing. However, the later transition to salmon fishing at some sites suggests that local environmental adjustment also occurred. It could be argued that salmon had been consistently available but ignored in favour of resources that required less intensive methods of capture and processing. However, it is difficult to sustain this argument for the early period at Mitchell's (1988) Queen Charlotte Strait sites where early salmon would have to have been ignored in favour of more intensive exploitation of ratfish. Until the potential for local environmental change and potential changes in the seasonality of site use are taken into account, it is premature to suggest that the early economic importance of salmon has been overemphasized.

The local as well as the regional availability of salmon undoubtedly played a major role in determining its economic value. Local salmon productivity fluctuates over the short term and can exhibit dramatic changes over the long term in response to local environmental conditions. It is impossible to rate the salmon productivity of specific site locations either in the present or at a specific point in the past and expect that level of productivity to have remained constant throughout prehistory. Changes in resource use over time and a lack of correlation between site location and the present distribution of salmon productivity (Hobler 1983:155) are insufficient to discount the importance of availability in promoting cultural dependence on salmon.

At the same time, the availability of a resource, even one as rich and predictable as the Northwest Coast salmon fishery, does not ensure its intensive utilization. Peak post-glacial productivity was not the sole determinant of salmon utilization at Namu or anywhere else. The Namu subsistence economy was heavily dependent on salmon fishing before the presumed peak in environmental conditions. Enhanced salmon productivity at around 6000 B.P. also did not demand the increased utilization evident at that time. Although the evidence for further intensification between 5000 and 4000 B.P. is problematic, there is a strong indication of such a transition, which was not dependent on any increase in availability. Salmon availability is a necessary but not a sufficient precondition for its intensive exploitation. To explain the trend toward its increasing use it is necessary to examine cultural explanations.

Culture Change

Cultural explanations for Northwest Coast economic transitions generally are set against a backdrop of constant resource availability. Although culture change can seem a spurious explanation for economic transition, since the economy cannot stand apart from culture, two forms of cultural explanation have been used to account for the changing emphasis on salmon fishing on the Northwest Coast. One cites the need for cultural innovation and technological development to enable the catching, processing, and storage of large quantities of salmon (Burley 1980, Matson 1983, Schalk 1977). A more normative view ascribes resource selection and emphasis to cultural tradition (Borden 1975, Mitchell 1988), and subsistence change to cultural migration and interaction.

The cultural selection of salmon has been described as a matter of taste. Even the emphasis that archaeologists place on salmon has been attributed to their own cultural preferences (Croes 1988). From this perspective it could seem that the intensive exploitation of salmon was unrelated to its food value, volume, predictability, and capacity for storage. This almost certainly exaggerates the role of "purely" cultural factors, but proponents of cultural explanations have tended to minimize the attraction of salmon in favour of cultural disposition toward its use.

Borden (1975) proposed that early south coast populations were preadapted toward the use of terrestrial resources, and therefore were unable or unwilling to take full advantage of available marine resources. Borden acknowledged a potential lack of salmon fishing expertise and necessary technology, but in explaining the apparent contrasts in the early north and south coast subsistence economies he also stressed the influence of enduring cultural tradition. Mitchell (1988) arrives at a stronger position in favour of a cultural explanation for subsistence change in the Queen Charlotte Strait region. According to Mitchell, the late shift to intensive salmon fishing is not attributable to any obvious technological improvements, which leaves a difference in preference or desire for salmon between early and late populations in the region. The change in subsistence is attributed to cultural intrusion from the north.

The problem with explanations based on cultural preference is that they do not acknowledge any positive incentive for ever having made the transition to intensive salmon fishing. Most other cultural explanations take the subsistence value of salmon as a given, but they stress the technological and organizational requirements of intensive salmon fishing (Matson 1983, Schalk 1977). Technological development is seen as a gradual process, which culminated in full dependence on the available salmon resource.

At Namu the early dependence on salmon is not associated with any apparent innovation in harvest or storage technology. The use and intensification of salmon fishing follows in accord with resource availability. Early establishment of winter settlement at the site also implies a capacity for salmon storage. It remains possible that the processes of cultural development on the south and south-central coast were different from those on the central and northern coasts. However, the Namu evidence precludes a general model of technological innovation and cultural selection as the explanation for intensive salmon fishing on the Northwest Coast.

If a pattern of gradual technological development cannot explain the economic focus on salmon at Namu, then other underlying factors must be responsible for the choice to invest in the intensive harvest and preservation of salmon. Few supporters of technological innovation models would deny the need for underlying positive incentives for the adoption or development of productive capacity. The key underlying variable in most explanations is population pressure, either through a tendency for population growth or through resource stress brought about by natural fluctuations in productivity. These Boserupian models stand in contrast to Malthusian models (e.g. Fladmark 1975), which see economic intensification as the basis for population growth. However, the Namu evidence suggests a much more subtle interplay between population and economic production.

Population Pressure

The Namu data do not provide any direct measure of population size or growth, which makes it difficult to determine if population pressure was either the cause or effect of economic change. A possible indirect measure is the intensive exploitation of shellfish. Advocates of population growth and those that stress the desire to achieve resource security seem to agree that shellfish exploitation represents an effort to support larger numbers of people in a given territory, even at the expense of greater labour investment (Cohen 1977:79, Croes and Hackenberger 1988, Fladmark 1975, Osborn 1977). Their differences relate to the sequence of causal relationships. One view would suggest that areal circumscription led to increased use of shellfish, which subsequently allowed population growth, which in turn forced intensification of salmon fishing (Croes and Hackenberger 1988, Matson 1983). The alternative view is that increased salmon production promoted sedentary settlement and population growth, which forced increased reliance on shellfish (Fladmark 1975). In both views population growth is treated as a constant independent variable, which responds to a combination of increased food supply and decreased mobility.

If the common assumption that shellfish gathering is closely associated with population growth is correct, then the early absence of intensive shellfishing at Namu suggests that population growth was not the consequence of either reduced mobility or access to a reliable food supply. The faunal data show that intensive salmon fishing and semi-sedentary settlement were in place for ca. 1000 years before the significant accumulation of shell midden deposits began. Based on 1000 years of fall through late spring occupation of the site with only minimal gathering of shellfish, it has to be concluded either that low residential mobility did not promote population growth or that any population increase was insufficient to force the increased use of shellfish. The conclusion that semi-permanent settlement is not a factor in population growth agrees with the results of cross-cultural analysis of contemporary foraging societies (Hayden 1981, Keeley 1988), though it runs counter to widespread assumptions (Binford 1968, Paludan-MÅller 1979:153). Preservation and storage of salmon was probably a major factor in promoting and allowing the early establishment of permanent winter villages, especially given the lack of equally viable alternative winter subsistence strategies. The implication is that access to a reliable food supply also was insufficient to promote major population growth.

The major shell midden accumulation, which begins with the increase in salmon production at 6000 B.P., suggests that population growth at that time was an indirect consequence of economic intensification. However if permanent settlement and a reliable food supply were already long established, then some other factor must intervene in the relationships among resource availability, production, and population growth. In seeking to eliminate explanations based on cultural tradition, technological innovation, and population, the preceding discussion was contrived to leave social demand and deliberate human agency as the only remaining explanation for transitions in the Namu economy.

Social Demand

Recent disaffection with simple determinist models of population growth or technological progress has led to increasing stress on social explanations of economic change and demographic adjustment (Bender 1978, Chapman 1988). However, social complexity is still regarded as more the consequence than the cause of economic transitions on the Northwest Coast (Ames 1983, Burley 1980, Matson 1983).

It is impossible to determine if the early Namu social organization was completely egalitarian or if it included positions of incipient status and authority. What is more important is the assumption of relative social stability during the period 7000-6000 B.P., when the local population could maintain itself through the exploitation of predictable, abundant, and stable food resources without increasing labour investment to include intensive gathering of shellfish. If conditions had remained unchanged, this envisioned social and economic pattern also could have remained stable and virtually unchanged. However, if the productivity of salmon was later enhanced, as Fladmark (1975) suggests, then subsistence production could have been increased with only moderate increase in labour investment. Whatever the resulting level of economic disparity, the potential would exist for greater individual accumulation with little extra effort.

Whether individuals were motivated toward extra accumulation to minimize risk of shortage, to support a wider network of kin, or to entertain and develop trade alliances is of little consequence. Any change in relative accumulation would disrupt existing social relations and set in motion a competitive cycle of social comparison and increasing economic disparity. Grave goods are an inadequate measure of the absolute degree of social distinction, but the goods from the Namu burials dating to between 6000 and 4000 B.P. do indicate disparate levels of investment in the symbols of social display.

