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A ZOOARCHAEOLOGICAL STUDY OF GENERATIONAL DECISION-MAKING: MODELING
SUBSISTENCE AND DEMOGRAPHIC CHANGE IN LATE-HOLOCENE OCCUPATIONS OF
HOUSEPIT 54 AT THE BRIDGE RIVER SITE (EeR14), MID-FRASER, B.C.

By

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Dissertation

presented in partial fulfillment of the requirements
for the degree of

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ABSTRACT

Walsh, Matthew J., Doctor of Philosophy, Oct, 2015

Anthropology

A Zooarchaeological Study of Generational Decision Making: Modeling Subsistence, Demographic, and Environmental Change in Late-Holocene Occupations of the Bridge River Site (EeRI4), Mid-Fraser, B.C.

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The Bridge River site is a winter pithouse village near the confluence of the Bridge and Fraser Rivers in the Mid-Fraser Canyon that was occupied periodically from as early as 1800BP to the mid-19th century. Prentiss et al. (2008) divide the range of occupations into four Periods: Bridge River (BR) 1, c. 1800-1600BP, BR2, c. 1600-1300BP, a short-lived BR3, c. 1300-1100BP (by the end of this period the village appears to have been largely abandoned), and BR4, a late reoccupation of the site, c. ~500 to 100BP (Prentiss et al. 2008, 2011, 2012). During BR2 and into BR3, between 1500-1100BP, the village experienced punctuated population growth and then underwent dynamic and rapid population decline and abandonment at the end of BR3. This trend continued throughout the Middle Fraser region toward the end of BR3, as major village populations experienced rapid declines and abandonment events leading up to roughly 1000 BP.

The goal of this research is to investigate patterns of subsistence change through the course of pithouse occupations to determine if changes in subsistence reflect demographic fluctuations or indicate processes of intensification of key resources. Conflicting theories have been proposed to explain population decline in the Mid-Fraser, all centered around depletion of subsistence resources: 1) as the result of the onset of warmer/drier temperatures during the Medieval Warm Period that caused declining production of valuable subsistence resources (i.e. salmon) in the region (Prentiss et al. 2005); 2) as the result of the obstruction of salmon runs caused by a catastrophic landslide blocking salmon migration routes into the Mid-Fraser Canyon (Hayden 1997; Hayden and Ryder 1991, 2003); 3) due to the overexploitation and subsequent depletion of terrestrial resources, particularly deer and upland geophytes (Kuijt and Prentiss 2004); and 4) as the result of naturally occurring phenomena such as perennial fluctuations or falloffs in salmon production at major fisheries (Kew 1992).

Through the analysis of the Housepit 54 archaeofaunas and other materials and features, and the application of systematic methods of assessing taxonomic variability and population dynamics (Grayson 1981; Chamberlain 2006), this research seeks to evaluate the relationship between changing subsistence practices and the distinct population fluctuations that define the period between the onset of BR2 and the end of BR3. The intact stratified floor sequence at Housepit 54 offers the potential to observe changes in subsistence at a near generational scale spanning the periods of major village growth and decline circa BR2-BR3. Looking at changes in subsistence at the household level over time within a single pithouse provides a unique opportunity to test how households coped with demographic and subsistence changes.

This research draws on zooarchaeological data and applies concepts of resource intensification and decline to comment on the effects on food availability during the period of population growth and decline experienced from BR2 to the end of BR3. A Malthusian Model (Malthus 1798; Prentiss et al.

2014; Puleston et al. 2013) is used to juxtapose subsistence intensification scenarios with changes in household population within Housepit 54 specifically.

Finally, a brief evaluation is offered of how a general Malthusian framework may offer a synergistic perspective from which to assess test expectations regarding population pressure and its effects on subsistence change at the household level.

Acknowledgements

This research was funded by the National Endowment for the Humanities (Grant #RZ-51287-11). Previous work at Bridge River has been funded by the National Science Foundation (Grant #s BCS-0313920 and BCS-0713013). All research at Bridge River has been undertaken with the express permission, supervision, and support of the Xwisten Band of the St'at'imc First Nation of British Columbia, Canada – without their continued backing none of this research would have been possible, and for that I am truly grateful. Laboratory space was provided by Dr. Anna M. Prentiss in the Department of Anthropology at the University of Montana and the Philip L. Wright Zoological Museum and Montana Comparative Skeletal Collection under the curation of David Dyer and Paul Hendricks provided comparative skeletal materials that were used for analysis of the animal bone assemblage. Many students and volunteers contributed to excavation efforts and laboratory work for the 2013 and 2014 investigations at Housepit 54 and I am indebted to each of them for their hard work, curiosity, and enthusiasm.

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TABLE OF CONTENTS

	Page
Abstract.....	iii
Acknowledgements.....	v
Table of Contents.....	vi
List of Figures.....	vii
List of Tables.....	ix
 Chapter 1: Background and History.....	 9
 Chapter 2: Theoretical Frameworks.....	 47
 Chapter 3: Methods.....	 85
 Chapter 4: Assemblage and Analysis.....	 104
 Chapter 5: Discussion and Conclusion.....	 183
 References Cited.....	 199
 Appendix A.....	 228
 Appendix B.....	 294
 Appendix C.....	 315

List of Figures

Figure	Page
1.1.....	3
1.2.....	22
1.3.....	23
2.1.....	78
3.1.....	88
4.1.....	116
4.2.....	118
4.3.....	121
4.4.....	122
4.5.....	123
4.6.....	124
4.7.....	125
4.8.....	126
4.9.....	127
4.10.....	128
4.11.....	129
4.12.....	130
4.13.....	137
4.14.....	140
4.15.....	141
4.16.....	144
4.17.....	146
4.18.....	148
4.19.....	154
4.20.....	155
4.21.....	157
4.22.....	159
4.23.....	160
4.24.....	162
4.25.....	166
4.26.....	172
4.27.....	173
4.28.....	176
4.29.....	178
4.30.....	179
A.1.....	277
A.2.....	279

List of Figures (Cont.)

Figure	Page
A.3.....	281
A.4.....	283
A.5.....	285
A.6.....	287
A.7.....	289
A.8.....	291
A.9.....	293
A.10.....	295
 B.1.....	 296
B.2.....	298
B.3.....	300
B.4.....	302
B.5.....	304
B.6.....	306
B.7.....	308
B.8.....	309
B.9.....	310
B.10.....	312
 C.1.....	 315

List of Tables

Table	Page
1.1.....	11
1.2.....	12
4.1.....	118
4.2.....	137
4.3.....	143
4.4.....	146
4.5.....	150
4.6.....	153
4.7.....	156
4.8.....	158
4.9.....	159
4.10.....	161
4.11.....	168
4.12.....	171
4.13.....	173
4.13.....	178
4.13.....	179
A.1.....	295
A.2.....	297
A.3.....	299
A.4.....	301
A.5.....	303
A.6.....	305
A.7.....	307
A.8.....	309
A.9.....	311
A.10.....	313

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CHAPTER ONE

INTRODUCTION

LAND and PEOPLE

The indigenous people of the Bridge River area are members of the Bridge River Band (*Xwisten*) and are part of the larger confederated peoples of the St'at'imc Nation. The St'at'imc Nation is divided into three groups: the Upper Lillooet, Lower Lillooet, and the Lakes Lillooet, designations based on their respective geographic distributions along the Fraser River Canyon and adjacent Coast Range waterways. Members of this extensive community are part of the widely-dispersed Interior Salish-speaking peoples whose traditional lands comprise much of the Pacific Northwest coast and immediate interior of northwest North America (Elmendorf 1965: 64). The Upper Lillooet (and the *Xwisten* in particular) have traditionally residing along the western side of the Fraser River in the areas immediately adjacent to the confluence of the Bridge and Fraser Rivers, and along the lower portions of the Bridge River Valley which stretches northwest from the Fraser confluence to Bridge River's point of origin at Carpenter Lake. The area encompasses nearly 4000 hectares within the Middle Fraser Canyon portion of the Interior Canadian Plateau in south-central British Columbia.

Where it is joined by Bridge River, the Mid-Fraser Canyon is a dynamic mosaic of creeks and river valleys cut into deep glacially-modified canyons (Figure 1.1). Steep-walled river gorges and overlooking terraces meander through bedrocks of gneiss and granite which extend upwards to become the mountain peaks of the immediate Camelsfoot subrange and the more expansive Coast and Cascade Ranges to the west (Mathews and Monger 2005). At 50°N latitude, the Bridge River village sits along the northeast side of the Bridge River drainage at roughly

250m above sea level in the semi-arid rainshadow along the eastern base of the Coast Mountains.

The surrounding microenvironments comprise an array of environmental contexts – what

Prentiss and Kuijt (2004: vii) describe as an “astounding variation in geophysical and vegetative conditions, including deserts, grasslands, parkland forests, and even rainforest environments.”

Alexander (1992a: 47) divides the environments of the region east of the Fraser River into seven categories consisting of Alpine, Montane Parkland, Montane Forests, Intermediate Grasslands, Intermediate Lakes, River Terraces, and River Valleys, a system that translates well to environments immediately west of the river.

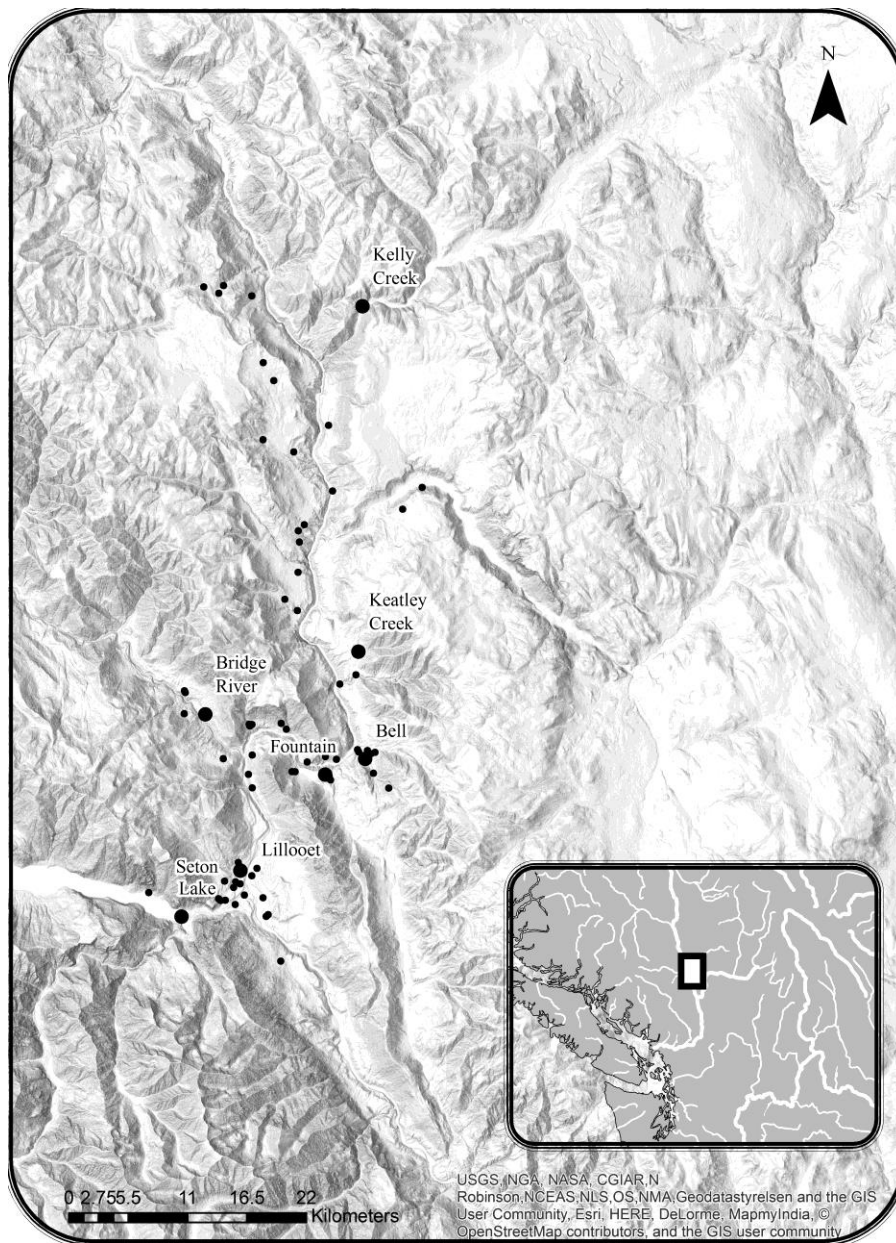


Figure 1.1. Overview of the Middle Fraser Canyon showing the Bridge River winter pithouse village, the Six-Mile Fishery near the confluence of the Fraser and Bridge Rivers, and other major pithouse villages in the area.

The following summarizes archaeological understandings of the prehistory of the Interior Canadian Plateau. Particular attention is given to the prehistory of the Bridge River site (EeR14)

and surrounding localities. Environmental conditions during the Holocene are also provided as they pertain to the prehistoric lifeways described. Finally, an outline of local and regional flora and fauna is presented to give an idea of the subsistence resources utilized by prehistoric hunter-gatherer-collectors in the area.

PREHISTORIC HUNTER-GATHERERS IN ARCHAEOLOGICAL CONTEXT

Understanding the diversity of lifeways practiced by prehistoric peoples is a major goal of archaeology. Archaeologists have long developed complex culture histories and other descriptive systematics for organizing human social and cultural units (Binford 1965). Lewis Binford (1980) introduced a model for interpreting hunter-gatherer lifeways based on the identification of mobility strategies along a continuum from highly mobile foragers to semi-sedentary collectors. Binford's system has since allowed archaeologists to interpret cultural processes, such as technological adaptations, within a larger context based largely on the organization of subsistence labor and the variable mobility that different strategies necessitate. This model predicts the existence of particular site types based on evidence for different degrees of mobility practiced by past peoples. Scholars generally agree that mobility studies can be useful in identifying variability within a wide range of archaeological contexts in the Interior Plateau of northwestern North America (see Ames 1991, 1994; Chatters 1995; Prentiss et al. 2005). Clearly, as the site name implies, the inhabitants of the Bridge River village were largely sedentary during the period analyzed here. Despite this, they actually practiced a seasonal-round that involved late-spring, summer, and early-fall movements to various hunting and fishing camps, berry-picking camps, root-gathering camps, and so on, with the onset of winter

culminating in households coming together into the village with a prepared stockpile of preserved goods and weathering out the cold winter months in the relative comforts of pithouse life. In this sense the prehistoric inhabitants of Housepit 54 fall neatly into Binford's "collector" category, but in many ways their subsistence practices were far more complex.

Within Binford's forager-collector model, foragers are highly-mobile and "map-on" to resources, characteristically making many seasonal residential moves between resource patches. They tend to have a broad spectrum diet that does not take advantage of storage. At the opposite end of the spectrum, collectors logistically organize their activities regarding resources, practicing reduced residential mobility through the use of base camps from which they employ resource acquisition forays ("logistical" moves) targeted at specific resources. This initial research into differentiating between foragers and collectors was based on variability in mobility strategies between these two categories. The model assumes that different mobility strategies are associated with particular formation processes leading to the development of features and sites that can be identified as either "residential" or "logistical" based on the nature and extent of the activities played out at particular locations.

Residential sites are centralized "base" locations within a larger foraging radius. These are sites where people commonly remain for some period of time, semi-annual shorter-lived seasonal occupations within a transhumant cycle, or for extended or indefinite periods as with the emergence of pithouse villages like that at Bridge River. Residential sites may be the result of people becoming tethered to a centralized location that allows access to a localized resource or group of resources (Carlson 1979). At the Bridge River pithouse village, this process of

“tethering” to a particular resource is well-illustrated by the ubiquitous and increasingly-reliant use of salmon throughout the life of the village. In contrast, logistical sites are those locales used for short-term seasonal procurement of a specialized resource at distance from a residence or base camp. Because they are organized with a specific resource goal in mind, logistical sites are associated with whatever resource was being targeted (Binford 1980: 10).

Originally, Binford (1980) subdivided his mobility model partitioning residential sites into “base camps” and “locations”. Logistical sites were similarly divided into “field camps”, “stations”, and “caches”. Each of these has implications for the archaeological record encountered in sites falling within the respective term. At the most basic level, residential sites (like the Bridge River village) tend to contain high densities of artifacts, debitage, trash/middens, and other features associated with long-term occupations such as stratified occupation layers and hearth features, site furniture (e.g. Binford 1979), and architecture (like pithouses). Logistical sites tend to be much more ephemeral and rarely retain evidence of structures.

While these definitions are commonly used to describe patterns seen in hunter-gatherer sites, they tend to simplify complex human practices and decision-making strategies. Despite this contention, they are useful as a framework from which to develop an understanding of subsistence- and settlement-related patterns in the archaeological record. As Carlson (1979: 269) points out, ultimately site types must be distinguished by establishing the “range of activities performed” at the individual site through analysis of “the distribution of features, tool types, and faunal and botanical (sic) remains”, in addition to considerations regarding temporal, geographic, and ecological contexts. Understanding the distinction between mobile hunter-

gatherers and more sedentary forager-collectors is necessary to understanding the culture-historical chronologies developed for the late-Holocene prehistory of the Interior Plateau as it relates to the development of the Bridge River village and the peopling of the Middle Fraser Canyon.

PLATEAU CHRONOLOGY

Chatters and Pokotylo (1998) outlined a cultural-environmental chronology for the Interior Plateau Holocene that divided prehistoric cultural adaptations into three general intervals: the “Early”, “Middle” and “Late” Periods largely based on changes evident in hunter-gatherer subsistence and mobility strategies. They further subdivided these into intervals based on changes in the extent of prehistoric hunter-gatherer mobility, changes in general subsistence patterns, and technological adaptations. They originally provide dates in B.C.; but here I have converted the time scale to before-present (BP) for consistency and clarity. Chatters and Pokotylo’s chronology is summarized as follows.

Early Period 11000-8000 BP

The environment during this time was a relatively continental, seasonally variable climate with the retreat of glacial ice following the last Ice Age. Terrestrial faunas were similar to modern taxonomic richness – with northern Plateau emphasis on “deer, elk, and fish (possibly salmon)” and southern Plateau emphasizing a greater range of subsistence diversity including “riverine resources, small mammals, and birds” as well as shellfish and various fish, particularly

salmonids (Chatters and Pokotylo 1998: 73). Mobile foragers during this time exercised high residential mobility with subsistence variability highly dependent on the time of year and conditions of the local environment.

Middle Period 8000-4000 BP

Early Middle Period 8000-5300 BP

Late Middle Period 5300-4000 BP

During this period the environment was relatively warmer than modern conditions, becoming continually “maritime” after 8000 BP, with increasing expansion and incursion of conifer forest and shrub steppe as well as increased productivity of a variety of root plants. These included balsam root, biscuitroot, and camas - all of which would become staple root harvests of inland forager-collectors throughout the Inland and Pacific Northwest (Chatters and Pokotylo 1998: 74; Teit 1906; 1930; Turner 1997).

Around 5500 BP, ecological conditions in the region’s rivers (including the Fraser) became increasingly favorable for salmon (Grabowski 2015). At around 5000 BP there occurred a “sharp increase in regional moisture... increasing the productivity of southern steppes” and causing forests to expand (Chatters and Pokotylo 1998: 74). This environmental change probably led to the initial development of semi-sedentary settlement strategies concentrated around areas of seasonal resource abundance. On the Canadian Plateau, this “Middle Period” persisted until c. 3500 BP, placing its end roughly 500 years later than elsewhere on the Interior Plateau.

Late Period 4000 BP – 230 BP

Early-Late sub-Period 4000-2500 BP

Middle-Late sub-Period 2500 BP – 1500-1000 BP

Late-Late sub-Period 1500-1000 BP – 230 BP

The transition from highly mobile hunter-gatherers to semi-sedentary collectors during the Late Period has been well documented and marked a turning point in the prehistory of the region in terms of the development of large aggregate villages like Bridge River and Keatley Creek throughout the Middle Fraser Canyon (Prentiss and Kuijt 2004; 2012). This period also saw notable increased reliance on salmon and plant resources (particularly geophytes) and the emergence of hierarchical social complexity (Hayden 1996; 1997; Hayden and Schulting 1997; Prentiss et al. 2008; Prentiss and Kuijt 2004; 2012).

This period is also generally associated with intensive technological innovations relating to food capture and storage (Chatters 1989; 1995). Subsistence innovations such as preservation and storage during this time mark what Rousseau (2004: 21) refers to as the “intensification of logistical collecting” and what Binford (1980) described as a “logically organized collector” strategy. This period saw the full development of seasonally occupied winter villages in the Middle Fraser Canyon, along with increasing dependence and specialization on key resources like salmon throughout the Interior Plateau (Plew and Guinn 2015).

CANADIAN PLATEAU

On the Canadian Plateau, the most comprehensive culture histories have been described by Chatters and Pokotylo (1998) and Richards and Rousseau (1987), and were revisited by Rousseau (2004). The following section provides a brief outline of the culture-historical systematics used to describe the prehistory of the region with additional references to contributions such as Arnoud Stryd's chronology of the Nesikep Tradition and David Sanger's model of the Lochnore-Nesikep Tradition. All chronological references made after this discussion are based on Prentiss et al.'s (2005) framework for the prehistory of the overall northwest Plateau (Table 1.1) and Rousseau's (2004) synthesis for the Canadian Plateau (Table 1.2). Following Richards and Rousseau (1987: 5), the late-Holocene cultural traditions of the Canadian Plateau as described below are typological constructions based on "extended temporal persistence... spatial continuity over a large, environmentally distinctive space... and material cultural remains reflecting a unique culture pattern (i.e., subsistence practices, technology, ecological adaptation, social organization, ideology, etc.)". In simple terms, they are generalized cultural designations based on continuity of site types, site locations, and technologies.

Table II. Summary of Cultural and Environmental Chronology for the Late Holocene on the Plateau

Period	Date	Climate period	Characteristics
I	3500–2400 b.p. (3600–2500 cal. B.P.)	Neoglacial (cool/moist)	First Classic Collectors
IIa	2400–1700 B.P. (2500–1800 cal. B.P.)	Transition to little climatic optimum (warm/dry)	Classic Collector throughout Plateau; Complex Collectors in Lower Columbia and Lower Fraser
IIb	1700–1200 B.P. (1800–1250 cal. B.P.)	Early little climatic optimum (warm/moisture increasing)	Complex Collectors in Mid-Fraser; Classic Collector population decline in north; rising numbers in the south
IIc	1200–700 B.P. (1250–650 cal B.P.)	Peak little climatic optimum (warm/dry)	Mid-Fraser Complex Collector villages at peak size and complexity early; Classic Collector populations peak, stabilize, and drop in south; Classic Collector populations generally rise in north
IId	700–200 B.P. (650–250 cal. B.P.)	Little Ice Age (cooler/greater moisture)	Large villages abandoned in Fraser and Upper Columbia areas; Some large villages occupied in south; Classic Collector population expansion in north, but eventually reduced numbers throughout region

Table 1.1. Prentiss et al.'s (2005: 54) Cultural and Environmental Chronology for the Late Holocene Plateau.

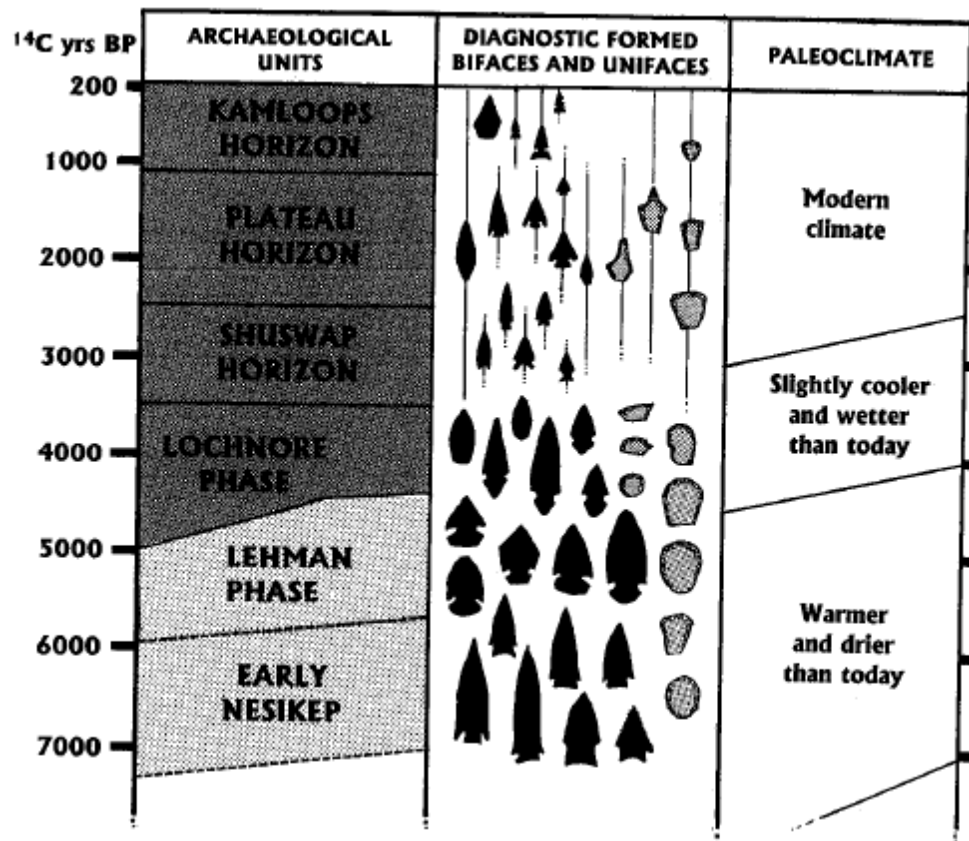


Table 1.2. Rousseau's (2004: 10) Chronology for the Canadian Plateau.

The Nesikep Tradition 7000-4500 BP (based on Rousseau 2004)

Arnoud Stryd (1973) divided the Nesikep Tradition into two periods, the *microlithic period* (~7000-2800 BP) and the *non-microlithic period* (~2800 BP into the Contact Period, 1858 A.D.). The Nesikep Tradition is representative of a foraging subsistence strategy largely dependent on ungulate predation (Chatters and Pokotylo 1998; 74; Stryd and Rousseau 1996). This strategy typifies Binford's (1980) mobile hunter-gatherers practicing frequent residential mobility within a general foraging system.

David Sanger's extensive early survey and excavation work in the region (1961, 1962, 1968, 1969, 1970) led him to establish the Lochnore-Nesikep Tradition, named after the respective creeks of the same names that drain into opposite sides of the Fraser River, Lochnore Creek from the east and Nesikep Creek (just southeast of Texas Creek) from the west. From these studies Sanger developed a cultural chronology consisting of the Early Period, or "Lochnore Complex" (pre-5000 BP) and the (lower and upper) Middle and Late Periods, all falling within the "Nesikep Tradition" (5000 BP- 200 BP). For the most part, Sanger distinguished these cultural designations on changes in lithic technology. Prentiss and Kuijt (2004: 50) note that Lochnore Complex assemblages are characterized by notched, leaf-shaped bifaces and pebbles, a variety of unifacial scrapers, and microblades, while the Nesikep Period presents the development of semi-subterranean housepits and a greater variation of toolstone raw materials and other materials such as wood, antler, and bone (Sanger 1963, 1970). Based on further excavations in the region (largely interpreted from the rather anomalous Baker Site – see Wilson et al. 2002), Rousseau (2004: 11) notes that the Lochnore Phase represented distinct increases in sedentism and logistical "collector" strategies in response to a composite combination of changing social, cultural, and environmental conditions. Because of such developments during this time, Stryd and Rousseau (1996) include the late Lochnore Phase in the *Plateau Pithouse Tradition* (PPt), while Prentiss and Kuijt (2004) suggest that the Lochnore Phase simply represents the late Nesikep Tradition. To this end, Prentiss and Kuijt (2004) contend that the PPt originated along the Northwest Coast and moved up the Fraser Valley into the Interior sometime after 4000 BP, as people represented by the Shuswap Horizon eventually replaced those of the Lochnore Phase. What is clear is that cultural changes occurring in the

region throughout this period were complex and marked by increased sedentism and developing persistent localized subsistence strategies.

Arnoud Stryd (1970, 1971a, 1971b, 1972, 1973a, 1973b, 1980; Stryd and Hills 1972; Stryd and Rousseau 1996; Blake 1973; Rittenberg 1976) developed Sanger's "Upper Middle" and "Late" Periods of the Nesikep Tradition into three Phases: the Nicola Phase (3500-1800 BP), Lillooet Phase (1800-1200 BP), and the Kamloops Phase (1200-200 BP). The Nicola Phase is generally defined by the absence of microblade technology and small projectile points (Stryd 1973a; Harris 2011: 53). The Lillooet Phase is defined by the presence of relatively small, corner-notched projectile points, and the Kamloops Phase is defined by the presence of distinctively small, triangular, side-notched projectile points. Stryd and Rousseau (1996) further reassessed the lithic assemblages of the Nesikep Tradition and divided it into two different but similar traditions, both characterized by highly mobile foragers: the Early Nesikep Tradition (7000-6000 BP) and the Lehman Phase (6000-4500 BP). Their Early Nesikep period was a time in which highly mobile foragers practiced a strategy based on a wide diet-breadth centered on the acquisition of terrestrial mammals and the collection of plants resources such as seeds and berries, with little to no evidence for storage or long term settlements. The climate of the period was generally warmer and drier than that of today, and people tended to move around the landscape exploiting a wide variety of ecological niches. Areas along protected creek-river confluences, locations with good visibility/vantages, and along upland waterways with easy access to non-anadromous fish, waterfowl, and other aquatic resources were commonly utilized (Rousseau 2004: 4; Stryd and Rousseau 1996: 191).

Continuing from the Early Nesikep, the Lehman Phase exhibits similarly wide diet-breadth. During this time foragers utilized a variety of terrestrial, aquatic, and (to a lesser extent) avian species, with a general emphasis on larger game. Human populations are characterized by a gradual increase in overall population density, although groups remained relatively small, seasonally mobile, and likely kin-based. Some evidence suggests that salmon begins to become increasingly important during this time, as does the use of non-local fine-grained lithic raw materials such as dacites and cryptocrystalline quartzites (Rousseau 2015). Prentiss (personal communication 2013) proposes that the Lehman Phase is likely a variant of the Lochnore Phase, pointing out temporal overlap between the two phases and distinct similarities in point morphology.

For the Lillooet area, Richards and Rousseau (1987) provide a detailed cultural chronology for the interval between 3500 BP and 200 BP, segmenting the local Nesikep Tradition into the Kettlebrook Phase (3500 BP-2500 BP), the Lillooet Phase (2500 BP-1250 BP), and the Fountain Phase (2500 BP-200 BP). Richards and Rousseau (1987: 21) propose that late-Holocene occupants of the local area represent the *Late Period* or *Plateau Pithouse Tradition* (as above) consisting of logistically organized, semi-sedentary, pithouse-dwelling hunter-gatherers, generally reliant on perennial availability of anadromous fish supplemented with wild mid-altitude roots and some terrestrial mammals. Within the PPt, Richards and Rousseau (1987) propose a number of cultural “Horizons” based on relatively minor similarities in subsistence and mobility adaptations and some particulars of material culture, such as variation in the morphological characteristics of bifaces and other stone tools, and in some cases the appearance of novel technologies (as in the appearance of root-digging sticks during the Plateau Horizon).

Due to the obvious complexity of culture change and technological variation in the region over time, I will utilize a more regionally inclusive set of cultural units for the late Holocene, structured around Richards and Rousseau's (1987) PPt and consisting of: the Shuswap Horizon, the Plateau Horizon, and the Kamloops Horizon, described below. Although the basic details of these cultural Horizons is important to understand in order to appreciate the developments that emerge during the late-Holocene at the Bridge River venue, the late Plateau and early Kamloops Horizon are of the greatest relevance to this research.

Shuswap Horizon (3500-2400 BP)

The Shuswap Horizon marks the earliest emergence of semi-subterranean winter housepit villages in the Mid-Fraser region (Richards and Rousseau 1987: 22). Climatic conditions during the beginning of the Shuswap Horizon are marked by generally cooler, wetter conditions as an increasingly stronger Aleutian low developed following the earlier mid-Holocene Altithermal. This suggests that change toward gradually cooler environmental conditions may have facilitated (or even necessitated) cultural adaptations that emerge during this time, such as population aggregation into pithouse villages, interior hearth features, internal food storage pits, and emerging coastal and interior trade (Hebda 1983, 1985; Heusser 1985; Heusser et al. 1985; Richards and Rousseau 1987; Walker and Pellatt 2001).

Archaeological faunas indicate that subsistence was largely based on logistical foraging focused on acquisition of a wide variety of terrestrial mammals, including elk, deer, mountain

sheep, black bear, beaver, muskrat, red fox, snowshoe hare, domestic dog, wolf, striped skunk, porcupine, and yellow-bellied marmot, with secondary consumption of water fowl, including trumpeter swan, ducks and other birds, and various, but limited marine resources including freshwater mussels, salmon, trout, squawfish, and other freshwater fish. Toward the end of the Shuswap Horizon, external cooking features and external storage pits emerge, c. ~2900 BP, at the same time that climatic conditions began an upturn toward contemporary warmer, drier conditions. Hayden (Hayden 1997a, 1997b, 2000c, Hayden and Schulting 1997) suggests that evidence for dog domestication and the presence of slaves at Keatley Creek, and the emergence of medium- to large-sized pithouses during the late Shuswap Horizon point to emerging cultural complexity in the form of socio-economic status differentiation. However, this suggestion is constructed on speculation on later Kamloops Horizon floors at Pithouse 7 at Keatley Creek not associated with occupations during the Shuswap Horizon (see Lenert 2001; Prentiss et al. 2000; 2002; 2003). In contrast, Prentiss et al. (2003) point out that complex social hierarchies did not manifest until the late-Plateau/early-Kamloops Horizon, instead corresponding with optimal resource conditions that encouraged increased salmon production in the Mid-Fraser, leading to increasing large-scale aggregation and eventually to hierarchical complexity.