Ownership of resources and recruitment to domestic units of production would follow efforts to establish and maintain social position under conditions of greater affluence. Competition between production units combined with a more abundant food supply also could have actively encouraged changes in reproductive strategies, leading to population growth. Increasing economic disparity and larger settlements would finally force greater reliance on shellfish as an economic mainstay. The intensification of salmon and herring fishing and seal hunting between 5000 and 4000 B.P. may indicate further increase in demand and an enhanced organizational capacity for harvesting seasonally abundant resources. However, it was impossible to maintain the same scale of economic production and social demand following the later decline in salmon productivity.

Although the social demand scenario is entirely speculative, affluence-engendered social disruption and competition would have created a context in which there was some positive incentive for the economic transitions that environmental conditions simply allowed. None of the alternatives of population pressure or culture change are consistent with the Namu evidence and all suffer from a general neglect of the role of human agency in effecting economic change.

CONCLUSION

This chapter opened with the caveat that the methodology of zooarchaeology allows for many different readings of faunal data. Having proceeded from that point to draw inferences that go well beyond the safe bounds of the available data it is appropriate to repeat the caveat and return the data interpretation to the more modest realm of Namu's economic prehistory.

Every site embodies its own pattern of economic transition over time, and each archaeologist depending on their methods and perspective will tell a different story of that transition. The story told here could have been very different had it been based on small samples of material from selective parts of the site. Conversion of faunal abundance to measures of minimum numbers or useable meat weight might have altered the results still further. Fortunately the interpretation of Namu's economic prehistory is greatly constrained by the quantity and quality of the available data. The full implications of the Namu study will depend on the complete analyses of data of similar quality from many other sites, but the story of even one site has an interest and a value all its own.

Seven thousand years of faunal data provide a fascinating testament to the ways in which the people of Namu have defined and made a living in the shifting contexts of resource availability and their own social and economic needs. The duration of site features attractive for settlement and economic activity has provided an 11,000 year backdrop for an ever-changing pattern of economic activity, which has continued into the site's recent historic past and present. Economic prehistory may have few practical lessons to offer the present or the future, but the Namu story is an impressive heritage for the people whose ancestors first settled the site, and it deserves humble appreciation by those who so recently came after to define their own needs and opportunities in the resources of the region.

APPENDIX A

Frequencies of Recovered Fauna by Excavation Unit

MAMMAL

Table A-1. Combined Main Trenches (68-70S, 4-10W; 32-34S, 2-10W).

	Period			
Taxon	**2**	**3**	**4**	**5**
Castor canadensis	8	5	15	8
Erethizon dorsatum	7	19	33	12
Delphinidae	9	10	23	15
Canis familiaris	11	41	86	79
Ursus americanus	3	2	8	2
Procyon lotor	0	0	1	0
Mustelidae	15	33	45	30
Lutra canadensis	9	5	9	13
Enhydra lutris	1	4	47	4
Otariidae	6	10	7	6
Phoca vitulina	44	65	521	20
Odocoileus hemionus	83	173	502	224
Oreamnos americanus	0	1	2	1
Unidentified mammal	39	64	143	52
Aves	41	314	90	78

Table A-2. Rivermouth Trench (68-70S, 4-10W).

	Period			
Taxon	**2**	**3**	**4**	**5**
Castor canadensis	6	1	14	5
Erethizon dorsatum	5	2	28	9
Delphinidae	8	3	18	9
Canis familiaris	6	14	48	43
Ursus americanus	1	0	5	2
Procyon lotor	0	0	1	0
Mustelidae	15	10	23	20
Lutra canadensis	8	3	7	13
Enhydra lutris	1	1	46	4
Otariidae	6	1	6	3
Phoca vitulina	32	12	498	13
Odocoileus hemionus	56	25	427	156
Oreamnos americanus	0	1	2	1
Unidentified mammal	23	9	117	29
Aves	35	21	60	45

Table A-3. Central Main Trench (32-34S, 2-10W).

	Period			
Taxon	**2**	**3**	**4**	**5**
Castor canadensis	2	4	1	3
Erethizon dorsatum	2	17	5	3
Delphinidae	1	7	5	6
Canis familiaris	5	27	38	36
Ursus americanus	2	2	3	0
Procyon lotor	0	0	0	0
Mustelidae	0	23	22	10
Lutra canadensis	1	3	2	0
Enhydra lutris	0	3	1	0
Otariidae	0	9	1	3
Phoca vitulina	12	53	23	7
Odocoileus hemionus	27	148	75	68
Oreamnos americanus	0	0	0	0
Unidentified mammal	16	55	26	23
Aves	7	293	27	33

Table A-4. (24-30S, 2-4E).

	Period			
Taxon	**2**	**3**	**5**	**6**
Castor canadensis	3	0	0	0
Erethizon dorsatum	1	3	4	3
Delphinidae	10	5	7	0
Canis familiaris	25	12	16	35
Ursus americanus	2	0	0	0
Procyon lotor	0	0	0	8
Mustelidae	30	10	1	4
Lutra canadensis	1	1	1	4
Enhydra lutris	0	1	0	0
Otariidae	0	1	1	3
Phoca vitulina	17	8	0	1
Odocoileus hemionus	106	54	0	61
Oreamnos americanus	0	0	0	0
Unidentified mammal	35	15	0	23
Aves	20	6	1	13

Table A-5. (32-33S, 0-7E).

	Period				
Taxon	**2**	**3**	**4**	**5**	**6**
Castor canadensis	0	0	0	0	0
Erethizon dorsatum	1	0	0	1	0
Delphinidae	1	2	0	0	0
Canis familiaris	2	2	4	7	0
Ursus americanus	1	0	0	0	0
Procyon lotor	0	0	0	0	0
Mustelidae	0	4	0	0	0
Lutra canadensis	0	0	0	0	0
Enhydra lutris	2	0	0	0	0
Otariidae	0	0	0	2	0
Phoca vitulina	8	2	0	3	0
Odocoileus hemionus	1	7	6	9	0
Oreamnos americanus	0	0	0	0	0
Unidentified mammal	5	2	4	4	0
Aves	5	2	0	4	0

Table A-6. (30-31S, 0-2E).

	Period			
Taxon	**2**	**3**	**4**	**5**
Castor canadensis	0	0	0	0
Erethizon dorsatum	0	0	0	1
Delphinidae	0	0	1	0
Canis familiaris	0	3	2	0
Ursus americanus	0	0	0	0
Procyon lotor	0	0	0	0
Mustelidae	0	0	2	0
Lutra canadensis	0	1	0	0
Enhydra lutris	1	0	0	0
Otariidae	0	0	0	0
Phoca vitulina	12	1	0	0
Odocoileus hemionus	1	2	11	2
Oreamnos americanus	0	0	0	0
Unidentified mammal	4	2	4	0
Aves	3	0	0	0

BIRD

Table A-7. Rivermouth Trench (68-70S, 4-10W).

	Period			
Taxon	**2**	**3**	**4**	**5**
Gavidae	0	2	0	1
small	2	3	1	2
small - medium	1	0	0	0
medium	0	0	0	1
large	0	13	1	0
Podicipedidae				
small	0	0	2	0
large	1	0	0	3
Procellariidae				
Puffinus sp.	0	0	1	0
Phalacrocoracidae	0	0	1	3
small	0	0	0	1
large	0	0	1	2
Phalacrocorax pelagicus	0	0	4	1
Anatidae				
Anserinae	0	0	0	1
Duck	11	0	25	14
Aythyinae	0	0	1	0
Buteo jamaicensis	0	0	2	0
Haliaeetus leucocephalus	4	0	4	10
Laridae				
large	1	0	1	0
Alcidae				
small	0	0	1	0
Tytonidae/Strigidae				
large	0	0	1	0
Corvidae				
Corvus corax	0	0	0	1
Unidentified	15	3	14	6

Table A-8. Central Main Trench (32-34S, 2-10W).