Plateau Horizon (2400-1200 BP)

The Plateau Horizon was marked by climatic change toward a general warming trend accompanied by drier conditions beginning shortly after 3000 BP (Hebda 1983, 1985; Mathewes 1985; Walker and Pellatt 2001). In the Middle Fraser, Plateau Horizon housepits tend to be notably larger than elsewhere, as the general trend outside the Mid-Fraser is toward smaller

dwelling (Richards and Rousseau 1987: 32). Adaptations that emerged during this time included central interior hearth features, smaller hearth and storage pit features along the outside edges of interior pithouse walls, peripheral earthen benches along outside interior walls, and shallow external pit features that served a variety of functions from cooking/roasting (earth ovens), to storage (cache pits) and trash disposal (Richards and Rousseau 1987; Hayden 1997). In addition to lithic artifacts showing an “increase in the quality of chipped stone workmanship... compared to the Shuswap horizon”, native copper artifacts appear during this period, likely toward the end of the Horizon (Richards and Rousseau 1987: 34).

Another development during this period was the use of bark as a material for storage and/or container construction, although earlier evidence may simply be lacking due to deficient preservation. Other artifacts such as beads, gaming pieces, figurines, and a variety of incised and decorated objects also appear during this period. Bone, antler, and tooth artifacts are common in archaeological assemblages from the Plateau Horizon. In the Mid-Fraser particularly, artifacts of nephrite and steatite become more common toward the mid- to late-Plateau Horizon and may represent a distinct craft specialization and/or increasing trade interactions in the region during this time.

Subsistence strategies during the Plateau Horizon remained similar to the logistical foraging generally employed during earlier times, with the notable introduction of edible root collecting, a shift toward increased reliance on marine resources, and increased storage (Lepofsky and Peacock 2004; Pokotylo and Froese 1983; Rousseau 2004). Hayden (1997) suggests that social complexity toward the end of the Plateau Horizon became increasingly

manifest in institutions such as recognized private ownership of goods and property, hierarchical social and economic inequality, and heritability of social status (see also Arnold 1993; 1996). It is likely that during this period increased trade and cultural contact with outside groups played an important role in the emergence of these institutions, as access to (and control of access to) exotic goods, raw materials, and new ideas provided differential economic privilege to some groups or individuals.

Kamloops Horizon (1200-200 BP)

Climate during the Kamloops Horizon was more-or-less similar to contemporary conditions with the notable exceptions of variations such as those experienced during the Little Neo-Glacial (LNG, beginning ~1600BP), Medieval Warm Period (MWP or Medieval Optimum, beginning ~1100BP), and the Little Ice Age (LIA, beginning ~600BP). Housepits during this period tend to vary greatly in size and structural composition, but generally show similar internal hearth, cooking, and storage facilities, and external storage pits and earth ovens to those of the earlier Plateau Horizon (Richards and Rousseau 1987: 41). Some adaptations that appear during the Kamloops Horizon, such as increased frequency of birch-bark basketry and storage containers, and continued increases in bone, antler, and tooth implements are likely continuations of earlier technologies that simply have a higher survivorship in later assemblages than those from earlier periods. The frequency of decorated items increases during the Kamloops Horizon, particularly in the form of incised geometric patterns on both exotic materials and everyday goods, including such items as incised digging stick handles, drinking tubes, gaming pieces,

bone needles, and bone beads, along with ornamental items such as perforated elk teeth, shells, and shell beads (Richards and Rousseau 1987: 47).

One major subsistence development that becomes pervasive during this time is the widespread use of marine resources and associated technological adaptations developed for food storage. Isotope studies of Pacific Northwest hunter-gatherers have shown that a significant portion of dietary protein (up to 50-60% in some populations) came in the form of marine resources, largely beginning during this period (Schwarcz et al. 2014). A large portion of the diet was derived from salmon and considerably supplemented by wild roots, as attested by increased occurrences of root-roasting features and digging sticks throughout the northwest (Pokotylo and Froese 1983; Richards and Rousseau 1987: 47; Sanger 1968). It also appears that during this time bow and arrow technology fully supplanted the use of atlatl and dart projectiles. This is reflected in a marked reduction in lithic projectile point size (see Hildebrandt and King 2012) and probably had a significant impact on the continued acquisition of deer and other locally available ungulates such as elk and mountain sheep (Alexander 1992: 141; Richards and Rousseau 1987: 47).

Bridge River Locality and the Bridge River Village

The Bridge River/Lillooet area falls within the gorge of the Middle Fraser Canyon at the northern edge of the Cascade Range south of the Camelsfoot Range, bordered to the west by the Coast Mountains, and to the north and east by the intermountain troughs of the Fraser - Thompson Plateau. Much of the Bridge River drainage lies within the Yalakom fault and is

hemmed along most of its length by steep forested slopes. The geology of the area is reflected in a complex network of mountainous and riverine terrain consisting of Cretaceous sandstone, shale, black and gray slate, conglomerate, chert, basaltic volcanic rock, serpentinite, and a variety of other metamorphic and ultramafic rocks (Mathews and Monger 2005). Many of these local rocks were utilized by pre-Contact people as raw material for stone tools (Rousseau 2015).

The Bridge River village site (EeRl4) is situated on a grassy terrace nearly 100 meters up a steep slope from the bottom of the Bridge River basin, on the river's northeastern side. The site is roughly three and a half kilometers northwest of the Bridge River's confluence with the Fraser River. The Fraser River is the second largest river system in British Columbia, inferior in size only to the upper Columbia River, and at present is home to 43 native fish species, and five species of Pacific salmon. Immediately north of the Bridge-Fraser confluence are two major sets of rapids walled into the Mid-Fraser Canyon by rugged extrusive igneous escarpments of bedrock, many of which have been used for centuries by fishermen to gain access to productive but hard to reach sections of the river (Figure 1.2).



Figure1.2. View of the Fraser River looking north-northeast at “Sxetl”/the Six-Mile Rapids from the west shore. Note fish-drying racks in foreground and upriver on both sides of the river. Photograph by the author.

The waters at this location are called Sxetl (meaning to “drop-off” in the St’át’imc dialect indicating the vicinity of a major drop off and rapids where the Fraser Canyon dramatically constricts the waters of the river (Kennedy and Bouchard 1992: 339). The common English names for this spot are interchangeably Bridge River Rapids or Six Mile Rapids. The unpredictable waters of this section of the river facilitated the mass capture of fish that made salmon the dominant dietary and economic commodity in the Mid-Fraser Canyon. This is due in large part to the geomorphology of the river at Six-Mile-Rapids where migrating salmon cluster in the deep pools and eddies on the way to their upriver spawning grounds (Prentiss and Kuijt

2012: 117). Salmon moving into this narrow section of the river congregate in the few bankside shoals and slow-moving eddies to rest during the difficult ascent upstream. As the fish shoal in large numbers at the heights of their runs, it is possible for fishers to catch and harvest them en masse. These mass capture opportunities made the area immediately surrounding the Bridge-Fraser confluence one of the most productive riverine fisheries on the North American continent. The unique environmental and geographic conditions particular to this stretch of the Fraser River Canyon made a specialized set of subsistence practices, namely the capture of salmon by dip-net and techniques of processing and wind-drying salmon, highly productive for prehistoric people in the area.



Figure 1.3. View looking west-northwest up the Bridge River watershed from the west foothills of the southernmost ridge leading up to Camelsfoot peak. Note the Bridge River winter

pithouse village at bottom left. Housepit 54 is visible in the image at the right end of the village covered by a tarp.

Located on the northwestern portion of the Bridge River winter pithouse village, Housepit 54 was a medium-sized semi-subterranean pithouse of roughly 13.3m in diameter (Figure 1.3). The stratigraphy at Housepit 54 is complex, indicating that it was occupied at multiple intervals during Bridge River Period 2 (BR2), ~1600-1300 BP (though somewhat late in this sequence, beginning c. 1400 BP) and thru Bridge River Period 3 (BR3), ~1300-1100 BP, toward the end of which populations declined and eventually abandoned the village. A few pithouses were reoccupied around 500-600 BP and continued to be used into the Colonial Period, but this later occupation is not addressed in this study (see Prentiss et al. 2008: 31). The complex stratigraphy on the BR2-BR3 occupations suggest a more-or-less continuous series of probably annual reoccupations of the pithouse beginning during the late-Plateau Horizon and extending into the early-Kamloops Horizon, with reconstruction of the living floor and roof taking place at roughly 20-25 year intervals.

ENVIRONMENT

The dynamic environments of the northwest Plateau have been described extensively (Alexander 1992; Baker 1970; Chatters 1998; Rousseau 1993). As detailed above, paleoclimatological data suggest that late-Holocene climatic events have been relatively minor in intensity since deglaciation, presenting an “interval of relatively stable climate extending from ca. 4500 cal. year BP through to the present-day” (Walker and Pellatt 2008). However, within

this stable interval lie sub-phases of climatic fluctuation, particularly back-and-forth shifts between moderately cooler and warmer temperatures and wetter and drier conditions, similar to short-term manifestations such as El Niño and La Niña events, that may have significantly altered local and regional environments, ecological regimes, and would likely have had an effect on the subsistence strategies of human populations throughout the region (Mathewes 1985; Hebda 1995; Walker and Pellatt 2003, 2008; Walker 2004).

The contemporary Middle Fraser Canyon experiences some of the most regionally extreme temperatures in southern British Columbia. Weather in the Bridge River area can change rapidly. Systems converge on the locality from multiple directions due in part to extreme variances from deep valley floors to high, steep mountain peaks. In the rain shadow of the Coast Range, the immediate area receives relatively low levels of precipitation compared to other parts of the Pacific Northwest. Humidity is generally low and the area experiences exceptionally low levels of snowfall for the Canadian Plateau. Summer temperatures can climb well above 40° C (104°+ F) and winter lows can reach below -32°C (-25° F). Weather comes together in the Mid-Fraser in dynamic fashion: from the south and west by way of the Fraser Valley from the coast and over the Coast Range. Colder air comes down from the north along the eastern edge of the Coast Range, and dry air moves in from the Plateau to the east. The immediate Bridge River village area (and lower terraces of the river basin itself) can be categorized as River Valley in sections where its farthest depths are not hemmed in by cliff walls. The surrounding hill slopes and drainages are Montane Forest with interspersed patches of Montane Parkland upslope to the peaks of the Camelsfoot Range and the ridgeline of the Blackhills to the north, and up-slope to Mt. McLean and Mission Ridge to the south (see Alexander 1992a). Open pine forest dominates

the woodland slopes. Moving northwest up the Bridge River Valley patches of meadowed Montane Parkland dot a steep landscape of high, gently sloping forested terraces. In many places the river cuts through deep gorges that drop hundreds of feet from the eroding edges of the pine and sedge-rich terraces above.

Alexander (1992a: 76) characterizes the Montane Parkland as “equivalent to the Parkland subzone of the Engelmann Spruce-Subalpine Fir Zone, a mosaic of parkland meadows, krummholz tree clumps, and very open stands of subalpine tree species.” Foliage in the Fraser Canyon consists variably of Ponderosa pine (*Pinus ponderosa*), bunchgrasses, and steppe shrubs (various *Allium* sp., *Artemisia* sp., *Lewisia rediviva*, *Lomatium* sp., etc.) bordered at progressively higher altitudes by subalpine forests dominated by whitebark pine (*Pinus albicaulis*), subalpine fir (*Abies lasiocarpa*), lodgepole pine (*Pinus contorta*), and Englemann spruce (*Picea engelmannii*) (Alexander 1992; Chatters 1989: 35). In general, the Bridge River area is a mixture of steep forested mountains and hillsides characterized by dramatic talus cones, rock screes, and peppered with large granitic boulders.

Richards and Rousseau (1987: 8) make the point that few localities in the Mid-Fraser possessed the ideal characteristics that would make a locality suitable for winter habitation, such as shelter from wind, exposure to sunlight, access to fresh water, suitable geophysical characteristics necessary for the construction of pithouses and access to productive hunting/fishing and gathering grounds, as well as defensibility, and just the right proximity (or distance) to neighbors, kin, and trading partners. For these reasons it is likely that winter pithouse villages were not vacated post-winter to the degree that has sometimes been suggested,

but were likely used as central basecamps, occupied and modestly maintained year-round by at least some contingent of a household, in order to preserve a household's claim to specific properties (Prentiss and Kuijt 2012: 90).

SUBSISTENCE RESOURCES

The region immediately surrounding the Lillooet/Bridge River area consists primarily of Montane Parkland and River Valley ecosystems surrounded by open lodgepole pine forest and low-lying river terraces as described above (Alexander 1992: 47). Animal biota in the region have also been described in considerable detail elsewhere, so here I will provide a summary of the major contributions to the subject of Canadian Plateau and Middle Fraser Canyon faunas, both contemporary and archaeological.

Chatters (1989: 38) notes a variety of animals of “economic potential” to hunter-gatherers in the diverse environs of the Interior Plateau, including: snowshoe hare (*Lepus americanus*), white-tailed jackrabbit (*L. townsendii*), black-tailed jackrabbit (*L. californicus*), cottontail rabbit (*Sylvilagus* spp., *S. idahoensis*), yellow-bellied marmot (*Marmota flaviventris*), hoary marmot (*M. caligata*), woodchuck (*M. monax*), red squirrel (*Tamiasciurus hudsonicus*), Douglas squirrel (*T. douglasii*), western grey squirrel (*Sciurus griseus*), flying squirrel (*Glaucomys volans*), ground squirrels (*Spermophilus* spp.), Muskrat (*Ondatra zibethicus*), beaver (*Castor canadensis*), mountain lion (*Felis concolor*), lynx (*F. canadensis*), bobcat (*F. rufus*), river otter (*Lutra canadensis*), ermine (*Mustela ermine*), mink (*M. vison*), longtailed weasel (*M. frenata*), gray wolf (*Canis lupus*), coyote (*C. latrans*), wolverine (*Gulo luscus*), red fox (*Vulpes vulpes*), badger

(*Taxidea taxus*), fisher (*Martes pennant*), pine marten (*M. americana*), black bear (*Ursus americanus*), grizzly bear (*U. horribilis*), and raccoon (*Procyon lotor*), in addition to “over 300 bird species”. Chatters also describes a wide variety of fish species in the watersheds and river systems of the Plateau, including Pacific salmonids: Chinook salmon (*Oncorhynchus tshawyscha*), Sockeye salmon (*O. nerka*), steelhead and rainbow trout (*O. mykiss*), Chum salmon (*O. keta*), and Coho salmon (*O. kisutch*). McPhail and Carveth (1993: 35) note that of these, only *O. gorbuscha*, *O. kisutch*, *O. mykiss*, *O. nerka*, and *O. tshawyscha* currently exist into the Mid-Fraser. Other anadromous fishes include Pacific lamprey (*Lampetra tridentate*) and white sturgeon (*Acipensur transmontanus*). Resident fresh water fish include various suckerfish (*Catostomus* spp.), northern squawfish (*Ptychocheilus oregonensis*), peamouth (*Meiloecheilus caurinus*), mountain whitefish (*Prosopium williamsoni*), burbot (*Lota lota*), cutthroat trout (*O. clarkii*), a variety of char - Dolly Varden trout (*Salvelinus malma malma*), and lake trout (*Salvelinus namaycush*). McPhail and Carveth (1993: 62) also mention two species of sculpin extant in the Mid-Fraser, *Cottus cognatus* and *C. alueticus*, Slimy sculpin and Coast Range sculpin, respectively. The latter is present only in tributaries adjoining Bridge River.

Alexander (1992) presents the animals utilized by Shuswap and Lillooet peoples as: deer, grizzly bear, black bear, wolf, coyote, wolverine, long-tailed weasel, bighorn sheep, mountain goat, moose, elk, snowshoe hare, beaver, porcupine, red squirrel, northern flying squirrel, cougar, lynx, bobcat, red fox, marten, mink, muskrat, fisher, long-tailed weasel, short-tailed weasel, as well as additional potential prey species in the area such as yellow-bellied marmot, white-tailed ptarmigan, various ‘grouse’, and a variety of swans, geese, and ducks. She also describes a personal communication from ethnobotanist Nancy Turner indicating three species of

bivalves - freshwater mussels that may have been accessible in the local region surrounding Seton Lake and the Fraser River: western pearlshell (*Margaritifera falcata*), western floater (*Anodonta kennerlyi*), and winged floater (*A. nuttalliana*) (Alexander 1992: 89).

James Teit (1909: 77) recorded that Mid-Fraser peoples utilized “deer, elk, caribou, marmot, sheep, hare, beaver, grouse, bear, moose, duck, goose, crane, squirrel, [and] porcupine.” Though apparently mountain goat (*Oreamnos americana*) was available to some degree in many areas, Teit suggests that it was not commonly looked upon as a tertiary food option. Particular to the Upper Lillooet area were mule deer (*Odocoileus hemionus*), mountain-goat, bighorn sheep (*Ovis canadensis*), caribou (*Rangifer tarandus*) in the northernmost expanses of Lillooet hunting territory, as well as hoary marmot, black bear, beaver, rabbit, rock-rabbit, squirrel, porcupine (*Erethizon dorsatum*), panther, lynx, and coyote. By the time Teit was writing in the early 20th century he attests that moose, caribou, and elk were rare – either relegated to more northern latitudes as in the case of moose and caribou, or having been hunted to near extinction in the case of elk. He does note that prior to their decline, elk were a primary and highly valued prey species. However, elk are rarely present in the faunal assemblages of the area. Teit (1906: 223) also describes that, among the Lillooet in particular, dog was eaten “extensively”. As will be presented in detail below, these observations are reflected in the faunal assemblage at Housepit 54.

The lack of elk and dominance of deer in the study area may be the result of variations in climate over time. It has been suggested that climatic cooling (in addition to altering salmon productivity) may have caused ungulate populations to fluctuate, causing browsers such as deer

and moose to proliferate during conditions of climatic cooling that supported the growth of lowland trees and shrubs. This same cooling would have inversely diluted the growth of upland grasslands relied upon by elk, bighorn sheep, and mountain goats (Alexander 1992: 53). Deer (as well as upland plants like geophytes) would have thrived during conditions that stimulated the expansion of more open forests and Alpine and sub-Alpine meadows, effectively expanding their habitat ranges at the expense of limiting the habitats of grazers like elk (Alexander 1992: 108).

Archaeological faunal assemblages from Mid-Fraser sites corroborate much of the early ethnographic subsistence assessments when it comes to prey species representations. Salmon dominate late-Holocene Mid-Fraser assemblages. Medium and large mammals make up the bulk of terrestrial faunas, with upland birds and water fowl, non-anadromous fishes, and freshwater shellfish descending in frequency, and assumedly in dietary importance, in that order. There is little archaeological evidence of plant remains in subsistence contexts, but many varieties of plants were likely a major part of the diet. Stryd (1972) reports archaeofaunas consisting of “deer, beaver, and fish (presumably salmon)” at the Gibbs Creek Site (EeRk7); deer, pack rat (*Neotoma* sp.), fish (again, presumably salmon), unidentified bird, and two specimens of fresh water bivalve (*Margaritilera* sp.) at the Fountain Site (EeRl19); and an abundance of fish and deer, along with horse, unidentified bird, and small rodent throughout the Mitchell Site (EeRl22). At Nesikep Creek (EdRk4), Sanger (1963, 1966, 1967) accounts for mule deer, middens consisting of salmon bones, as well the remains of mice and small birds; while at the Kamloops Phase, Cow Springs Site (EdRk5) articulated fish remains were recovered, leading him to conclude that salmon were a continuing component at sites throughout Lochnore-Nesikep

localities (Sanger 1967:193). Pokotylo et al. (1987: 9) note that at the Cache Creek Burial Site (EeRh1) deer, salmon, rodents, and dog made up the majority of recovered faunas, while at other burials in the vicinity, unidentified small mammals, birds, beaver, fish, and ungulates were commonly represented. Kusmer (2000a: 137) identified snowshoe hare, red squirrel, beaver, muskrat, red fox, grizzly bear, fisher, lynx/bobcat, elk, moose, bighorn sheep, and mountain goat, as well as few remains of a variety of birds, rodents, and freshwater shellfish, in addition to more commonly distributed deer, dog, and extensive salmon remains at housepits throughout the Keatley Creek Site (EeR17). Prentiss et al. (2007: 312) observed a mammal-oriented subsistence pattern in later occupation floors at Keatley Creek along with evidence for gradually widening diet breadth toward site abandonment around 1000 years ago. At Bridge River, Carlson (2010: 96) identified mule deer, dog, beaver, fisher, rabbit, squirrel, unidentified bird, elk, rodent, mink, and limited amphibians and mollusca, in addition to ubiquitous salmon remains in assemblages from three housepits with occupations spanning BR2 and BR3, including Housepit 54. Many of these faunas are locally available, although the elk remains reported at Bridge River consisted of a single bone sample from a BR2 context at Housepit 20, and was likely introduced to the site as a tool rather than the discarded product of subsistence usage (Eric Carlson, personal communication, March 27, 2013). Two vertebra fragments from Roosevelt elk (*Cervus canadensis roosevelti*) were identified from the 2014 excavation assemblage at Housepit 54 but these were recovered from Stratum IIk in Block A, and pre-date the earliest BR2 floor, and thus are not included in the analysis presented here. Nevertheless, occurrence of elk in this earlier context does indicate that they were present in the region and potentially accessible at some point during the late-Holocene.

The 2008 excavations at Housepit 54 produced 1114 mammal specimens, 2623 salmon specimens, ten *Galliforme* sp. specimens, three *Mollusca*, two amphibian, and 209 indeterminate element specimens, of which the remains of deer (presumably *O. hemionus*), beaver, fisher, and mink were positively identified to species (Prentiss et al. 2009: 96). Carlson and Schremser (2009) suggest a distinctive reduction in prey species diversity at Housepit 54 between BR2 and BR3, and note a slight increase over time in the frequency of mammals.

Pacific Salmon

Five extant species of Pacific salmon migrate into the Middle Fraser. These include: Pink (*O. gorbuscha*), Coho (*O. kisutch*), Sockeye (*O. nerka*), and Chinook or Spring salmon (*O. tshawytscha*), as well as steelhead (*O. mykiss*). Freshwater *O. nerka* (Kokanee) and *O. mykiss* (Rainbow trout) are also present in many lakes and streams in the area.

At the Bridge River sector of the Middle Fraser, Kennedy and Bouchard (1992: 272) point out that the earliest run of Spring (Chinook) salmon arrive around April, while a second run appears between late May and early June. Michael Kew (1992: 190), utilizing data from the 1960s and 1970s, presents that Sockeye run the earliest in the year, appearing in large numbers from late June until early October, peaking in late August. Later run Chinook appear with greater frequency shortly thereafter in late June-early July and continue into early October. Pinks appear in early September and continue into mid-October (but would have been rare above the Seton River drainage), while Coho appear in mid- to late October and persist into late November. The differences in migration times are likely due to modern alterations of the riverine habitat along portions of the Fraser River and its tributaries, such as dams and rockslides

caused during highway construction, as well as changes in ocean temperatures in the last century. It is difficult to say with certainty the range of timing, duration, or density of prehistoric runs but considering the general stability of late-Holocene climate, these patterns have likely been relatively consistent for millennia.

Certain salmon sub-species were available during different parts of the year “at unique but regular and predictable times”, and some were easier to catch than others (Kew 1992: 178; Speller et al. 2005: 1386). Ethnographic observations paint a picture that follows the general run intervals described above. Teit (1906: 224) reports that during the “Seventh Moon, or Kwo'ltus sku'klep ("when strawberries are ripe")... People fish small fish and the first salmon.” Wild strawberry (*Fragaria californica*) ripens in the region between June and July, coinciding with the spring Chinook salmon run, corroborating Teit’s ethnographic account and Kew’s (1992) findings. Again according to Teit (1906: 224), during September, or the “Tenth Moon, or Laq a stso'qaza ("the salmon come")... Salmon run in great numbers, and people fish”. This likely references the late August Sockeye run that passes by the Bridge-Fraser confluence – historically by far the most abundant run of the year. At this time, abundant Sockeye and some Chinook would be available depending on the exact fishing location accessed and subject to the depth, temperature, swiftness, and soil saturation of the water.

Depending on the time of year that salmon were harvested, some measure of preservation was required to meet non-immediate subsistence demands. Berry (2000: 135) describes various modes of fish processing, from “drying, filleting, immediate consumption, extraction of salmon oil, pulverization”, to preservation and storage, and suggests that different salmon species were

differentially valued for the characteristics that fit their appropriate use or efficiency related to the above processing tasks. For example, he suggests that Pink and Chum salmon tend to be easier to catch and to dry than Chinook or Sockeye, but the latter are more highly valued due to their size, taste, and fat content (see also Kew 1992; Romanoff 1992). While as we've seen above, salmon are *somewhat* predictable, they are also highly variable in both size and abundance and annual productions always fluctuate (sometimes dramatically) with changes in climate and water conditions, as well as by seasonal lifecycles of the fish themselves.

The overall productivity of seasonal salmon migrations can be severely altered by changes in the environment, particularly those effecting water temperature, depth and flow strength, and by obstructions to the waterway. MacDonald et al. (2000) reported on the drastic effects to migrating Sockeye populations due to low water and drought throughout the Fraser drainage during 1998. Rand et al. (2006) extrapolate this further, combining the effects of river discharge and increased temperature between 1950 and 2001, and show that even within this relatively short period of time, the increased energy expenditure required for many Fraser River Sockeye runs to reach their spawning grounds, exacerbated by the effects of increased water temperatures and water discharge has steadily increased, making returning Sockeye leaner and leaner over the years. In recent years the upstream migration has also become more challenging due to increasing frequencies of disease, introduced parasites, and dramatic changes in oceanic conditions brought on by increasing overall global temperatures. Because of these effects of recent centuries it is exceptionally difficult to model prehistoric salmon availability.

As today, climatic changes no doubt played a role in varying salmon productivity throughout the northwest coast and inland during prehistory. Prentiss et al. (2005; 2011) suggest occasions of periodic instability across much of the Interior Plateau during the late Holocene. Cooler temperatures during the period following the Roman Warm Period (RWP, ending ~1600 BP; Wing et al. 2012) or post-Neoglacial marked a transition from warm/dry conditions to increasingly moist conditions. This may have encouraged productivity of North Pacific salmon throughout the coastal and inland northwest. During this time, the aggregate villages along the Middle Fraser Canyon expanded both in numbers of houses and in general population (Prentiss et al. 2011). Alternately, the onset of the Medieval Warm Period (~1100BP) seems to have caused declines in fisheries production, brought on at least in part by increasingly warm/dry conditions (Prentiss et al. 2005: 76; 2011). This decrease in productive salmon habitat coincides with the large-scale destabilization of the Middle Fraser village complex. Similarly, increasingly cool temperatures during the succeeding Little Ice Age likely altered salmon productivity, perhaps boosting it to the fisheries levels observed into the proto-historic period.

In addition to environmental conditions leading to optimal and sub-optimal fisheries, technological adaptations emerging after 3500 BP included developments in more efficient storage and processing that altered how humans could effectively exploit various resources. These included the development and refinement of techniques that facilitated wind-drying of butchered salmon as well as for oil extraction from highly fatty fish or fish parts (such as heads). This period also saw the development of increasingly effective storage, such as use of birch bark-lined storage pits, use of cold-sink pits, and layering of storage pits with organic materials to

deter the onset of decay and presence of pests. The most effective local adaptation regarding the successful long-term storage of salmon in the Middle Fraser Canyon was the development of salmon butchery techniques that allowed salmon to wind-dry very efficiently, causing the meat to retain considerable oil and flavor but to also store very well. Exceptionally well-preserved Sockeye could go unspoiled in favorable conditions for up to two years.

Deer and Other Terrestrial Mammals

While salmon were the most ubiquitously utilized animal resource in the North American northwest during the late-Holocene, deer and other ungulates were also very important to the aboriginal diet, and mammal bones make up the bulk of the non-salmonid fauna represented in archaeological assemblages of the region and at Housepit 54. Nutritionally, though a diet rich in fish could meet most of an individual's protein/amino acid needs, a variety of fats and carbohydrates are also required to maintain healthy levels of nutrition (Reitz 1979: 26; Speth and Spielmann 1983). As important as salmon was to the diet of the Housepit 54 household, terrestrial mammals, particularly large ungulates, were an important subsistence resource, not only for meat, but because they provided materials such as hides, sinew, antler, and bone in addition to providing the social prestige that was lauded upon skilled hunters (Alexander 1992; Romanoff 1992b; Teit 1906). Although mule deer (*O. hemionus*) are mentioned throughout the ethnographic literature (see Dawson 1891; Teit 1906, 1909, 1912), other animals, particularly alternative ungulates and fur-bearing mammals played correspondingly important roles in subsistence practice. This was especially true during different times of the year when salmon were not available in large numbers or under different environmental conditions, such as

uncharacteristic weather extremes like harsh or exceptionally mild winters or similarly extreme summers (Kennedy and Bouchard 1998). Teit (1906: 225) states that “In times of scarcity the flesh of lynx, coyote, and other animals, was eaten”, and it seems likely that most animals, when killed, would have been introduced into the diet. Clearly, terrestrial prey was commonly sought and played an important role as part of the staple diet of pithouse occupants.

Ethnographically, meat was often the centerpiece of communal feasting. Hunters were obligated to share their catch with members of their hunting party and with other villagers, in a process of meat redistribution that produced a relatively egalitarian circulation of meat throughout the village (Romanoff 1992b: 474, 499). Dried meat was often presented as a gift during communal gatherings, called *xeli'txal*, “gathering” or “calling the people together” (Kennedy and Bouchard 1978; Romanoff 1992). As mentioned above, Romanoff (1992b: 480) also suggests that meat from terrestrial prey was a vital source of food during times of the year when salmon were unavailable, or when preserved salmon stores began running low. In similar fashion to that of salmon meat, deer was often air-dried or smoked and set aside for storage or for use in trade or feasting (Romanoff 1992b).

It has been suggested for other areas of the Interior northwest that some large ungulates (such as elk and moose) may have been more wide dispersed prior to the introduction of horses and European firearms (Chatters 1986: 71). However, in the Lillooet area firearms appear not to have taken as drastic a toll on animal distributions, at least into the early 1920s. Clarke (1923: 16) attests that, despite having already been a favorite hunting destination for the 20 years following the turn of the century, the Lillooet area was still rife with mountain sheep, mule deer,

and mountain goats, and that the areas adjacent to Bridge River were “excellent bear country.” Evidently, the areas surrounding the Bridge River village have been productive hunting grounds for centuries (if not millennia), exhibiting only short-term declines in various prey populations.

Domestic Dog

One interesting aspect of prehistoric diet in the Middle Fraser is the common presence of domesticated dog in archaeological assemblages (Prentiss et al. 2005: 79; Prentiss et al. 2014). Dogs are mentioned by early ethnographers throughout the region and excavations at Bridge River have exhumed dog remains that have been interpreted to have been part of ritualized feasting practices (Cail 2011). The remains of multiple canids have been found in association with Housepit 7 at nearby Keatley Creek, where Kusmer (2000: 143) notes that “dog remains are relatively common in the assemblage.”

As a commodity, domesticated dogs were mentioned by Teit as having been raised for their hair, which, as in other parts of the Pacific Northwest, was used or incorporated into the manufacture of blankets. Dog skin was used to make both twisted and woven robes, aprons, and leggings (Teit 1906: 210, 212). Among the Upper Lillooet, domesticated dogs also provided meat on the paw. Teit (1906: 223) notes that “Unlike the Thompson and the Shuswap, the Lillooet ate dog-flesh extensively, and many families raised dogs for their flesh and skins. The Lillooet dogs were of the same kind as those of the Thompson and Shuswap, and differed from those of the Lower Fraser and Coast tribes, which had very thick, fine, and in some cases almost woolly hair, which was used in blanket-making.”

Indigenous domestic dogs were important for a variety of reasons. While eating dog meat may have been common among the Upper Lillooet, it was not so among some neighboring groups like the Shuswap, who considered consuming dog to be practiced only as an alternative to starvation (Teit 1909: 517). Describing dogs raised by the Shuswap, Teit (1909: 520) notes that:

“Dogs of the old Indian breed, the same as those of the Carrier and Thompson Indians, were very much used for hunting-purposes. Those of the Shuswap were known at times to breed with both the timber wolf and the coyote. They were led with halters having toggles. Sometimes hunting dogs were sweat-bathed, and frequently luke-warm drinks prepared from 'Hudson Bay plant' were given to them. The decoction was also run through their nostrils to cleanse them. For this reason the plant is called "dog-plant" by the Shuswap.”

Among the Chilcotin, “Dogs were used in hunting, some of them being specially trained for bear, beaver, deer, and other animals” and some were also used as pack animals (Teit *ibid*: 782). Analyzing DNA from ancient dog coprolites from Bridge River, Yang et al. (2010) found evidence for two distinct mitochondrial canine lineages present at the site between 1300-1100 BP and concluded that dogs had at least some access to Sockeye salmon.