	Period			
Taxon	**2**	**3**	**4**	**5**
Gavidae	0	13	2	0
small	0	18	1	1
small - medium	0	4	1	0
medium	0	14	1	0
large	2	46	3	4
Podicipedidae				
small	0	2	1	0
medium	0	3	0	0
large	0	8	1	0
Aechmophorus occidentalis	0	1	0	0
Phalacrocoracidae	0	7	0	0
small	0	2	0	1
large	0	11	2	1
Phalacrocorax pelagicus	0	4	0	0
Ardeidae				
Ardea herodius	0	0	1	0
Anatidae				
Anserinae	0	1	0	0
Duck	3	63	1	9
Aythyinae/Merginae	0	5	2	0
Aythyinae	0	4	0	0
Haliaeetus leucocephalus	0	4	3	6
Charadriidae/Scolopacidae	0	0	0	3
Laridae				
very small	0	1	0	0
small	0	1	0	0
medium - large	0	1	0	0
large	1	3	1	0
Alcidae				
small	0	7	0	0
Uria aalge	0	14	0	0
Tytonidae/Strigidae				
large	0	1	1	0
Corvidae				
Cyanocitta stelleri	0	1	1	0
Corvus corax	0	6	0	0
Corvus caurinus	0	1	0	0
Unidentified	1	47	5	8

Table A-9. (24-30S, 2-4E).

Taxon	**Period** **2**	**3**	**5**	**6**
Gavidae	0	0	0	1
small	0	1	0	0
medium	2	0	0	0
large	1	0	0	0
Podicipedidae				
large	0	0	0	1
Phalacrocoracidae	1	0	0	0
large	1	0	0	0
Anatidae				
Anserinae	1	0	0	0
Duck	4	1	0	0
Athyinae/Merginae	1	0	0	1
Merginae	2	0	0	0
Haliaeetus leucocephalus	0	0	1	4
Laridae				
small - medium	1	0	0	0
medium - large	0	2	0	0
large	0	1	0	2
Tytonidae/Strigidae				
large	1	0	0	0
Corvidae				
Corvus caurinus	0	0	0	2
Unidentified	5	1	0	2

Table A-10. (32-33S, 0-7E).

Taxon	**Period** **2**	**3**	**4**	**5**	**6**
Podicipedidae					
medium	0	0	0	1	0
Anatidae					
Duck	1	2	0	0	0
Aythyinae	1	0	0	0	0
Haliaeetus leucocephalus	0	0	0	1	0
Alcidae					
Uria aalge	0	0	0	1	0
Unidentified	3	0	0	1	0

FISH

Table A-11. Combined Main Trenches (68-70S, 4-10W; 32-34S, 2-10W).

All elements

	Period			
Taxon	**2**	**3**	**4**	**5**
Rajidae	1	0	1	3
Squalus acanthias	33	31	47	60
Hydrolagus colliei	30	57	73	239
Clupea harengus pallasi	2	17	360	46
Oncorhynchus sp.	1351	13901	55825	8182
Gadidae	48	44	293	70
Sebastes sp.	117	152	708	637
Anoplopoma fimbria	4	14	17	44
Hexagrammidae	37	15	163	195
Cottidae	3	1	15	19
Pleuronectidae	25	43	178	134
Unidentified fish	22	37	61	97

Vertebra centra (*dental plates)

Rajidae	1	0	1	3
Squalus acanthias	33	31	47	60
Hydrolagus colliei (*)	30	57	73	239
Clupea harengus pallasi	2	16	353	45
Oncorhynchus sp.	1331	13772	54466	8065
Gadidae	33	33	270	52
Sebastes sp.	67	97	446	339
Anoplopoma fimbria	4	14	17	42
Hexagrammidae	24	14	126	148
Cottidae	3	1	14	13
Pleuronectidae	22	42	160	117

Table A-12. Rivermouth Trench (68-70S, 4-10W).

All elements

Taxon	**Period** 2	3	4	5
Rajidae	0	0	1	3
Squalus acanthias	33	23	40	48
Hydrolagus colliei	18	4	49	165
Clupea harengus pallasi	0	11	352	43
Oncorhynchus sp.	1244	6839	45968	6587
Gadidae	46	25	289	31
Sebastes sp.	103	44	622	540
Anoplopoma fimbria	4	1	16	41
Hexagrammidae	31	11	156	174
Cottidae	3	1	15	19
Pleuronectidae	22	9	173	108
Unidentified fish	19	7	50	60

Vertebra centra (*dental plates)

Taxon	2	3	4	5
Rajidae	0	0	1	3
Squalus acanthias	33	23	40	48
Hydrolagus colliei (*)	18	4	49	165
Clupea harengus pallasi	0	10	345	42
Oncorhynchus sp.	1225	6730	44891	6486
Gadidae	32	16	269	18
Sebastes sp.	57	32	399	273
Anoplopoma fimbria	4	1	16	39
Hexagrammidae	22	6	118	128
Cottidae	3	1	14	13
Pleuronectidae	19	8	154	91

Table A-13. Central Main Trench (32-34S, 2-10W).

All elements

	Period			
Taxon	**2**	**3**	**4**	**5**
Rajidae	1	0	0	0
Squalus acanthias	0	8	7	12
Hydrolagus colliei	12	53	24	74
Clupea harengus pallasi	2	6	8	3
Oncorhynchus sp.	107	7062	9857	1595
Gadidae	2	19	4	39
Sebastes sp.	14	108	86	97
Anoplopoma fimbria	0	13	1	3
Hexagrammidae	6	4	7	21
Cottidae	0	0	0	0
Pleuronectidae	3	34	5	26
Unidentified fish	3	30	11	37
Vertebra centra (*dental plates)				
Rajidae	1	0	0	0
Squalus acanthias	0	8	7	12
Hydrolagus colliei (*)	12	53	24	74
Clupea harengus pallasi	2	6	8	3
Oncorhynchus sp.	106	7042	9575	1579
Gadidae	1	17	1	34
Sebastes sp.	10	65	47	66
Anoplopoma fimbria	0	13	1	3
Hexagrammidae	2	8	8	20
Cottidae	0	0	0	0
Pleuronectidae	3	34	6	26

Table A-14. (24-30S, 2-4E).

All elements

Taxon	**Period** **2**	**3**	**5**	**6**
Rajidae	0	0	0	0
Squalus acanthias	20	5	12	17
Hydrolagus colliei	29	12	13	68
Clupea harengus pallasi	24	6	0	0
Oncorhynchus sp.	3552	2720	395	379
Gadidae	29	9	10	45
Sebastes sp.	178	58	121	39
Anoplopoma fimbria	0	2	4	1
Hexagrammidae	34	13	3	5
Cottidae	0	0	0	0
Pleuronectidae	21	15	10	9
Unidentified fish	23	33	0	18
Vertebra centra (*dental plates)				
Rajidae	0	0	0	0
Squalus acanthias	20	5	12	17
Hydrolagus colliei (*)	29	12	13	68
Clupea harengus pallasi	24	6	0	0
Oncorhynchus sp.	3486	2694	384	377
Gadidae	27	8	7	41
Sebastes sp.	119	38	85	34
Anoplopoma fimbria	0	2	4	1
Hexagrammidae	29	7	4	3
Cottidae	0	0	0	0
Pleuronectidae	21	14	9	9

Table A-15. (32-33S, 0-7E).

All elements

	Period				
Taxon	**2**	**3**	**4**	**5**	**6**
Rajidae	0	0	0	0	0
Squalus acanthias	2	1	2	1	0
Hydrolagus colliei	0	1	1	2	1
Clupea harengus pallasi	2	0	2	2	0
Oncorhynchus sp.	739	624	1543	923	1
Gadidae	4	0	3	6	0
Sebastes sp.	12	0	38	43	2
Anoplopoma fimbria	0	0	2	0	0
Hexagrammidae	5	0	9	9	0
Cottidae	0	0	0	0	0
Pleuronectidae	2	0	6	2	0
Unidentified fish	8	0	3	13	0
Vertebra centra (*dental plates)					
Rajidae	0	0	0	0	0
Squalus acanthias	2	1	2	1	0
Hydrolagus colliei (*)	0	1	1	2	1
Clupea harengus pallasi	2	0	2	2	0
Oncorhynchus sp.	738	624	1502	920	1
Gadidae	4	0	2	4	0
Sebastes sp.	8	0	22	30	1
Anoplopoma fimbria	0	0	1	0	0
Hexagrammidae	5	0	3	3	0
Cottidae	0	0	0	0	0
Pleuronectidae	2	0	5	2	0

Table A-16. (30-31S, 0-2E).