Although Teit does not distinguish which Lillooet group (Upper or Lower) ate dogs most extensively, Crellin (1994: 25) suggests that due to their close proximity and trading relationships with coastal groups who would have found such a practice distasteful, the Lower Lillooet were not likely to have adopted such a tradition. Thus, he contends that Teit must have been referring to the Upper Lillooet. Kroeber (1941: 9) states that “among the Fraser Salish, Ray records the Lillooet and probably Shuswap as eating dogs; also the Thompson and Chilcotin in time of famine.” Crellin (1994: 26, citing Lamb 1960) also makes reference to Simon Fraser’s

early 19th century journal entry stating that “the Thompson and possibly the Upper Lillooet” consumed dogs, and Fraser himself was fed dog in a Lillooet village along the east bank of the Seton River, less than 15 km from the Bridge-Fraser confluence (Lamb 1960).

Among the Lillooet, dogs were also used in the hunt, for driving beavers from their dens, and for running down deer and bear (Teit 1906: 226). Trained hunting dogs were a noteworthy commodity and were treated rather well. Teit (1906: 233) notes that “one good hunting-dog was counted equal to one large dressed elk-skin”, and provides that dogs were inherited by the sons of a deceased owner (1906: 255), and that upon a man’s death some of his dogs were sacrificed and hung from his grave pole or from nearby tree branches. Among the neighboring Shuswap there was a similar tradition involving the killing of the deceased’s “best or favorite dog” (Teit 1909: 593).

Dogs were common enough within the winter pithouse villages to have necessitated cultural taboos regarding their treatment and the treatment of animal remains which they may have gotten into. Among the Lillooet, “Hunters threw the bones of animals, particularly of the deer and of the beaver, into the water, so that dogs could not defile or eat them, and thus offend the animals” (Teit 1906: 281). Likewise, among the Shuswap – “The bones of the first deer killed on a hunting-trip were generally burned. No meat of deer or any animal killed for food was given to dogs until the people had first had a meal of it. If the meat were given to dogs first, these animals would be angry, and afterwards not allow themselves to be shot” (Teit 1909: 603). Teit (1906: 211) goes on to hint that multiple breeds of dog were maintained among the Lillooet, differentiating between hunting dogs and a different breed used specifically for their hair, and

possibly for consumption: “A variety of dogs with long white hair was raised for this purpose [for their hair]: it has been extinct for some time”. Teit (1909: 507, 520) also contends on a number of occasions, that Shuswap garments of dog skin were worn specifically by the poor. In contrast, Crellin (1994: 90) supposes that dog skins would have been valuable among the Lillooet due to limited access to deer, elk, moose, and caribou skins, though this contention is not supported in any of the pertinent ethnographies.

Among the remains of medium-sized mammal, dog remains are relatively common in the faunal assemblage from Housepit54, attesting to their presence within the pithouse. Whether as a repast saved for ritual consumption, a last ditch starvation food, or a regular part of the everyday diet, dog meat may have been an important food resource among prehistoric occupants at HP 54, and their domestication for consumption may have been a clever adaptation for dealing with food stress during lean times.

Plants:

Plants were harvested throughout the non-winter months, and collection strategies varied by plant and season. There is a wealth of ethnographic and ethnohistoric evidence regarding the subsistence use of a huge variety of plants by Native people throughout the Interior Plateau (Turner 1992; Turner et al. 2000; 2003). These include a wide range of wild greens and leafy vegetables, geophytes, mosses, fungi, seeds and nuts.

Traditionally, root gathering was undertaken specifically by women and at various times of the year. Early spring was a time for gathering the roots of skunk cabbage, cat-tail, and ferns, as well as the chocolate lily. Late summer was a time for picking berries and when many edible bulbs reached the peak of their maturity. Berry patches and plant gathering grounds were considered communal property, but were held under the supervision of clan chiefs who regulated access to them in order that resources were not harvested too early (Teit 1906: 256). The Upper Bridge River area was considered particularly resource-rich, “noted for its abundance of roots and game” (Bouchard and Kennedy 1978: 3). Roots and bulbs were harvested with the aid of a digging-stick made from hawthorn, Saskatoon, or antler with a handle fashioned of horn, antler, or wood. Roots were roasted, dried, reconstituted and boiled in stews, or eaten on the spot depending on the variety and the time of year (Bouchard and Kennedy 1978: 72). Dried roots were stored inside the pithouse for use during the winter.

Plants made up a significant portion of the diet and were ubiquitous in medicinal practices. In addition to dietary and medicinal contributions, plants provide materials for textiles and cordage, insulation for shelters, clothing, and foot ware, as well as having recreational, ceremonial, and social uses. For example, *Nicotiana attenuata* was smoked (mixed with bearberry leaves and sometimes scented with beaver castoreum) for enjoyment, for ritual purposes, and as a form of conciliation between enemies (Teit 1906: 250). The cambium layer of the lodgepole pine (also, alder, choke-cherry, and poplar) was so commonly consumed that George Dawson commented in 1875 that “the woods all through this part of the country consist largely of a small species of pine... & almost everywhere the natives have peeled great slabs of bark off the trees to get at the soft Cambium layer beneath. In spring this is scraped off & eaten”

(Cole and Lockner 1989: 80; see also Teit 1906: 222). Plant materials recovered at Bridge River include evidence of the fleshy berries of Saskatoon (a pre-Contact dietary staple), raspberry, kinnikinnick (bearberry), soapberry, hawthorn, elderberry, and mountain ash, as well as from members of the Heath (*Ericacea*) and Rose (*Rosaceae*) families. The presence of *Ericacea* (likely from huckleberry or blueberry) in archaeological flora assemblages is sometimes an indicator of a particularly anthropogenic landscape, as Heathland vegetation often flourishes in areas that are systematically exposed to controlled burning (Pyne 1998; Turner 1999).

Clearly, plant foods (particularly wild roots beginning during the Plateau Horizon) were an integral part of everyday consumption practice and likely played a much larger role in the prehistoric diet than can be archaeologically reconstructed at present (see Fowler and Turner 1999: 421). Of significant dietary importance, root plants were exceptional, as they provided much needed sources of carbohydrates, complex sugars, fiber, and essential vitamins and minerals (Wing and Brown 1979).

Plants were not only a major source of nutrients to supplement a protein-rich diet of animal flesh, but were a vital source of medicine and raw materials. For the nearby Thompson Indians, Teit (1930) provides a list of no less than 69 plants used for food, not including those used for ritual and medicinal purposes. An archaeological example of medicinal plant use is offered by Lepofsky (2000a: 77) and Cousins (2000), both of whom note the presence of *Phacelia* at HP7 and other pithouses at Keatley Creek - a plant that Teit reports was used to treat wounds and sores. Plant fibers provided cordage used in tool manufacture, construction of storage, cooking, and household implements, and plant products were used in clothing, shelter

construction, and for many other technological elements of everyday life (Kennedy and Bouchard 1998; Kuhnlein and Turner 1991; Lepofsky and Peacock 2004; Turner 1992, 1997, 1998; Turner et al. 1980).

Teit (1906: 222) describes a number of plants specifically by name, as well as berries and seeds that were collected by the Lillooet. Important dietary staples noted include: Columbia or Tiger Lily (*Lilium columbianum*), Yellow Glacier Lily (*Erythronium grandiflorum*), Biscuit Root (*Ferula dissolute* or *Lomatium dissectum*) – also known by a number of names such as Indian parsnip and wild carrot, Chocolate Lily (*Fritillaria lanceolata*), Arrowleaf Balsamroot (*Balsamorhiza sagillata*), various wild onion and garlic variants (*allium* sp.), Spring Beauty (*Claytonia* sp.), Serviceberry or Saskatoon (*Amelanchier alnifolia*), Canadian buffaloberry or Soapberry (*Shepherdia canadensis*), Oregon Grape (*Mahonia aquifolium*), Evening Primrose or Fireweed (*Epilobium angustifolium*), and the seeds of Black Pine (*Pinus contorta*). In the Mid-Fraser, certain plant species were more important to the indigenous diet than others - for instance, Teit (1909: 780) mentions, describing the Shuswap, that “*Claytonia* sp., hog-fennel (*Peucedanum macrocarpum*), *Lilium Columbianum*, wild onion (*Allium* sp.), *Erythronium grandiflorum*, Indian rice (*Fritillaria lanceolata*), [and] fern-root” were the most common plants used as food. Dietz (2005: 13) notes that Yellow Avalanche Lily (*Erythronium grandiflorum*) was the most common geophyte cooked in roasting pits (citing Peacock 1998; Peacock and Lepofsky 2004; Teit 1900, 1906, 1909; Turner 1992, 1997; Turner et al. 1990).

Clearly, a wide variety of geophytes, fruits, berries, seeds, nuts, and leafy greens were relied upon by foragers in the region during different seasons and for various purposes (Lepofsky

2000; Turner 1992). In addition to subsistence and general utility, plant foods (particularly geophytes) served as important elements of feasting events, rituals, and other community gatherings (Hayden and Adams 2004).

SUMMARY

This chapter has detailed the cultural adaptations, environmental contexts, and subsistence resources experienced by prehistoric hunter-gatherer-fishers of the Bridge River village and surrounding area. Prehistoric people of the region utilized a variety of natural resources in various ecotones, gravitating over time from high residential mobility to semi-sedentism and subsistence specialization revolving around the acquisition and storage of salmon, supplemented by terrestrial animals and a diverse assortment of plant resources. Beginning around 1800 BP, changing climate produced conditions that facilitated increased productivity of anadromous salmon, deer, and wild roots, which allowed foragers throughout the Mid-Fraser Canyon to coalesce and seasonally occupy communal hubs such as winter pithouse villages adjacent to productive fisheries or other resource acquisition sites.

At Housepit 54, multiple generations spanning much of the occupation intervals of the last 1600 years relied on the surrounding environment for their survival. Subsistence resources in the Mid-Fraser varied at times under different environmental conditions. Foragers in the area were adept at adjusting to changing conditions to meet their needs and changes in the archaeological record reflect this. As village population increased over time, over-hunting of large terrestrial resources likely led to depletion of important local sources, forcing foragers to

travel increasingly farther afield to acquire desired prey (for instance). With an array of foodstuffs to utilize, and increasingly effective storage technologies, Bridge River village foragers continued to rely heavily on anadromous salmon and other particulars. During the later phase of BR3, and prior to 1100 BP as the village experienced significant and rapid declines, dietary flexibility was likely integral to subsistence practices.

CHAPTER TWO

THEORETICAL FRAMEWORKS

The following chapter introduces the theoretical frameworks used to develop the hypotheses that this dissertation seeks to address. Key concepts presented include Evolutionary Ecology and the application of Optimal Foraging Theory (OFT) and accompanying models to archaeological assemblages of prehistoric hunter-gatherers. I will also present concepts surrounding models of resource intensification processes as they relate to subsistence strategies and the relationship between changing population demographics and local resources during periods of demographic change. This research assesses the connection between population growth and subsistence change within a single pithouse over time that ultimately ends in a known abandonment event. Because it is already presupposed that the series of events evaluated ends with the collapse of the Bridge River village system, I evaluate the potential causes from the perspective of a Malthusian Intensification Model (Malthus 1798; Prentiss et al. 2014; Puleston et al. 2013). Finally, an evaluation of how these differing models offer a synergistic perspective from which to assess test expectations regarding population pressure and subsistence change at Housepit 54 is offered.

Conflicting theories have been proposed to explain population decline in the Mid-Fraser during the late Holocene circa 1300-1000 BP. To some degree these are all concerned with the depletion of subsistence resources: 1) as the result of the onset of warmer/drier conditions (see Prentiss et al. 2005) at the onset of the Medieval Warm Period (Hughes and Diaz 1994) that caused dwindling production of salmon in the region; 2) as the result of the obstruction of salmon runs caused by a catastrophic landslide(s) blocking salmon migration routes into the

Mid-Fraser Canyon (Hayden 1997; Hayden and Ryder 1991, 2003); 3) due to the overexploitation and subsequent depletion of terrestrial resources, particularly deer and upland geophytes (Kuijt and Prentiss 2004), and finally; 4) as the result of naturally occurring phenomena such as perennial fluctuations or falloffs in salmon production (Kew 1992). This research uses faunal assemblage data to assess subsistence practices between occupation floors spanning the distinct population increase and ultimate decline that defines the period between the onset of BR2 and the end of BR3 within Housepit 54.

Numerous archaeological studies have used concepts from OFT such as Selective Efficiency, Prey-Choice, and Central-Place Foraging to illustrate variability in resource acquisition, use, depression, intensification, and extensification over time (e.g. Bayham 1979; Bettinger 1991; Bettinger and Baumhoff 1982; Betts and Friesen 2004; 2006; Bird and O'Connell 2006; Broughton 1994*a*, 1994*b*; 1995; Broughton and Grayson 1993; Elston 1986; Grayson 1991; Hawkes, Hill and O'Connell 1982; Janetski 1994; 1997; Madsen 1986; Metcalfe and Barlow 1992; Simms 1987; 1994; Stiner 1994; Stiner *et al.* 2007; Szuter and Bayham 1989; Szuter and Gillespe 1994; Winterhalder 1981). These various models provide a means of testing human decision-making processes from archaeological data based on the assumption that behaviors are selected for based on individual fitness. Alternative models that also examine the effects of decision-making behaviors, such as Niche-Construction Theory (NCT) - in which ecosystems and their constituents evolve synergistically - have also been developed but have rarely been successfully applied to archaeological data (Laland *et al.* 1996; 2000; Odling-Smee *et al.* 1996; see also Day *et al.* 2003; Griffiths 2005; Vandermeer 2008). This is largely due to the obvious complexity that a synergistic model presents, making NCT difficult to quantitatively

apply to archaeological interpretations. However, archaeologists are increasingly developing conceptual frameworks developed around concepts from NCT (Broughton *et al.* 2010; Kuijt and Prentiss 2009; Leland and O'Brien 2010; Smith 2011; and for a critique of OFT in favor of NCT see Zeder 2012). Overall, the theoretical concepts presented here is based on evolutionary models that assume that decision making ultimately affects fitness in populations.

Evolutionary Modelling

Human Behavioral Ecology (HBE) emerged as an anthropological framework borrowed from evolutionary biology and theoretical ecology to address the relationship between how complex decision-making strategies are impacted by environmental stimuli and evolve as the product of those interactions. At the heart of Evolutionary Ecology (and its archaeological application HBE) are concepts concerning adaptation, natural selection, and the interactions between evolutionary processes and environmental conditions, as well as the influence of such processes on human decision-making strategies and adaptive behaviors. Ultimately, HBE examines the human management of energy, or the adoption and use of adaptive decision-making in the acquisition and utilization of energy or some other currency.

As a discipline, Evolutionary Ecology (or HBE, see Broughton and O'Connell 1999:153) materialized from the works of ecologists such as Eric Pianka (2011), Robert H. MacArthur (MacArthur 1984; MacArthur and Pianka 1966), and E.O. Wilson (1975) working with various animal species and populations. Evolutionary ecologists initially sought to understand patterns in “community diversity, population regulation, sex ratios, feeding strategies, competitive

equilibria” through the application and testing of simple mathematical models (Bettinger 1992: 5). E.O. Wilson’s (1975) proposition that human social behaviors were products of complex evolutionary processes, though initially largely misunderstood, opened the door for the social sciences to debate the origins of culture in the same breath as concepts like natural selection of genetic variability, or the demographic trends from population ecology. Applications of evolutionary ecology in archaeology (and anthropology in general) have allowed theorist to speculate quantitatively on fitness-related decision-making schemes based on the archaeological remnants left as by-products of those behaviors.

HBE was developed from these initial frameworks by ecologically-minded anthropologists as a means of assessing human decision making strategies and their consequences in adaptive evolutionary contexts. Winterhalder and Smith (1992: 3-5) define evolutionary ecology as: “the study of evolution and adaptive design in ecological context” through “the application of natural selection theory to the study of adaptation and biological design in an ecological setting.” Thus, HBE methods rely on concepts derived from studies of human behavior, statistical models of rational decision-making, and theories pertaining to optimal foraging practices – all of which aim at modeling human behavior (Cronk 1991). Like those of Pianka, MacArthur, and Wilson, the observations of naturalists and biologists influenced the groundwork upon which anthropological human behavior studies would be built. For instance, Brown’s (1964) assessment of territoriality influenced future notions of how behavioral adaptations enhance the probability of survival in some species. Brown (1964: 160) noted how aggressive behaviors tend toward an adaptive advantage toward individual defensibility, mate retention, and survivability, and ultimately maximizing fitness. Similarly, Charnov (1976)

described the Marginal Value Theorem, or how predator mobility is driven in part by depression of immediately available resources distributed in various patches across a landscape, causing migration from one patch to another when resources reach a marginal value. Although these theorists were working with non—human animals (Pianka was working primarily with lizards, MacArthur with birds, Wilson with ants, Brown with cormorants and sage grouse, and Charnov with mantids), anthropologists extrapolated the core of evolutionary ecology’s ideas to apply to human social-ecological behaviors and how they applied to evolutionary diversity in those behaviors (Broughton and O’Connell 1999: 156; Winterhalder and Smith 1992: 6).

In anthropology, Steward’s concept of Cultural Ecology was initially a response to Alfred Kroeber and Boasian anthropologists who established the notion of ecological regions or “culture-areas” in which hunter-gatherer groups resided (Kroeber 1947; Steward 1955). Steward’s Cultural Ecology attempted to describe human behaviors as they played out in specific environments and landscapes without trying to describe the universality of any particular strategy. As Steward (1955: 31, 34) pronounced: “social or human ecology emphasizes the human community as the unit of study. But “community” is a very general and meaningless abstraction... Cultural ecology differs from human and social ecology in seeking to explain the origin of particular cultural features and patterns which characterize different areas rather than to derive general principles applicable to any cultural-environmental situation.” To do this, cultural ecology looked at the interplay between environment and specific cultural practices that made up a “cultural core” – the foundation around which cultures are constructed (Steward 1955: 36). To Steward, the concern behind the cultural core was that sets of behaviors and technologies change with differing environments and systems that work in some places simply won’t in others. In

evolutionary terms, the means of achieving adaptive advantage ultimately dictates the strategies necessary for survival to that of the environment in which they must perform (Winterhalder and Smith 1992: 21). Thus, how various technologies are utilized in the production and acquisition of resources, is directly influenced by localized behavioral strategies – particularly as they relate to getting food. This methodology was further built upon in Leslie White’s (1949: 364) notion of cultural “technological, sociological, and ideological systems” - especially the technological elements employed in the acquisition and consumption of energy (i.e. food). White’s concept suggests that the cultural system is dependent on the amount of energy that can be harnessed and controlled in a given environment with particular sets of technological means. Within this framework cultural evolution occurs as “the amount of energy harnessed per capita per year is increased, or as the efficiency of the instrumental means of putting the energy to work is increased” (White 1949: 365). Later scholars would turn their attention toward addressing variation in the construction of cultural materials, closely examining resource usage and risk-management in procurement, strategies of preparation of goods, and the transmission of technological methods (Eerkens and Lipo 2005: 319; Fitzhugh and Trusler 2009: 204). Although the idea of energy capture as the prime mover of decision making processes (the “nutrient currency” - usually kcal/unit of measure/per unit of time) remains integral to many test applications of EE and HBE models, energy is just one of many currencies that may form the basis around which decision making strategies are quantified (see Bird and O’Connell 2006: 146; Lupo 2006: 146).

The interplay between humans and environmental stimuli continued to emerge in anthropological studies as anthropologists increasingly concentrated on evaluating subsistence

practices and cultural behaviors as they relate to the attainment of resources within specific environmental contexts (Gowdy 1998). Similarly, Rappaport's study of Tsembaga Maring pig-farmer horticulturalists in New Guinea (1968), and Thomas's (1973) examination of Andean Quechua Indian pastoralism and trade in the high Puna and other regions of the Nunua District of Peru, also examined energy expenditure differences between age- and sex-groups exemplify the early applications of energetic returns rates to cost-benefit analyses pioneered through cultural ecological methods (Kelly 2007: 44). Over the last few decades, counting calories has become an important business in anthropological studies.

HBE materialized in part from this increased attention to cost-benefit analyses of fitness-generating behaviors through the use of Optimal Foraging Models and game theory (Cronk 1991). As Broughton suggests (1994), HBE proposes that human adaptations function in response to evolutionary processes as determined with their surroundings and subsistence needs. Kelly (2007: 50) notes that "[behavioral ecology] makes explicit use of evolutionary theory" to directly address how "natural selection shapes human societies." One major focus of HBE has been to evaluate how specific environmental conditions in which humans subsist factor in to adaptive decision-making in those particular environmental contexts. As Winterhalder and Smith (1992: 8) conclude: characters of the environment in which decisions come about directly inform how and why those basic decisions are made – i.e. human behavior "is the product of simple rules played out in an exceptionally complex environment." With application to a wide range of decision-making predictors, HBE is a useful framework for designing hypotheses and test expectations. One important observation regarding Optimal Foraging Models is that models

are designed to make predictions and test hypotheses, but they are not intended to directly *answer* questions on their own.

At its core HBE attempts to explain variability in human behavior given a range of choices in diverse environmental conditions. Extrapolations of the models have been ventured to explain the behavioral adaptations of ancient humans and archaic primates considering energy and resource utilization in varied subjects from social organization to subsistence practices to lithic reduction strategies (Broughton 2002; Byers and Ugan 2005; Elston and Brantingham 2002; Grayson and Delpech 1998; Kaplan et al. 2000; Kelly 1999; Lovejoy 1981; O'Connell et al. 1999; Rindos et al. 1980). For example, as mentioned above, Broughton (1994; 2002) examined resource variability in late Holocene western North America by looking at the archaeofaunas of the Emeryville Shellmound in California. Utilizing a number of HBE models including the Patch-Choice Model, Marginal Value Theorem, and the Fine-Grained Search (or Prey) Model and employing Relative Abundance Indices, Broughton determined that large prey in close proximity patches to human basecamps declined over time in the regions immediately surrounding Emeryville and determined that declines in foraging efficiency in the local vicinity could be inferred from variability observed in the age composition of archaeological faunas, because as prey declined hunters caught younger, and subsequently smaller prey..

Others have used Optimal Foraging Models to test a myriad of hypotheses. Example include: Byers and Ugan (2005) examined archaeological evidence of Paleoindian hunting practices in North America using modern faunal corollaries to determine the energy efficiency tradeoffs involved in mega-fauna exploitation; Elston and Brantingham (2002) used risk and

utility indices to model catastrophic technology failure and how risk-reduction plays a role in technological innovation and utilization of raw materials; Grayson and Delpech (1998) used the Diet Breadth Model to infer land use and subsistence strategies during the Upper Paleolithic in Europe. The basic tenet of the Diet-Breadth Model states that the optimal diet is one that provides the greatest nutritional return proportional to the cost of acquisition. The model predicts that higher-ranked (i.e. higher nutritional value/procurement cost) resources will be chosen over those of lower rank (Kaplan and Hill 1992: 171). Robert Kelly (1999) has looked at, among other things, issues of population dynamics involved in the rapid rate of Clovis migration and the colonization of North America using the Marginal Value Theorem. He proposed that the first phase of early migrants into North America were highly mobile hunters with little utility for caching food or settling in one place for any long period of time. Kelly's (2007) work has also focused on adapting various models to the interpretation of different hunter-gatherer behaviors and resource procurement strategies. Other scholars have used HBE and Optimal Foraging Models to investigate the transition between hunting and gathering and the emergence of agriculture (Winterhalder and Kennett 2006).

At Housepit 54, concepts from Optimal Foraging Theory provide means for inferring human decision-making from variability in the animal bone assemblage.

Modeling Change in Subsistence Resources: Decline, Depression, and Intensification

Archaeologists have long been concerned with patterns in the use, and particularly over-use, of subsistence resources in prehistory. Grayson and Delpech (1998) and Broughton (1994a; 1994b; 1995) were some of the first zooarchaeologists to systematically use multiple analytical

methods to look at questions of variability in faunal assemblages. Broughton's (1994b) application of relative abundance indices to observe relationships between apparent declines in some resources and not in others has been particularly influential to studies aimed at assessing causes of variability in archaeological faunal assemblages. Similarly, Betts and Friesen (2006) address issues relating to what they describe as "inexhaustible resources" and resource overexploitation and depression, considering a number of potential implications for empirical observations pertaining to the quantification of zooarchaeological data – namely: considerations regarding abundance indices, prey "behavior, demographics, and distribution" and reactions to environmental change, and issues regarding hunter-gatherer "social, demographic, economic, and territorial organization." Along similar lines, Butler and Campbell (2004: 331) ask whether resource depression of salmon populations in prehistoric northwestern North America resulted from extended and intensive dependence on salmon by collector strategists, and was depression the result of overharvesting or was it a product of increased harvest efficiency due to technological adaptation. Alternately, they question whether depression in anadromous fish populations was even possible:

"Was salmon, or any other resource, used more intensively over time and does overall animal use vary with development of logistical organization? Could animal resources have been used intensively for thousands of years without suffering from decline?"

Climate change played a major role in varying salmon productivity and local run densities throughout the late Holocene (Yu 2015: 5). Salmon populations fluctuated as temporal climatic and environmental conditions changed at cyclical perennial degrees (Ames 1994; Beamish 1995; Butler and Campbell 2004; Chatters *et al.* 1995; Chatters 1995; Finney *et al.* 2000; 2002; Fryxell and Daugherty 1963; Grove and Switsur 1995; Hare and Francis 1995; Helle

and Hoffman 1995; Hinch *et al.* 1995a; Hinch *et al.* 1995b; Ishida *et al.* 1995; Jochim 1983: 215; Lyman 1992; Mann *et al.* 1998; Moss *et al.* 2007; Sanger 1967; Schalk 1981, 1983; Whitlock 1992). Hare and Francis (1995) posit that salmon populations in the Northeastern Pacific fluctuate variably between high and low productivity synchronously with climatic changes on regional and larger marine ecosystem scales. Similar processes have likely affected Pacific salmonids. Kew (1992) and Schalk (1977) both suggest that due to the natural variability of anadromous fish year-to-year, salmon are variable to such a degree as to be patently unpredictable, presenting salmon-dependent foragers with a potentially precarious existence. Alternatively, Jochim (1983: 216) concluded that, under varying climatic conditions, compared to migratory terrestrial animals such as reindeer, “salmon are a much more predictable, spatially stable resource.” However, under circumstances of relative climatic stability, salmon numbers returning to the Mid-Fraser, though still highly seasonally variable, may not have fluctuated to such a degree as to cause drastic problems for foragers maintaining relatively low population densities during the late-Holocene. When population densities significantly increased in the area (as at Bridge River during the end of BR2 and the final phases of BR3), an unexpected decline in salmon productivity could potentially have had devastating implications for larger human populations (Prentiss *et al.* 2014).

In environments with spatially homogeneous resource variability (see Kelly 2007: 320; Richardson 1982) like the salmon-rich riverine environments of the Pacific Northwest of North America, local resources like anadromous salmon offered the potential for sustained periods of predictable resource acquisition. Over only a few years of stability, this may have allowed human population growth to increase at rates not experienced by hunter-gatherers before the

increasingly systematic predation of salmon. This predation was made even greater by increasingly efficient social organization of labor, processing, and storage techniques. Soffer (1985) looked at resource intensification in the Central Russian Upper Paleolithic, and found that abundances and distributions of subsistence resources (prey procurement and storage) greatly influenced the conditions leading up to the emergence of complex social networks, socio-political structures, and specialization of production among hunter-gatherers of the Central Russian Plain.

In contexts where recurrent, relatively stable, and thus seasonally foreseeable, rates of harvestable resources are present through much of the year, non-domesticated resources may be modeled, at least theoretically, in similar fashion to those of agricultural or domesticate production and acquisition (Arnold 1996: 85; Hayden 1981; Ingold 1983; Testart 1982; Woodburn 1982). This was arguably the case in the Middle Fraser Canyon for much of the late-Holocene. In the Middle Fraser of the early late-Holocene, economies became increasingly reliant on the acquisition of migrating salmon as fisheries-dependent adaptations made their way from the Pacific coast up the Fraser River and into the Interior, tying ancient people (at least seasonally) to productive patches of riverine zones in much the same way that agricultural societies are bound to agriculturally-useful landscapes. Rowley-Conwy (1983: 114) addressed this concisely:

“...when several migratory species are exploited, *differential seasonality* of these species enables each to be exploited in turn. A particularly notable example is the series of salmon species exploited on the Northwest Coast and by the Ainu - the various species do not run at the same time, so their overlapping seasonality ensures that salmon may be caught over several months and a sufficient quantity stored.

Concentration on migratory species also means that permanently residing native species (e.g., non-migratory deer, plants, shellfish) may be left alone for parts of the year, and can be utilized alongside stored food during the periods of the year when no migrant visitors are available.”

Influenced by Boserup (1965), Earle (1980: 13) notes that increases in harvestable yields of gathered resources may be obscured by processes of intensification due to the fact that constant innovations in technique and technology facilitate continually expanded production potential.

Mobility and Storage

Morgan (2008, 2009) suggests that environmental changes necessitated a shift in mobility among late-Holocene Western Mono of California, where aggregation in winter villages was in many ways similar to that at Bridge River. Morgan (2008: 382) further posits that winter village aggregation was a risk-averse strategy that developed to cope with resource variability in different spatial, temporal, and geographic contexts. In both cases (western California and in the Mid-Fraser Canyon) logistical highland foraging was practiced during part of the year, followed by aggregation supported by “winter population fusion, logistical mobility, and storage.” (Morgan 2009: 392). As we shall see, storage is one particularly effective way of compensating for resource deficits.

Primary dependence on salmon, at least seasonally, required that people in prehistoric Mid-Fraser Canyon villages remain bound to village areas within close proximity to fishing grounds (Prentiss and Kuijt 2012: 116). In collector societies, as in agricultural ones, the key to

efficient exploitation of abundant resources (in the case of animal resources, high R-value/R-selected species) is the well-organized use of delayed-return strategies – i.e. extensive storage (Hayden 1981: 527; Ingold 1983: 554; Testart 1982: 524; Woodburn 1980, 1982). Earle also notes that within agricultural systems, “given continued population growth, agriculture's potential for intensification would cause agriculture to be increasingly emphasized in the subsistence economy” (1980: 21). It seems logical that similar processes would result from extended access to recurrent and predictable salmon runs – effectively what Piperno (2006: 141) presents as resources that are “dense, high-yielding, and resilient to human predation”.

Woodburn's model of *delayed-return* strategists describes societies in which sedentary or semi-sedentary groups maintain set or fixed dwellings with some level of territoriality and utilize specialized technologies, techniques, and social labor institutions to acquire, process, and store resources (1982: 432). In comparison, Binford's *collector* strategists are marked by groups of “logistically organized collectors [who] supply themselves with specific resources through specially organized task groups” concentrating on the procurement of “specific resources in specific contexts” (1980: 10). Both models may be used to adequately illustrate the general trend of occupations and subsistence systems in the mid- to late-Holocene of the Mid-Fraser region.

In the ethnographic record the Lillooet story of Owl provides some insights into protohistoric storage practices. In the story, Owl ransacks the houses of a village in search of his estranged wife. The tale reveals an interesting clue about Lillooet storage, as Teit (1912: 315) relates how, frustrated, blind, and still unable to locate his wife, Owl rifles through the village houses and eventually “tore down the salmon-caches, and searched through them.” This

indicates that at least a portion of salmon storage was done above ground, perhaps in baskets hung from the ceiling rafters of houses. Teit (1906: 223) describes two basic forms of food caching used by the Lillooet, which he refers to as “cellars”:

“The Upper Lillooet stored food in two kinds of cellars. One kind (called *powa'xvan*) was made very carefully and lined with bark. The roots, berries, and other food stored therein were done up in bundles and wrapped in birchbark. All the surplus food not required during the winter was placed in it, and not disturbed until spring. The other cellars (named *'sqo'zEks*) were b situated near the house, and made with less care. From them provisions were taken as required during the winter. Food stored in the permanent cellars and kept over until spring was called *ka'za*.”

Teit (1906: 224) describes Lillooet seasons in detail, noting that during “the *Seventh Moon*, or *Kwo'ltus 5sku'klep* (“when strawberries are ripe”), the first of the salmon fishing was undertaken. As strawberries are the first berries to ripen in early spring, this would herald the beginning of the earliest Chinook runs. During the “*Tenth Moon*, or *Laq a "stso'qaza* (“the salmon come”)” the bulk of the Sockeye salmon runs were exploited and processing and drying of meat would have been at its zenith and a daily endeavor for much of the community. In the “*Eleventh Moon*, or *"stse'pEq* (“boiling”)” salmon were boiled for the production and collection of oil. Finally, during the “*Rest of Year*, or *Llwe'lsten* (“fall” or “autumn”)” hunting and trapping was undertaken in preparation for the coming winter. It is likely during this time that the majority of hide processing occurred, though this was likely a necessity throughout much of the year.