All elements

	Period			
Taxon	**2**	**3**	**4**	**5**
Rajidae	0	0	4	0
Squalus acanthias	19	0	0	0
Hydrolagus colliei	0	0	2	0
Clupea harengus pallasi	0	10	4	0
Oncorhynchus sp.	78	27	1572	9
Gadidae	0	1	0	0
Sebastes sp.	11	0	9	14
Anoplopoma fimbria	0	0	0	0
Hexagrammidae	3	0	0	8
Cottidae	0	0	0	0
Pleuronectidae	0	0	1	1
Unidentified fish	0	3	0	0
Vertebra centra (*dental plates)				
Rajidae	0	0	4	0
Squalus acanthias	19	0	0	0
Hydrolagus colliei (*)	0	0	2	2
Clupea harengus pallasi	0	10	4	0
Oncorhynchus sp.	78	27	1557	9
Gadidae	0	1	0	0
Sebastes sp.	8	0	6	12
Anoplopoma fimbria	0	0	0	0
Hexagrammidae	3	0	0	7
Cottidae	0	0	0	0
Pleuronectidae	0	0	1	1

APPENDIX B

Namu Periodization and C-14 Chronology

Roy L. Carlson

Dates from 38 radiocarbon samples (Table B-1) from Namu provide a chronological framework spanning 9700 C-14 years before the present, which is equal to perhaps 11,000 calendar years ago. Four horizontally separate parts of the Namu site (Fig. B-1) have been dated by C-14 and are designated as follows: the Main Excavation or Main Trench (Hester and Nelson 1978, Fig. 13 FS 1-9; R. Carlson 1979, Fig. 2); the Rivermouth Pits or Trench (R. Carlson 1979, Fig. 2); Test Pits 1-5 (R. Carlson 1979, Fig. 2); and the Front Trench (Hester and Nelson 1978, Fig. 13 FS 10,12). Other excavation units shown in Figure B-1 have not yielded sufficient information to justify dating.

Namu has been subjected to three episodes of C-14 dating. The first consisted of 14 dates run by the Gakushuin Laboratory (Gak) in 1969-70 for the University of Colorado Bella Bella Prehistory Project (Hester and Nelson 1978, Table 3 and Figs. 77, 78) on samples excavated at that time. All of the Gakushuin Laboratory dates listed in Table B-1 are from this episode. The second episode of dating took place on samples excavated in 1977 and 1978 as part of the Simon Fraser University Namu Project (R. Carlson 1979). The 1977 samples were dated by the Washington State University Laboratory (WSU) in Pullman, and the 1978 samples by either the University of Waterloo Laboratory (WAT), or the new Simon Fraser University Laboratory (SFU). The third dating episode took place in 1982 when bone samples were selected from seven previously excavated human skeletons as part of a study of the Namu skeletal remains (Curtin 1984) with some of the dates from the Saskatchewan Laboratory (S) and some from SFU. All of the dates on bone samples in Table 1 are from this study. The dates from the Main Trench and Rivermouth excavations are plotted on the profile drawings in Figures B-2 and B-3.

There has been considerable recent progress in correcting C-14 dates by calibrating them with tree ring dates. Both uncalibrated and calibrated dates for Namu are given in Table B-1. The calibrated dates are based on the computer program provided by the Quaternary Isotope Laboratory at the University of Washington (Stuiver and Reimer 1987). In those instances in which the computer program gave several possible calibrated dates, those dates have been averaged to give the single calibrated date listed in Table B-1. Since this program does not extend beyond the 7800±200 B.P. C-14 date, the four oldest dates (8570±90 through 9720±140) have been calibrated using the following calibration formula: Calibrated B.P. Age = (C-14 B.P. Age x 1.05) ± 470 years (Stuiver et al. 1986:969-979). Calibration of the oldest date (9720±140 B.P.) using uranium-thorium calibrations (Bard et al. 1990: Table 1) would actually make this date older than the 10,676 date obtained using the formula, and place it about 11,090 cal. years B.P. Hence, the beginning of Period 1 at 11,000 B.P. is not without justification. Overall when combined with the stratigraphic data from the site, a sequence of six chronological periods emerges from the data.

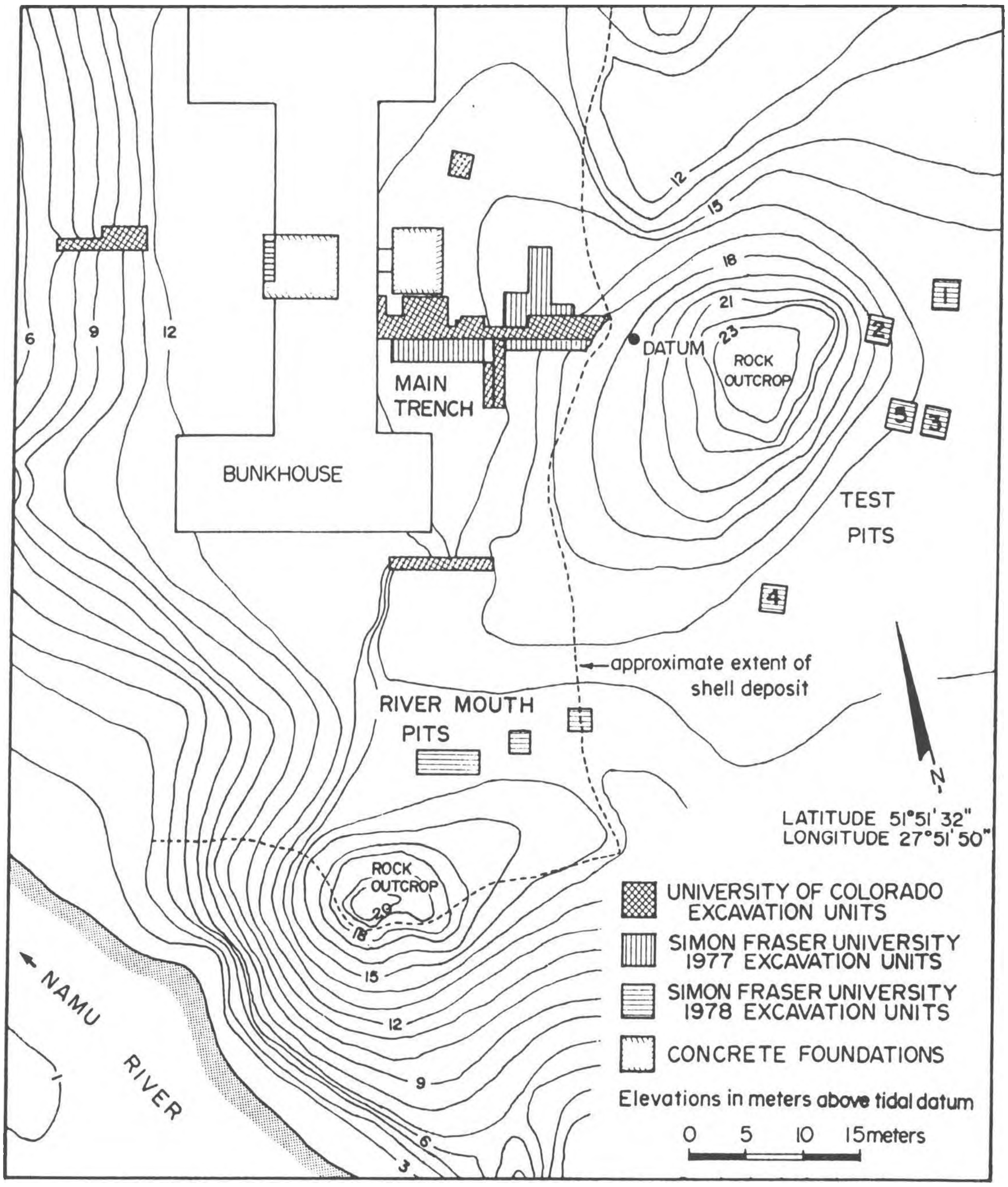


Figure B-1. Map of the Namu Excavations.

Period 1 - 11,000 to 7000 B.P.

Two dates of this period, 9140±200 and 7800±200, are from the very back of the Main Trench East (Hester and Nelson 1978, Fig. 78, dates nos. 3 and 4) where deposits rest against a bedrock outcrop (Fig. B-2). A number of non-shell humus layers dating to different time periods converge toward the eastern end of this trench. In the original analysis the lowermost of the converging strata was called the "black matrix" or Stratum II and its entire content was considered to extend backward to the time of these two dates (Hester and Nelson 1978, Figs. 74, 75), even though both dates were at the far eastern margin of the deposit. Subsequent analysis and dating of samples excavated in 1977 indicated that these two dates came from an attenuated portion of the "black matrix" in which there were a few artifacts, but no faunal remains. This earliest part of the "black matrix" was subsequently designated as Stratum IIa; it is 60 cm. thick at its maximum, rests on glacial till, runs 110 cm. east-west and no more than 2 m. north-south (Fig. B-2). A similar situation exists in the Rivermouth Trench in which the lowermost deposit, Stratum IIa, is devoid of faunal remains.