Prentiss and Kuijt (2012: 116) describe how forager-collector societies at Northern latitudes “had access to food in short bursts” and that “survival was predicated on harvesting a lot of food from a single species and storing it for the lean seasons.” For collectors at Bridge River, Chinook salmon or “Spring” or “King” (*Oncorhynchus tshawytscha*), and Sockeye (*O. nerka*) frequented the Mid-Fraser system in great abundances at annual cycles. In the Fraser River, various populations of Chinook run in spring-, summer-, and fall-cycles; and the largest Chinook stock in British Columbia originates in the Lower Fraser River (Heard 2007: 83; Henderson and Graham 1998; Irvine et al. 2009; Labelle 2009). Sockeye tend to run only during the summer months, but in generally great abundances punctuated by distinct four-year cycles of even greater profusion (Beamish and Cass 1997: 544; Prentiss and Kuijt 2012: 119; Roos 1991). The abundance and density of Sockeye populations during their relatively short late-July to mid-August spawning run, combined with their significant fat content that, while lower than that of Spring salmon, resulted in easier storage, made them a major species of subsistence concern through much of the Mid-Fraser Canyon (Prentiss and Kuijt 2012: 119). Teit (1912: 303) relates a native Lillooet tale that tells of two brothers and the origin of salmon, wherein one brother gets sick and remains so for four years, until the brothers go on a journey down the Fraser and eventually lead the salmon into the rivers and streams of the interior. The significance of the sick brother’s four year illness may be in relating information regarding the four year cycle of Sockeye population surplus. Also of note, Idler and Bitners (1958) found that the flesh of Sockeye loses a considerable percentage of water (~5-10%) during the first portion of the Fraser River spawning migration, and showed that samples taken at Lillooet lost between 6.6% (males) and 9.8% (females) total flesh water weight. During the final portion of the spawning migration, from Lillooet to Forfar Creek, the process was reversed and migrating salmon gained water.

While this may seem trivial at first glance, it suggests that salmon captured in proximity to the Lillooet area retained less water in their flesh than at any other point in their migration. This may have greatly increased the efficiency of the drying process of captured Sockeye in and around the Lillooet region. Both Chinook and Sockeye salmon feature prominently in the mythology of the region (see Teit 1912: 305).

The intensive use of salmon in the region during much of the last couple thousand years is clear from archaeological evidence and ethnographic data. However, the relationship between anadromous resources and others that are available at different times of the year is clearly complex and requires an understanding of how populations utilize key resources under different conditions and over time. One way to infer causes of change in key resources is to examine those resources under conditions of intensification processes.

INTENSIFICATION

“If something exists, then it exists in some quantity. If it exists in some quantity, then it can be measured.” Robert Thorndike (1918)

Quantifying archaeological intensification requires the use of proxy measures because the process itself cannot actually be measured. *Intensification* is the process of making something more intense, stronger, more acute, dense, contrasting, or sharp. By definition, use of the term intensification for describing incremental processes of socio-economic change, as it is most often used in archaeology is misleading. Archaeologically, intensification is not a process of simple

increase- it is a process of punctuated increases in response to specific (usually stress-related) conditions. Morrison (1994: 114) addresses this by pointing out Boserup's definition that "intensification of production refers to an increase in the productive output per unit of land or labor (or to some other fixed quantity)", but suggests that a difference must be established between actual intensification and a simple increase in productivity from some constant. Therefore, the variables used to define the acute changes in efficiency that suggest the *process* of intensification (i.e. proxies such as units of space, labor, or technology) determine how we interpret the changes observed in the archaeological record. In zooarchaeological studies, utilization of richness and abundance indices of prey species (see Betts and Friesen 2004, 2006; Broughton 1994a, 1994b, 1997, 1999, 2002, 2004; Grayson and Delpech 2002; Janetski 1997) provide a useful empirical way of illustrating variability in resource exploitation, resource depletion, and diachronically increased use of key resources - all of which may be used as proxies for measuring intensification processes.

From a dietary standpoint the range of variability in the presence or absence of resources exploited can often be an indicator of intensification because as one resource is depleted, others often enter into the resource-base to make up for the shortfall in the depleted commodity. Similarly, a wider area (in this case foraging radii) may be used to increase the production of the depleted resource, simply by seeking target resources at a greater distance than previously. Similarly, declines in one resource may indicate growing predation pressures (often a sign of increased predator populations). Inversely, increases in the presence of one resource may actually indicate declines in other resource populations. Diachronic increases in the amount of

resources used at a given site are also commonly associated with growing populations, but may also be used to infer that resource intensification may have occurred.

In evolutionary archaeology, intensification has been examined from two basic perspectives – population intensification and resource intensification. Fluctuations in fertility, mortality, and general demographics, and population packing have been examined under the auspices of population intensification, while resource intensification has been analyzed from the perspectives of increased land use, both in extent and effort, animal exploitation, agricultural productivity, and variability in raw material use.

Ester Boserup's (1965) landmark examination of population growth and agricultural intensification parted from the neo-Malthusian perspective regarding carrying capacity as being ultimately limited by production of agricultural output, instead arguing that, in agricultural societies, technological innovation (e.g. alteration of fallow periods) along with changes in the productivity of various labor regimes may lead to increased production irrespective of limited cultivation area. Broughton (1994: 372), paraphrasing Boserup (1965: 43), describes resource intensification in a manner that can be applied to more general resources and modes of acquisition as “a process by which the total productivity per areal unit of land is increased at the expense of overall decreases in foraging efficiency.” Boserup notes, of particular interest to forager responses to environmental change, that : “When increasing population density makes it necessary to change the pattern of land use in a given territory the changes are likely to be made in a way which takes account of the differences in natural conditions” (1965: 57) and further posits that in areas containing sparse populations, “food can be produced [acquired] with little

input in labour per unit of output and with virtually no capital investment... As density of population in the area increases... it becomes necessary to introduce other systems” (1965: 117; brackets mine) to meet the demands of the growing population.

Morrison (1994: 115) provides a lengthy discussion of economics and production relating to the Boserupian intensification concept, contending that intensification is a multivariate process that may comprise space, labor, technology, or combinations thereof that lead to increased capital gain. Morrison further uses Boserup’s basic model – “getting more out of a given area”, modified to archaeological application by the proposition that differing strategies of resource utilization – specialization, diversification, and intensification (a.k.a. investment) affect how energy is acquired and expended. Specialization denotes a dependence on fewer overall resources with greater, if not total, reliance on particular sources or a particular suite of resources (Price and Brown 1985: 8). The resource specialist strategy is well-illustrated with examples from the Pacific Northwest coast of North America where indigenous populations developed substantial reliance on collector subsistence strategies, particularly the acquisition and storage of salmon, or in the highlands of New Guinea where mono crop tuber cultivation, such as sweet potato and taro, dominates agricultural practice (Sillitoe 2009). Diversification refers to reliance on a wider range of technological and ideological strategies in order to minimize reduction of any particular resource. A suitable example of this is observed through the application of the wide diet-breadth model (see Broughton 1997). Morrison (1994: 142) contends that what she terms Investment is Intensification proper based on Kaiser and Voytek (1983: 329) which they describe as being a contingent threefold series of interdependent conditions: “(1) intensification proper, an increase in the net labor and resources devoted to productive activity; (2)

specialization, the channeling of labor and resources to achieve certain restricted ends; and (3) diversification of the combinations of labor and resources to produce a greater yield,” clearly more than just the process of extracting increasing capital from a limited area of land. Morrison (1994: 114) describes production as “the making, constructing, or creating actions of human beings”, and Kirsh (1994) asserts that intensification is likely to result in the “permanent modification of the landscape”; both these observations closely comply with Odling-Smee et al.’s (2003) description of niche construction to be addressed below.

Smith (1989: 313) proposes that intensification of seed use in late-Holocene Australia could be described as a response to “(a) new resource opportunities, (b) increased production pressure, or (c) resource stress.” While Smith’s context is specific (see also Lourandos and Ross; and for a case study from North America see Wohlgemuth 1996), the conditions he poses for the instigation of resource intensification processes are not. New resource opportunities are likely to cause a general increase in the resource usage of a newly exploited resource, they are not necessarily a probable cause of intensification proper. Increased production pressure and/or resource stress, on the other hand, are both likely candidates for the onset of intensification, especially under conditions of growing population or the onset of environmental perturbation. Lourandos and Ross (1994: 55) review the then emergent intensification debate by framing intensification as an observation of economic-environmental factors “relating to resource production and its ecological and sociocultural setting.” Earlier, Lourandos (1985: 389) proposed that intensification in hunter-gatherer societies must be viewed in context to the inevitable variability of environmental conditions that alter the “extractive efficiency” of foragers, forcing them to transform current capture/harvest methods and expand the exploited eco-niche. Morrison (1994: 111) echoes the significance of environment in assessing

intensification but reiterates the importance of the concept's use for "understanding change in productive systems", notwithstanding "the multiplicity of causes and the conditions under which they operate". She goes on to point out that population, though an obvious source dictating economic changes that lead to intensification in many circumstances, is too often proposed as the principal causal factor for the development of economic intensification, and that production – "craft production, subsistence production, [and] the production of built environments" (Morrison 1994: 112).

Steele and Klein (2009: 123) propose that resource intensification during the Late Stone Age in Africa was contingent on the development of technological change rather than variation in population demographic, though they contend that increases in localized populations likely led to increased diet-breadth with the incorporation of low-ranked species into the diet. Holly (2005) infers resource intensification among the Newfoundland Dorset and Paleoindians, as a process of diversification and the acquisition of lower-ranked resources. To Holly, these actions were necessary responses to increasing population pressure, but were also contingent on familiar resources and familiar resource niches – in the case of the Beothuk, only particular resources and landscapes were subject to intensification processes, while where and how these processes occurred was socially prescribed and culturally monitored.

Bettinger et al. (2006: 543), evaluating a model of technological intensification proposed by Ugan et al. (2003), propose that technological intensification is proximate to technological investment, and found with one model application that for tool production "intensification always enhances function at a rate greater than its cost." This observation is interesting because

it suggests that (at least for technological change) increased investment should always pay off, which is not always the case, as Bettinger et al. (2006) point out. In fact, Earle (1980: 20) notes that “hunting and gathering strategies have definite and restricted yields. Intensification in these strategies should thus quickly encounter sharply increasing costs, with the result that a major expansion in output from a subsistence economy would have to come from diversification.”

Diversification, or rather processes of diversification, sometimes described as the Broad-Spectrum Revolution (Flannery 1968), generally refer to a change in subsistence strategy by expansion of diet breadth to include less cost-effective, presumably less-desirable resources (Munro et al. 2009). Diversification is often determined by examining the diversity of resources used in a subsistence strategy. Changes in the diversity of an assemblage often indicate larger adaptive trends in subsistence strategy, and are often accompanied by other changing conditions. Diversification is often presented through the use of diversity indices of species richness and relative abundances: respectively, the diversity of species present in a particular ecological context or archaeological assemblage, and the percentage of individuals of each species within that context (Grayson 1984: 131; Lyman 2008: 173). In zooarchaeology, if the richness of species in an assemblage systematically increases over time, diversification is likely taking place. If relative abundances of certain species increase instead, specialization may be occurring.

Boserup's concept of agricultural intensification revolved around technological innovations necessitated by growing population pressures. These innovations eventually manifest as means of increasing the productivity of a given limited unit of land. For complex hunter-gatherers, variations on this theme of resource intensification have been proposed over the years. Price and Brown (1985) proposed that widening diet-breadth was a means of

intensification. Basgall (1987), Bean and Lawton (1976), Blackburn and Anderson (1993), and Bouey (1987), describe intensification processes in forager populations specializing in acorn production by means of selective harvesting leading to stimulated seed growth, as well as increasing use of innovative storage techniques, effectively boosting the productivity of local flora resources (acorns) through what Butzer (1982: 187) refers to as “normal systematic interactions”. Basgall (1987: 41) proposed that (in terms of balanophagy) the need for intensification is driven by “altered production requirements”, most commonly the result of disparities between population and its increase, the resources necessary to support that growing population, and the amount of actually available resources. Following Bettinger (1980), O’Connell and Hawkes (1981), and Winterhalder and Smith (1981), Basgall describes how an otherwise highly nutritious resource might remain under the radar, so to speak, due to particularly high handling costs, only to become utilized at a time when the trade-off between handling costs (increased production) and the need to support the population (productivity) (in this scenario the population need not necessarily be growing as is usually assumed, because changes in the environment, social structure, or other conditions may create extraneous demands on resource availability). In Basgall’s case of late prehistoric Californian acorn users arose in response to the need to support a growing population, as he points out: “Only when population densities reached a certain level, causing increased resource competition and constraints on residential mobility, would groups pivot to a reliance on acorns” (1987: 44). In the case of Mid-Fraser salmon utilization, what caused highly mobile hunter-gatherers to become semi-sedentary salmon-dependent collectors? Increasing population density does not seem to be the case, as this only appears after increasing reliance on salmon has become established – indeed, reliance on readily available salmon likely drove population increase, not vice-versa.

Bender (1996) approaches intensification under a Marxist framework of inter-social exchange, production, and inequality. In relating her idea back to complex hunter-gatherers (Bender's "gatherer-hunters") of the Middle Fraser Canyon, it is the social, rather than resource, aspect of intensification that becomes significant. Bender (1996: 54) suggests that "increased productivity, permitting a cut-back in time spent in food procurement, should be seen as a concomitant of social intensification" which leads to increased productivity, exchange, and social reproduction. This will become important when we later discuss increasing social complexity, its proxies in subsistence resource acquisition, and the emergence of social inequalities within and between households.

Ames (1985: 158), following Bender (1978; 1981; 1985) pointed out that intensification can manifest in different ways – it can represent "either increased productivity per capita or increased production per capita", but he points out that only in the latter case will any productive unit ("household") reap any material reward for their increased efforts. However, short-term material rewards may be mitigated by the increased availability of time and/or labor made available as a result of intensification processes, allowing for new socio-cultural investments – increased opportunities at multifaceted investments in social networks/interactions, ritual practice, and development of inter-personal or inter-household economic relationships such as alliances, marriage, exchange, craft production, or investment in aggregation such as development of architecture (Bender 1985: 23). Ames (1994: 211) later addresses the intensification of salmon resources among complex Pacific Northwest groups by asking how

increased reliance on salmon, facilitated by increased storage capacity and efficiency (i.e. intensification) affected socio-economic change in the region. Storage has been of particular interest in studies of persistent intensification of high-r-value resources (see Basgall 1987: 25; Jochim 1976, Prentiss and Chatters 2003: 51; Testart 1982, Winterhalder and Smith 1981).

Ames (1985) took the concept of intensification along the Northwest Coast further and proposed that efficiency in productivity and/or production per capita was the defining consideration when attempting to observe resource intensification. Earle (1980) proposed that intensification is more a question of specialization and diversification as means of increasing resource productivity, in that the relationship between energetic input and output are relative: investment/expenditure of additional energy is required in order to increase energy production. Elsewhere in the Northwest, Chatters and Pokotylo (1998: 76) suggest that “salmon was the focus of resources intensification efforts on the Columbia as well as the Fraser and Thompson rivers” during the Early-Late sub-Period as indicated by the dominance of salmon bones in faunal assemblages as well as isotopic evidence of high-degrees of marine-derived proteins in human bones falling within that time range. However, this inference is somewhat misleading in that while there are clear indicators of increasing levels of salmon utilization and emerging dependence, this is indicative of intense use but not indicative of “intensification” *per se*. The same is proposed for increasingly intensive use of plant resources, particularly camas, throughout much of the region during this period. Regarding geophytes, the use of the term *intensification* may be inappropriate, as no quantifiable data is offered to indicate “process[es] by which the total productivity per areal unit of land is increased at the expense of overall decreases in foraging efficiency (Broughton 1994)” - specialization of plants and other resources at this time

may or may not have actually required an increased expenditure of energy when compared to other foraging strategies, as required under our working archaeological definition of intensification. Butler and Chatters (1994) looked at variable survival rates of salmon bones as a result of differential bone density as a way of inferring salmon storage, and thus the intensification of production of salmon resources. Their study showed how denser vertebrae (compared to less-dense cranial elements) survive deposition at a much higher rate than most other salmon skeletal parts, thus bringing into question the general assumption that salmon-dominated assemblages with low frequencies of cranial parts are indicative of head removal prior to storage.