The remaining four dates for Period 1 are all from the Rivermouth Trench (Table B-1, Fig. B-3). The oldest date, 9720±140, is from the margin of the underlying sub-soil and the earliest cultural layer, Stratum IIa, at a surface depth of 390 to 395 cm. in association with flakes from the Period 1 artifact assemblage. The 9000±140 date is from a surface depth of 370 to 380 cm., and the 8750±90 date from below a large sandstone slab at a surface depth of 340 to 350 cm. The final dated sample of this period, 6550±90, was taken from the wall profile of the excavation toward the top of Stratum IIa at a surface depth of 330-340 cm. specifically for dating the end of the pre-shell occupation. Shellfish remains and some bones do occur in pits and pockets at lower surface depths, but these occurrences are intrusive from the overlying shell bearing layers. Stratum IIa is black to brown in color, runs throughout the Rivermouth Trench directly over glacial till, varies from 20 to 70 cm. in thickness, and contains a large number of disintegrating sandstone slabs. There is no clear stratigraphic break between Stratum IIa and IIb other than for the locations of elongate thin lenses of disintegrated shell which mark the beginning of the deposits assigned to the next period.

The absence of bone artifacts and faunal remains in the Period 1 deposits is related to soil acidity. This acidity is much reduced later because of the alkaline content of mollusc shells which first appear in Period 2. The artifactual remains of this period are mostly lithic workshop debris from cobble reduction, but do include finished as well as unfinished tools. Microblade technology based mostly on imported obsidian is added to the cultural inventory at about the middle of Period 1.

Period 2 - 7000 to 6000 B.P.

The deposits of Period 2 are differentiated from those of Period 1 by observable color differences, and by the appearance of seashells, bone faunal remains and bone tools in both the Main Trench and the Rivermouth Trench. Stratum IIb is the field stratum designation for deposits of this period.

In the Main Trench bands of a red/brown iron deposit are found and appear to have formed in situ; they do not represent depositional events. Stratum IIb extends 11 m. west from the bedrock outcrop at the eastern end of the excavation and is present throughout the north-south extent of the excavation; it reaches a maximum of 70 cm. in thickness, and rests on glacial till except at its far eastern end where it covers Stratum IIa. Ash laminae, rock concentrations suggesting hearths, and burials occur in the deposit. Bone occurs throughout this deposit, but shell is limited to small lenses of mussel most closely associated with the 5340±90 date. Five dates (Table B-1, Fig. B-2) were obtained on samples from Stratum IIb in the Main Trench: 6060±100, 5740±100, 5370±170, and 5240±90 were from separate charcoal concentrations, and one date, 5590±100, was on Burial 1.11B.1 (Curtin 1984:159). This burial had previously been dated tentatively to 4540 C-14 years B.P.

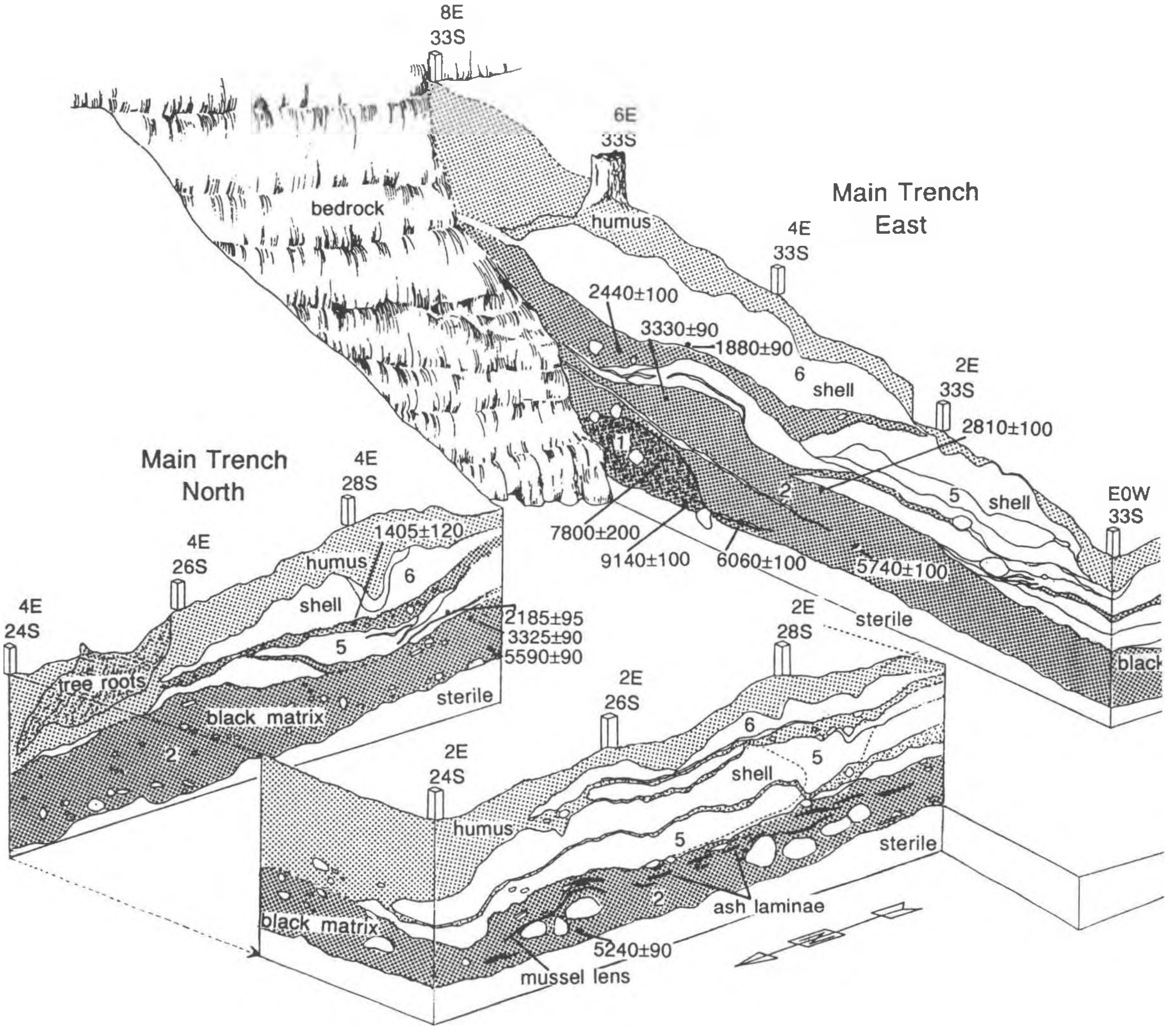
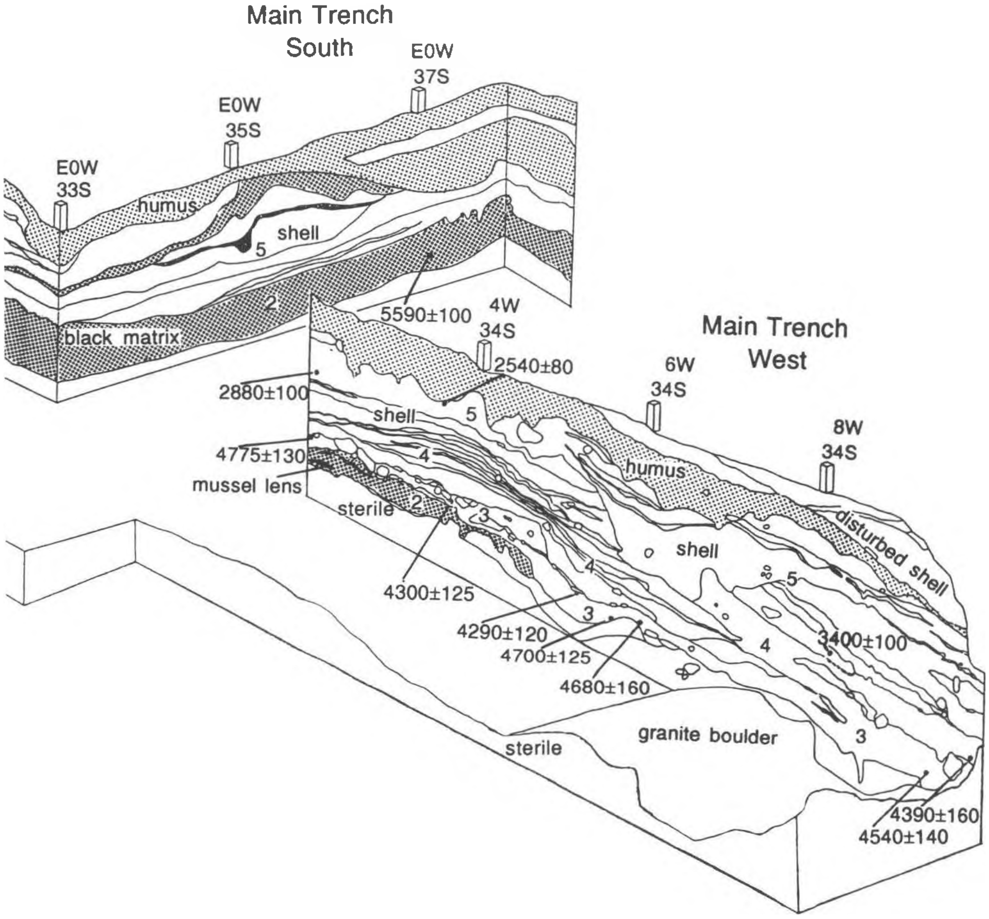


Figure B-2. Stratigraphy and C-14 dates in the Main Trench. Numbers 1 - 6 refer to the time periods to which the various strata have been assigned on the basis of associated C-14 dates and superposition. The profile at 2E, 24-30S has been displaced in order to show both walls of the excavation unit. The sterile layer underlying the cultural deposit is glacial till.


Main Trench South
E0W 37S
E0W 35S
E0W 33S
humus
shell
5
2
black matrix
5590±100
4W 34S
2540±80
Main Trench West
6W 34S
8W 34S
2880±100
shell
5
4775±130
4
mussel lens
sterile
2
3
humus
disturbed shell
shell
5
4300±125
4
4290±120
3
4700±125
4680±160
4
3400±100
granite boulder
sterile
3
4390±160
4540±140

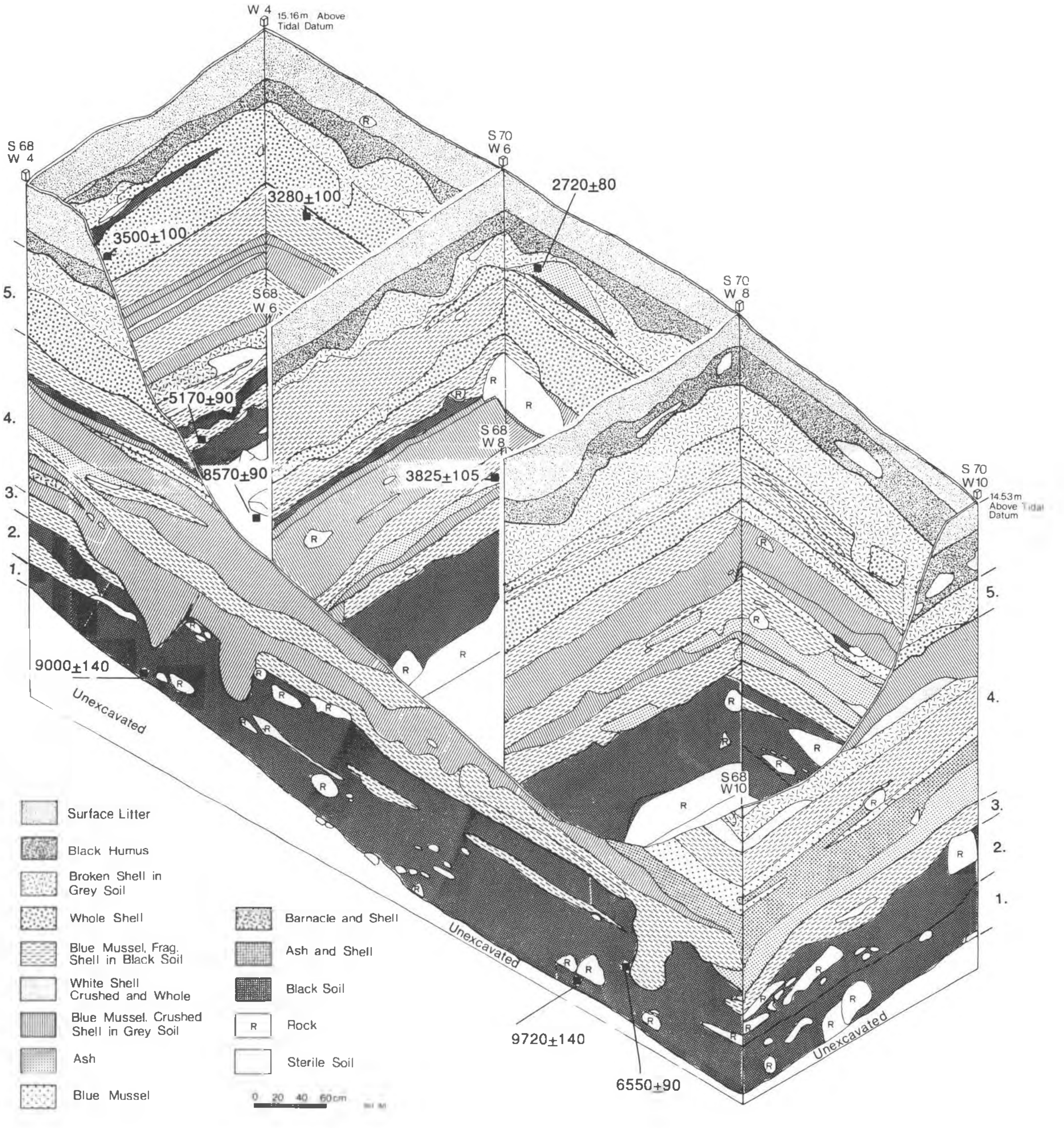


Figure B-3. Stratigraphy and C-14 dates in the Rivermouth Trench. Numbers 1 - 5 refer to the time periods to which the various strata have been assigned on the basis of associated C-14 dates and superposition. The lowermost part of the cultural deposit rests on sterile glacial till about 6 meters above present highest high tide.

(Hester and Nelson 1978:32) following a policy of dating burials to the overlying layer rather than to the deposit in which they were found. The 5740±100 sample was directly associated with flakes and hearth stones.

The only date on the deposit in the Test Pits belongs to Period 2. The 5700±360 date came from a small charcoal sample at the bottom of the cultural layer in Test Pit 2 at a surface depth of 88 cm. Stratification in all of the test pits at the back of the site (Fig. B-1) was uniform with glacial till succeeded by a black implementiferous layer with a few fire cracked rocks, followed by a sterile humus layer and the forest surface. No shell or bone was found in the Test Pits, and the charcoal sample dated was the only one large enough to date given the dating technology available at the time. This single date plus the appearance of the cultural layer and its artifact content indicate that the material from the Test Pits all belongs to Period 2. The absence of shell in the test pits tends to corroborate the general rule of thumb that the greater the distance from the shoreline, the less the probability of shell deposition.

Stratum IIb in the Rivermouth Trench is black, up to 40 cm. in thickness, and contains a number of long thin lenses of shell. The laminae are clearly shell, but are so soft and mushy that individual shells cannot be identified. The single date of this period from this excavation unit, 5170±90, came from scattered bits of charcoal in the lowermost shell lens at a surface depth of 310 to 320 cm.

The lithic industries of Period 1 including microblades continue throughout Period 2.

Period 3 - 6000 to 5000 B.P.

Deposits dating to Period 3 are not well represented. All Period 3 radiocarbon dates are on samples from the Main Trench West (Fig. B-2). The three oldest dates, 4775±130 (Burial SFU 77-2) and 4700±125 (Burial 4G8) and 4680±160 (Burial 4G2), are all from the western portion of the Main Trench. All are from multiple burials in what was clearly a designated burial area if not actually a burial house at this time period. These dates place these burials and their associated grave goods 500 to 1000 years earlier than previously estimated. The fourth date, 4540±140, is on charcoal from the lowest shell layer in this same part of the excavation. The deposits themselves are variable; humus and fragmented shell with lenses of mussels and clams is the most common matrix, but there is also a layer of barnacles and clams over some of the burials. More deposits were probably present west of the Main Excavation before the Bunk House was built.

There are no Period 3 C-14 dates from the Rivermouth Trench. The only deposit which falls stratigraphically in this period is a 10 to 20 cm. thick layer of blue mussel and gray soil which is found throughout the Rivermouth Trench at a surface depth of approximately 280 to 290 cm. between the strata belonging to Periods 2 and 4.

Period 4 - 5000 to 4000 B.P.

Deposits of this period make up almost half of the cultural layers from the Rivermouth Trench, but they are only weakly represented in the Main Trench.

Two of the dates of this period, 4390±160 and 4300±125, are on burials from the western portion of the Main Trench; they represent continued use of the circumscribed burial area which began in the previous period. The third date, 4290±120, came from charcoal in the deposit near these same burials (Fig. B-3). The deposits consist mostly of matrices of humus and fragmented shell alternating with layers of clams and barnacles. There is no clear separation from Period 3 deposits, and arbitrary levels have been used as a boundary. From 2 to 6 meters west two dark bands of humus mark the boundary with the succeeding deposits of Period 5.

Table B-1. Radiocarbon Dates from the Site of Namu (ElSx-1).

Period	C-14 Date B.P.	Tree-Ring Calibrated Date B.P.	Material	Lab. No.
contact				
6	480±80	(521)	Charcoal	Gak 3121
	680±90	(668)	Charcoal	Gak 3122
	980±100	(927)	Charcoal	Gak 3123
	1405±120	(1308)	Charcoal	WSU 1942
	1470±80	(1361)	Charcoal	Gak 3125
	1840±80	(1769)	Charcoal	Gak 3124
	1880±90	(1850)	Shell	Gak 3118a
2000 B.P.				
5	2185±85	(2226)	Charcoal	WSU 1939
	2440±100	(2527)	Charcoal	Gak 3119
	2530±160	(2650)	Bone	SFU 341
	2540±80	(2672)	Charcoal	WSU 1938
	2720±80	(2818)	Charcoal	SFU 10
	2810±100	(2922)	Charcoal	Gak 2714
	2880±100	(3013)	Charcoal	Gak 2713
	3280+100	(3516)	Charcoal	SFU 17
	3330±90	(3608)	Charcoal	WSU 1944
	3400±100	(3660)	Charcoal	Gak 2715
	3500±100	(3774)	Charcoal	SFU 19
4000 B.P.				
4	3825±105	(4218)	Charcoal	SFU 1
	4290±120	(4862)	Charcoal	Gak 2717
	4300±125	(4864)	Bone	S2327
	4390±160	(4928)	Bone	SFU 343
5000 B.P.				
3	4540±140	(5200)	Charcoal	Gak 2716
	4680±160	(5381)	Bone	SFU 342
	4700±125	(5380)	Bone	S2328
	4775±130	(5525)	Bone	S2326
6000 B.P.				
2	5170±90	(5940)	Charcoal	WAT 451
	5240±90	(5969)	Charcoal	WSU 1943
	5590±90	(6375)	Charcoal	WSU 1947
	5590±100	(6375)	Bone	SFU 344
	5700±360	(6480)	Charcoal	WAT 456
	5740±100	(6506)	Charcoal	WSU 1940
	6060±100	(6921)	Charcoal	WSU 1941
7000 B.P.				
1	6550±90	(7431)	Charcoal	WAT 517
	7800±200	(8559)	Charcoal	Gak 3120
	8570±90	(9468)	Charcoal	WAT 516
	9000±140	(9920)	Charcoal	WAT 519
	9140±200	(10067)	Charcoal	Gak 3244
	9720±140	(10676)	Charcoal	WAT 452
11000 B.P.				

In the Rivermouth Trench the strata of this period consist of broken and scattered shell in a gray humic matrix with lenses and bands of blue mussel, ash and fire cracked rock, and crushed clam shell. It reaches a maximum thickness of 140 cm. The one dated carbon sample gave a date of 3825±105. This sample came from Field Stratum IIIa at a depth of 280 to 285 cm. below the surface and was taken in order to date the beginning of the major shell accumulation in this excavation unit. This deposition terminates with Stratum IV, a layer of whole shell, which belongs to the next period.

Period 5 - 4000 to 2000 B.P.

The deposits (Field Strata 5 and 6) of Period 5 in the Main Trench achieve their maximum thickness of 120 cm. at the western end of the excavation. They consist of matrices of humus and shell fragments with layers of mussel, barnacles, clams and ash. A layer of humus with no shell at the eastern end of the Main Trench also belongs in this period. There are seven stratigraphically consistent dates from Period 5. The earliest date, 3400±100, is on Field Stratum Vb. The next youngest date, 3330±90, on Field Stratum Vc was obtained on a sample taken in an attempt to differentiate Stratum II from Vc at the far eastern end of the Main Trench where the convoluted strata thin and merge (Fig. B-2); a date of 2810±100 from a sample taken two meters to the west at about the same depth (Hester and Nelson 1978, Fig. 78, sample #5) also indicates that the upper part of the black matrix belongs with this period rather than earlier. The date of 2540±80 on charcoal from the uppermost layer of shell below the humus marks the termination of cultural deposition in the Main Trench West. Two dates, 2440±100 and 2185±95, mark deposits of Period 5 in the eastern and northern parts of the Main Trench.

The deposits of this period in the Rivermouth Trench are primarily layers of whole shell and lenses of whole shell within a matrix of gray humus and broken shell. There are also bands of blue mussel, ash, and fire cracked rock. The maximum thickness of this deposit is 140 cm. Four samples from the Rivermouth Trench (Fig. B-3, Table B-1) date to this period. The earliest, 3500±100, was obtained on scattered charcoal from Stratum IV, a layer of whole shell, at the eastern end of the excavation unit. The next youngest date, 3280±100, came from immediately below it in Stratum IIId. These two dates seem to constitute a slight stratigraphic reversal, but since there was only 10 cm. difference in depth between the samples, and there is only a 20 year gap between the outer limits of their standard deviations, this reversal is insignificant; averaging these two dates would probably produce the most valid date. The next sequent date, 2720±80, was on concentrated charcoal from near the top of Field Stratum IVb. The final date, 2530±160, was obtained from burial 78-1 which was also in the top of Stratum IV. The succeeding thick humus deposit, Stratum V, was sterile of cultural material except for some shell lenses which are probably borrow material from interring Burial 78-1.

Period 6 - 2000 B.P. to Contact

Cultural deposits dating to Period 6 are present only in the Front Trench and in the eastern and northern portions of the Main Trench (Fig. 2). No work was done in the area of the Front Trench in 1977-78.

In the eastern portion of the Main Trench the deposits consist of clam and mussel shell in a humic mix; burials are found in these shell deposits. Several depositional episodes are indicated by intercalated humus layers with differing C-14 dates. The 1405±120 B.P. charcoal sample came from Field Stratum 7, a black, shell-free, fine humus layer underlying Burials 77-10 and 77-11, which were covered with the shell midden of Field Stratum 8 at the very back of the excavation. The 1880±90 date (Fig. B-2; Hester and Nelson, Fig. 78, date no. 2) apparently belongs to a slightly earlier shell deposition in the same part of the site, although both deposits were considered to be part of Stratum 8 during the field investigation and both do date to Period 6.

Table B-2. Radiocarbon Dates by Main Excavation Unit and Period.

	Front Trench	**Main Trench**	**Rivermouth**	**Test Pits**
contact				
	480±80 (521)			
	680±90 (668)			
	980±100 (927)			
6		1405±120(FS 7) (1308)		
	1470±80 (1361)			
	1840±80 (1769)			
		1880±90(FS 8) (1850)		
2000 B.P.				
		2185±85(FS 6) (2226)		
		2440±100(FS 7) (2527)		
		2530±160(B78-1) (2650)		
		2540±80(FS 5d) (2672)		
			2720±80(FS 4b) (2818)	
5		2810+±00(FS 5) (2922)		
		2880±100(FS 6a) (3013)		
			3280±100(FS 3d) (3516)	
		3330±90(FS 5c) (3608)		
		3400±100(FS 5b) (3660)		
			3500±100(FS 4a) (3774)	
4000 B.P.				
			3825±105(FS 3a) (4218)	
4		4290±120(FS 4b) (4862)		
		4300±125(B 212E1) (4864)		
		4390±160(B 4J1) (4928)		
5000 B.P.				
		4540±140(FS 4a) (5200)		
		4680±160(B 4G2B1) (5381)		
3		4700±125(B 4G8) (5455)		
		4775±130(B 77-2) (5525)		
6000 B.P				
			5170±90(FS 2b) (5940)	
		5240±90(FS 2b) (5969)		
		5590±90(FS 2b) (6375)		
2		5590±100(B 1.11B.1) (6375)		
				5700±360(FS 2b) (6480)
		5740±100(FS 2b) (6506)		
		6060±100(FS 2b) (6921)		
7000 B.P				
			6550±90(FS 2a) (7431)	
		7800±200(FS 2a) (8559)		
1			8570±90(FS 2a) (9468)	
			9000±140(FS 2a) (9920)	
		9140±200(FS 2a) (10067)		
			9720±140(FS 2a) (10676) 1	
1100 B.P				

FS = Field Stratum B = Burial Number ( ) = Tree Ring Calibrated Date

Five carbon samples from the Front Trench yielded ages ranging from 1840±80 to 480±80 B.P. (Hester and Nelson 1978, Figs. 21, 77) and indicate build-up of three vertical meters of deposit in this part of the site during this period. There is a slight reversal of dates in the lower part of this excavation unit, but it does not alter the overall placement of all the material from the Front Trench in Period 6. Deposits dating to Period 6 are not present in the area between the Front Trench and the eastern part of the Main Excavation. The uppermost humus layer in the Main Excavation West caps Stratum 6 deposits belonging to Period 5, and the remaining part of the intervening area is covered by the Bunkhouse (Fig. B-1). It is probable that deposits of this period were present in this intervening area, but were removed as part of levelling for the building of the large bunkhouse.

Although no deposits with European trade goods dating to the contact period were discovered in the excavation, the youngest C-14 date, 480±80 B.P., is barely prehistoric. The ethnographic evidence indicates that the site was used in the historic period. Evelyn Windsor and Jennifer Carpenter of the Waglisla Cultural Center brought Alex Campbell, the eldest Bella Bella with traditional ties to Namu, to the excavations in 1977. According to Mr. Campbell, Namu was the site of the village of Mah'was. According to Neville Lincoln of the SFU linguistics department, the name Mah'was translates as "loading place." Mrs. Windsor ventured the possibility that the name Namu came from Lake Na'wamu which is about a kilometer inland and whose outlet, the Namu River, is at the site.

Other Radiocarbon Dates

Two dates are inconsistent with those cited above and have been discounted in building the preceding chronology. The first (WSU 1945) dated 108.4% modern, and the second (WSU 1946) dated 1640±130 B.P. Both samples were from Stratum IIb and should have dated in the 5000 to 6000 B.P. range. Both samples were taken in 1977 from locations very close to the margins of the earlier 1969-70 excavations, and contamination with modern carbon may have occurred during the intervening period.

The preceding chronology demonstrates that in terms of present knowledge Namu is the longest occupied site in British Columbia. The dating also indicates the complexities of shell midden stratification when sites are occupied for very long periods.

APPENDIX C

Faunal Analysis of Matrix Samples

Ingrid Fawcett

Faunal remains were recovered from thirteen matrix samples taken from the Namu excavations. Seven of the samples were taken in 1978 from the Rivermouth Trench; six samples were taken from adjacent to the Central Main Trench in 1977. The 1977 samples were selected from a single 50x50 cm. column; the 1978 samples were judgmentally selected from various strata during the course of excavation. The samples are small, and they cannot be considered representative of the stratum matrix from which they were taken. The faunal content of the samples would be expected to vary considerably according to relatively minor variations in micro-deposition patterns. One of the Period 4 samples from the Rivermouth Trench (Tab. C-2) was selected because of the high concentration of salmon within the sampled stratum. The matrix samples, therefore, cannot provide an accurate indication of changes in relative faunal abundance over time, but they can indicate the proportionate screening loss of small faunal remains from the overall excavation matrix. The samples were analyzed for shell content by passing the matrix through a series of nested screens of diminishing mesh size. All of the faunal remains retained in the screens were recovered for later identification. The sample volumes and frequencies of identified fauna are listed in Tables C-1 and C-2. Given the relative quantity of fish and mammal remains in the overall excavated matrix, it is not surprising that fish are the most abundant fauna in the matrix samples. The significant contrast with the overall fish assemblage is the relative abundance of herring *(Clupea harengus pallasi)*. The majority of herring vertebrae evidently passed through the 1/8 inch (3.2 mm.) mesh used to screen the excavation matrix. The small vertebrae of greenlings *(Hexagrammos sp.)* are also more abundant in the matrix samples. The presence of sablefish *(Anoplopoma fimbria)* vertebrae is somewhat surprising since they were extremely rare in the overall fish assemblage, but they are fragile elements, and they may have been destroyed more often during the water-screening of bulk matrix samples. However, even though sablefish may have been more common than indicated by their abundance in the total fish assemblage, they were still a relatively minor fish resource. The representation of salmon *(Oncorhynchus sp.)*, and the presence of single elements of deer *(Odocoileus hemionus)*, harbour seal *(Phoca vitulina)*, and dog *(Canis familiaris)* is consistent with the overall faunal assemblage. The small size of the matrix samples makes it difficult to extrapolate from their faunal content. Table C-3 shows the projected frequency of identified fauna per cubic metre of matrix samples. The results support an increase in salmon and herring in Period 4 (see Chapter 4), but without knowing whether the samples are representative it is impossible to infer temporal trends from these figures. The one clear implication of the matrix sample fauna is that herring was a major subsistence resource throughout the period of the faunal record. Table C-4 compares the abundance of salmon and herring from the total excavated matrix with their expected abundance as projected from the quantities recovered from the matrix samples. The figures show that the projected abundance of salmon in Periods 2 and 3 is actually lower than the quantities recovered. This is clear evidence that the matrix samples are not representative of the faunal content of the overall matrix from these periods. However, despite the inaccuracy of the absolute projections in Table C-4, they do indicate that herring are much more under-represented than salmon in the total faunal assemblage. Herring must be considered a major part of the Namu subsistence economy.

Table C-1. Frequencies of Identified Fauna in Matrix Samples from Adjacent to the Central Main Trench (Sample Volumes in cubic decimetres).

Period 5	**vol. = 15.6 dm.^{3}**	**vol. = 15.6 dm.^{3}**
Oncorhynchus sp.	0	39
Clupea harengus pallasi	48	199
Hexagrammos sp.	0	6
Unidentified Fish	1	0
Period 4	**vol. = 15.6 dm.^{3}**	**vol. = 12.5 dm.^{3}**
Oncorhynchus sp.	22	1
Clupea harengus pallasi	116	75
Hexagrammos sp.	7	5
Unidentified Fish	1	0
Period 3	**vol. = 13.5 dm.^{3}**	**vol. = 15.6 dm.^{3}**
Oncorhynchus sp.	1	2
Clupea harengus pallasi	16	80
Hexagrammos sp.	0	1
Canis familiaris	0	1
Period 2	**vol. = 6.25 dm.^{3}**	
Oncorhynchus sp.	1	
Clupea harengus pallasi	18	
Hexagrammos sp.	1	
Unidentified Fish	1	
Phoca vitulina	1	

Table C-2. Frequencies of Identified Fauna in Matrix Samples from the Rivermouth Trench (Sample Volumes in cubic decimetres).

Period 5	**vol. = 4 dm.^{3}**	**vol. = 4 dm.^{3}**	
Squalus acanthias	1	0	
Oncorhynchus sp.	2	3	
Clupea harengus pallasi	18	12	
Sebastes sp.	1	0	
Hexagrammos sp.	2	0	
Anoplopoma fimbria	1	0	
Unidentified Fish	4	0	
Period 4	**vol. = 4 dm.^{3}**	**vol. = 4 dm.^{3}**	**vol. = 4 dm.^{3}**
Oncorhynchus sp.	246	13	35
Clupea harengus pallasi	457	0	0
Sebastes sp.	3	0	0
Hexagrammos sp.	1	0	0
Anoplopoma fimbria	2	0	0
Unidentified Fish	8	0	0
Period 3	**vol. = 13.5 dm.^{3}**		
Oncorhynchus sp.	1		
Clupea harengus pallasi	121		
Hexagrammos sp.	3		
Anoplopoma fimbria	1		
Unidentified Fish	7		
Odocoileus hemionus	1		

Table C-3. Projected Frequencies of Identified Fauna per Cubic Metre of Matrix Samples.

	Period			
Taxon	**2**	**3**	**4**	**5**
Squalus acanthias	0	0	0	26
Oncorhynchus sp.	160	121	7406	1122
Clupea harengus pallasi	2880	6556	13791	7066
Sebastes sp.	0	0	75	26
Hexagrammos sp.	160	121	324	204
Anoplopoma fimbria	0	30	50	26
Unidentified Fish	160	211	224	128
Canis familiaris	0	30	0	0
Phoca vitulina	160	0	0	0
Odocoileus hemionus	0	30	0	0

Table C-4. Recovered and Projected Frequencies of Salmon *(Oncorhynchus sp.)* and Herring *(Clupea harengus pallasi)* in Excavated Period Matrix.

	Excavated	Salmon		Herring	
Period	**Volume (m^3)**	**Recovered**	**Projected**	**Recovered**	**Projected**
5	38.6	9509	43009	48	272748
4	16.3	58940	120718	366	224793
3	13.7	17272	1658	33	89817
2	13.4	5720	2144	28	38592

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