Finally, Broughton (1994a; 1994b) began examining resource intensification as a means of testing proposed ecological models of decreased foraging efficiency over time in prehistoric California. He describes intensification by late-Holocene hunter-gatherers as the result of growing population densities “causing decreases in the abundances of low-cost resources” resulting in higher-cost resources becoming “the focus of intensive human exploitation... a process by which the total productivity per areal unit of land is increased at the expense of an overall decrease in foraging efficiency” (Broughton 1994a: 501). Broughton’s study utilized trends in relative abundance indices to infer harvest pressures on extant vertebrate prey populations and compared those resource abundances with, among other things, seasonally available marine resources, under the assumption that prey size within an assemblage should change through time as predation becomes more intense, and in correlation to periods of variation in the availability of low-cost marine resources. In the context of salmon intensification, changes in the size of harvested individuals is not likely to be present within the

faunal assemblage, as spawning runs of salmon consist primarily, if not entirely, of mature individuals. However, cyclical changes in general size trends may correlate to observable environmental changes such as oceanic temperature change (see Beamish 1995). This said, Broughton's initial (1994b) foray into testing resource variability, depression, and intensification would lead to many more valuable applications of faunal analyses and models applicable for addressing questions of intensification and is still useful as regards interpreting the occurrence of salmon intensification specifically in that it suggests a means of looking at the comparative rates of terrestrial vertebrate faunas against ichthyofaunas in order to identify resource depression and to what degree seasonality of anadromous fish populations play a role in the development of semi-sedentism and emerging social complexity (Broughton 1984: 508). Nagaoka (2002) used a similar strategy to assess resource depression and its effects of diet-breadth, patch-use variability, and subsistence change in southern New Zealand, providing a good example of how comparisons between relative abundance indices can be used to illustrate patch-choice decisions as responses to resource depletion; her examination is also suggestive of evolving human behavioral adaptations in direct response to anthropogenic causes – a clear nod to niche construction theory. Broughton (2002) returned to late-Holocene California abundance indices to test whether indigenous Californian hunter-gatherers lived in relative equilibrium with local ungulate populations. He concluded that “declining densities of high-ranked prey and lower foraging efficiency imply greater foraging effort required to meet minimum caloric requirements and an increased risk of malnutrition.” This statement, regarding the relationship between declines in foraging efficiency and the overall health of hunter-gatherer populations experiencing them brings us to the necessary discussion of demographic modelling and Malthusian population demographics.

Clearly, concepts concerned with addressing variation in how resources are used are of importance to archaeological questions of prehistoric subsistence. Empirical evidence for intensification has often been cited as the product of the over-exploitation of key resources and a need by growing populations to increase the production of food. Evidence for intensification is often used to discuss changes in archaeological contexts, whether they be the presence or absence of technological adaptation under certain conditions, observed social or economic changes within a population, or to explain perturbations or declines in local ecology, or to postulate causes of growth or decline in human populations. It must be clearly stated that *intensification* is not simply the increased utilization of a given resource over time, but that it is a complex process of increased labor/effort that is often empirically observed in the archaeological record as simple increases or decreases (see Broughton 1994b) in the overall frequencies of resources over time.

DEMOGRAPHY

The preceding sections have discussed various concepts addressing resource intensification in archaeological contexts. I now turn to a discussion of how subsistence strategies and environmental conditions effect demographic change and how those changes may be observed and assessed in the archaeological record.

Beaton (1991) used the concepts of intensification and extensification to examine changing population demographics, subsistence strategies, and increasing social complexity in pre- and proto-historic California hunter-gatherer-collector populations. To Beaton (1991: 951),

intensification is simply the application of more labor and materials to escalate the productivity of presently utilized resources within the “estate” or vicinity. Extensification is similarly the application of more labor or materials in order to seize new resources from within or outside of the estate. Under these definitions, Beaton proposes that relatively small groups are more likely to deal with resource stresses by simply picking up camp and moving to a new resource patch, while larger populations are more conscripted by condition of their larger size to remain in a given area and intensify their use of particular resources through widened diet-breadth, social restructuring (i.e. labor organization), or technological innovation. In the case of Mid-Fraser salmon utilization, while we can clearly observe increases in salmon use over time throughout the region, the question remains: do those increases really indicate intensification? Using Beaton’s definition, the answer is yes, his assumption that population size dictates the level of mobility, and alternatively conscription, matches the data for the Mid-Fraser, as we have seen that population densities increased over time between BR2 and BR3, culminating in a level which would likely have necessitated large group conscription leading to intensification. One observed response to Basgall’s model, is that increasing population density appears to have been a product of increased reliability of food availability and production, not the other way around.

Lande *et al.* (2003: 3) present that “The dynamics of every population has both deterministic (predictable) and stochastic (unpredictable) components that operate simultaneously” and describe how, in general, populations fluctuate in a predictable fashion: those below carrying capacity tend to increase in numbers and those above carrying capacity tend to decrease. They divide stochastic data into three types: Demographic, or the independent probability that individuals within a given population will survive, perish, or reproduce, the

effects of which vary with population size; Environmental, in which entire populations fluctuate over time due to changing conditions within the environment, including extreme singularities such as “drought, fire, flood, landslide, volcano, hurricane, or epidemic” which effect the larger population as a whole; and Sampling error, where distortions in observed population size or density occur as the result of statistical error, estimation procedures, data collection/processing measures, or combinations thereof. Figure 2.1 provides an illustration of three generalized patterns of demographic change over time. These scenarios include: A) the “overshoot”/crash scenario in which population increases over time until it surpasses or “overshoots” carrying capacity and soon after population crashes as a result of food stress and increased mortality brought on by poor nutrition; B) the “oscillating” model in which population growth follows a stochastic equilibrium just over or below carrying capacity but in continuing flux between periods of growth and decline; and C) the “step” scenario that closely matches the Boserupian model of resource intensification and population growth in which, overtime, new intensification strategies or innovations facilitate the continued elevation of the local carrying capacity. A combination of models “A” and “B” best illustrates Malthusian demographic modelling, as discussed below.

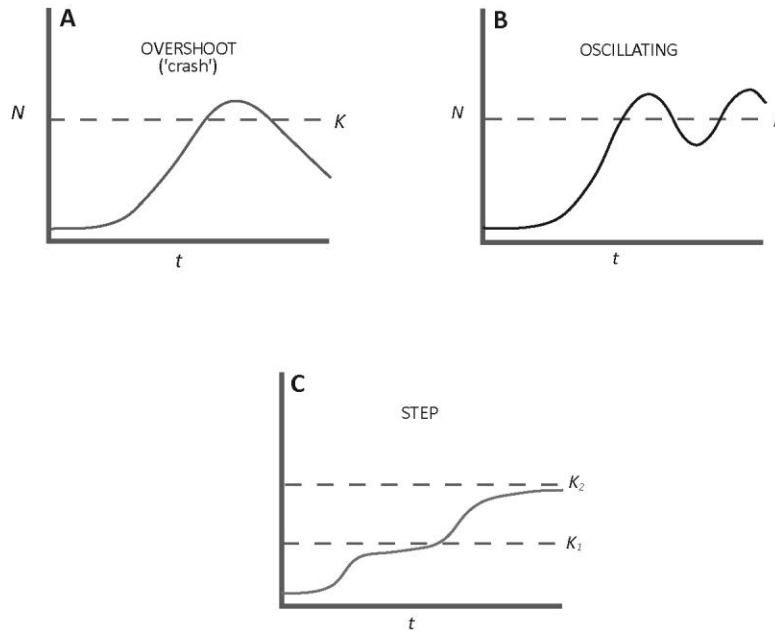


Figure 2.1. Models of demographic growth and decline where K equals carrying capacity, N equals population size, and t equals time (taken from Prentiss et al. 2013; redrafted from Kirch [1984]).

Lande et al. (2003: 13) go on to note that in a random, density-independent (i.e. sparsely populated) environment, environmental stochasticity tends to reduce population growth over an extended temporal span. However, spatial variability may offset overall population declines resultant from certain localized catastrophic environmental perturbations – the farther removed from a given event, the less drastic its effects are likely to be on the given population. In situations where population size is somehow constrained (i.e. density-dependent), environmental stochasticity remains a contributing factor affecting population growth, but populations experience less-drastic, but longer-term effects, tending “to undergo long excursions away from equilibrium” (Lande et al. 2003: 18). The density-dependent model closely matches the theoretical conditions conceptualized in Boserup’s (1965) concept of intensification and innovation under conditions of population growth and fixed-land area constraints and the

Malthusian model, where population growth is restricted by factors of food production and driven by exogenic technological and productive innovations and persistent intensification of land-use, likewise under land-area constriction (Adams 1966: 225). Both models see population restricted by the limitations of food production, allocation, and available land, but differ in their approaches regarding the ultimate results of those limitations. While the Boserup model assumes that innovation eventually leads to stochastic population equilibrium as the carrying capacity is increased through innovation and intensification, the Malthusian model predicts that population eventually reaches a point of no return where no amount of innovation or intensification can produce adequate resources to maintain increasing population levels (i.e. the “Malthusian Ceiling”), and population decline becomes inevitable. Similarly, Haldane (1957: 513) described how “negative density-dependent factors, such as disease promoted by overcrowding, competition for food, and space” contribute significantly to selection in cases where ecological contexts are otherwise more-or-less optimal. Haldane realized that rapid environmental change potentially precipitated similarly rapid evolutionary processes of adaptation. Discussing the effects of evolutionary processes on populations under stress, Haldane (1957: 522) pointed out that:

“A population is in equilibrium under selection... A sudden change occurs in the environment, for example, pollution by smoke, a change of climate, the introduction of a new food source, predator, or pathogen, and above all migration to a new habitat... The species is less adapted to the new environment, and its reproductive capacity is lowered.”

In general, the collective effects of both demographic and environmental fluctuation must be considered when observing temporal changes in population size and demographics. One

important thing to consider when examining the demographics of relatively low population density foragers, is that while they may avoid overall population decline on the macro level by remaining far-flung for extended periods of transhumant cycles, they run other risks as described by Lande et al. (2003: 36): “populations reduced to small size often experience deterministic declines in mean individual fitness due to the failure of cooperative interactions among individuals such as group foraging, group defense against predators...” To counterbalance these detrimental effects of rapid or extreme population decline, foragers often develop sociocultural institutions based on kinship, exchange, and other social extensions (see Kelly 2007: 161-292). At Bridge River, Prentiss et al. (2012) suggest that by BR3, wealth-based inequality and the emergence of social hierarchies may have started to manifest within and between at least some households giving rise to the possibility that more egalitarian sociocultural institutions had begun to break down under increasing socio-economic stressors. It is possible that as various resources became increasingly sporadic commodities, households or individuals with greater access to those commodities gradually stood out from their neighbors and began exercising control over particular resources, thus setting in motion processes of emergent socio-economic inequality.

Malthusian Dynamics

So far, archaeological interpretations of intensification have been discussed in detail in order to establish its importance in assessing change in the archaeological record. In general, the concept of intensification has primarily been applied as a variation on Boserup's (1965) initial concept of increased labor per unit of land (see Broughton 1994, 1995). But what happens if conditions occur where no amount of increased labor, output, land, or innovation can keep up

with the needs of a growing population and that population is inevitably set to overshoot the carrying capacity of its environment (Catton 1980)? In his *An Essay on the Principle of Population* (1798), Thomas Malthus addressed this very question, proposing that population growth is ultimately constrained by the availability of resources and the inevitability of other natural deleterious conditions – particularly famine. Although Malthus predicted that population growth should, in due course, be curbed by any number of natural causes, unrestricted growth should lead predictably to a point of such diminished returns that populations simply cannot continue to increase unabated and will decline in dramatic fashion in the face of compounding resource stresses. This point of demographic catastrophe has been described as the “Malthusian Crisis”, “Malthusian Collapse”, and “Malthusian Trap”. The point at which a population reaches carrying capacity and begins to transition toward this inevitable Malthusian event is referred to as a “Malthusian Ceiling”. In some cases, the Malthusian event is not the ultimate collapse, but the impetus for some form of change that allows the population to exceed or temporarily increase carrying capacity.

Puleston et al. (2013; see also Lee and Tuljapurkar 2008; Lee et al. 2009; Puleston and Tuljapurkar 2008; Rogers 1992; Winterhalder in press; Wood 1998) have developed models of Malthusian population dynamics that propose populations go through three basic phases of growth, a potentially lengthy “copial” phase in which surplus food production allows for increased fecundity, survivorship, and general growth, followed by a brief “transition” phase in which emerging food shortfalls cause rapid reduction in production, decreasing health, fertility, and survivability, and finally a “Malthusian” phase of stochastic equilibrium at carrying capacity with subsistence resources at which time populations experience an extended period of generally

depressed quality of life and arrested growth. Puleston et al. (2013: 12) go on to suggest that during the transition phase, populations often achieve maximum density with little warning and are faced with “a sudden and palpable impact on human quality of life” and must react accordingly to sudden shortfalls in subsistence production, subsequent food shortages, food deprivation, rising infant mortality, and reduced survivability under the stress of high population density once carrying capacity is reached, followed by demographic decline or collapse.

At Bridge River, Prentiss et al. (2014) suggest that the terminal phase of BR2 and the short-lived BR3 period evince conditions that accurately illustrate this proposition. They suggest that the late BR2 period may represent an initial (albeit low) Malthusian Ceiling, followed by a continuum of the copial phase and the shift into the transition phase, while BR 3 shows evidence of population densities finally reaching carrying capacity with local resources (perhaps due to a period of abnormally productive salmon runs or other environmental conditions), at which time a Malthusian Ceiling is reached and the village sees major declines in population within only a few generations. If this is indeed the case, the archaeological materials recovered from individual occupation strata at Housepit 54 (especially subsistence related materials) may be used to assess levels of population density and subsistence stress during different periods of occupation. As discussed in the Methodology essay, indicators of increasing population (higher FCR frequencies, hearth features, artifact densities, expanded activity areas, etc.) should be evident over time between BR2 and BR3. Under the Malthusian model, during the final phase of BR3 we should expect to see elevated population density coupled with evidence for subsistence resource stress (i.e. extensive processing of faunal remains, widened diet breadth, etc.) in the final occupation level(s) of the house.

Hunter-Gatherers and Malthusian Demographic Dynamics

Price and Brown (1985: 8) posit that intensification among complex hunter-gatherers is generally associated with certain socio-economic conditions: “societal circumscription, abundant resources, and higher population”. Circumscription refers to the limited mobility generally necessitated by subsistence specialization, what Prentiss and Kuijt (2012: 116) eloquently describe as the reality of being “tethered to the landscape” (see Brown 1985: 201). The abundance of resources is perhaps most intuitively clear, referring simply to the presence of subsistence resources and access to them within the local environment; put more complexly it is the compound interactions of numerous conditions including any number of combinations of resource “*richness, abundance, stability, predictability, reliability, diversity, niche width, and seasonality*” (Price and Brown 1985: 8). The term *high population* refers not only to numbers of individuals but to population density and variations in population demographic within a given community or locality, as well as the intricate arrangements of socio-political relationships that may persist as a result of increased population (i.e. Hayden et al.’s [1985: 183] brief discussion on cooperative socioeconomic co-residential groups). The question of population density brings up the subject of demographics and demographic change and how we can examine the dynamics of prehistoric populations through the use of archaeological materials.

One key reason that Malthusian conditions may have extreme effects like collapse of social cohesion among collector strategist hunter-gatherer-fishers like the prehistoric occupants of housepit 54 is that conditions like declining health and diminution of food supplies among populations large enough to exacerbate local resource declines but small enough to maintain

relatively low population densities overall, is that decreasing survivability of the very young and very old may have resulted in a loss of knowledge of local ecology and resources. Such information is usually retained by older generations and may have been easily lost from one generation to the next if only a few individuals died before sharing what they knew. This in itself could have played a role in making it difficult for stressed populations of relatively young individuals to foresee the onset of (or emerge intact from) a Malthusian phase of protracted subsistence shortfalls. Theoretically, Malthusian dynamics always lead to deleterious conditions, and over long enough periods of time, inevitable collapse. While copial phases and equilibrium may persist for generations, often maintained through technological adaptations, the adoption of novel social institutions, or the utilization of new resources, eventually all growing populations will experience the effects of reaching the Malthusian Ceiling and experience widespread population declines.

The goal of the next chapter is to outline the methods used in the archaeological excavations and laboratory analyses of materials from Housepit 54. Additionally, a hypothesis of subsistence change revolving around concepts described above will be developed and test expectations will be presented that can be evaluated given the Housepit 54 faunal assemblage.

CHAPTER THREE

METHODS

Studies of archaeological faunal remains have provided valuable insights into changing hunter-gatherer subsistence strategies over time in relation to ecological variability, and cultural adaptations (Broughton 1994, 1995). This research applies archaeological methods to the investigation of procurement strategies and associated processes of resource specialization, depletion, and intensification, and in response to environmental perturbations and fluctuating population dynamics during the late-Holocene at the Bridge River site in the Middle Fraser River Canyon. The goal of this research is to provide a greater understanding of how complex hunter-gatherers adapt to changing environments and how changing populations (through growth, decline, or equilibrium) interact with available resources. Variability in the acquisition and use of salmon will be a major contributor to this study, as will its influence on the use of other resources, and how resource choices play a dynamic role in population demographics, and *vice versa*. These analyses will ultimately provide a framework for modeling subsistence dynamics under various ecological and demographic conditions, particularly the constraints facing increased population given environmentally-driven resource limitations.

Many scholars (Butler and Campbell 2004; Chatters et al. 1995; Matson and Coupland 1995; Sneed 1971) have looked at the socio-economic effects of salmon fishing on the Pacific coast and Interior Plateau areas. To date, no scholars in the region have yet applied quantitative models to the questions of population dynamics in relation to resource depletion and intensification, whether by human agency or environmental factors (for a similar examination

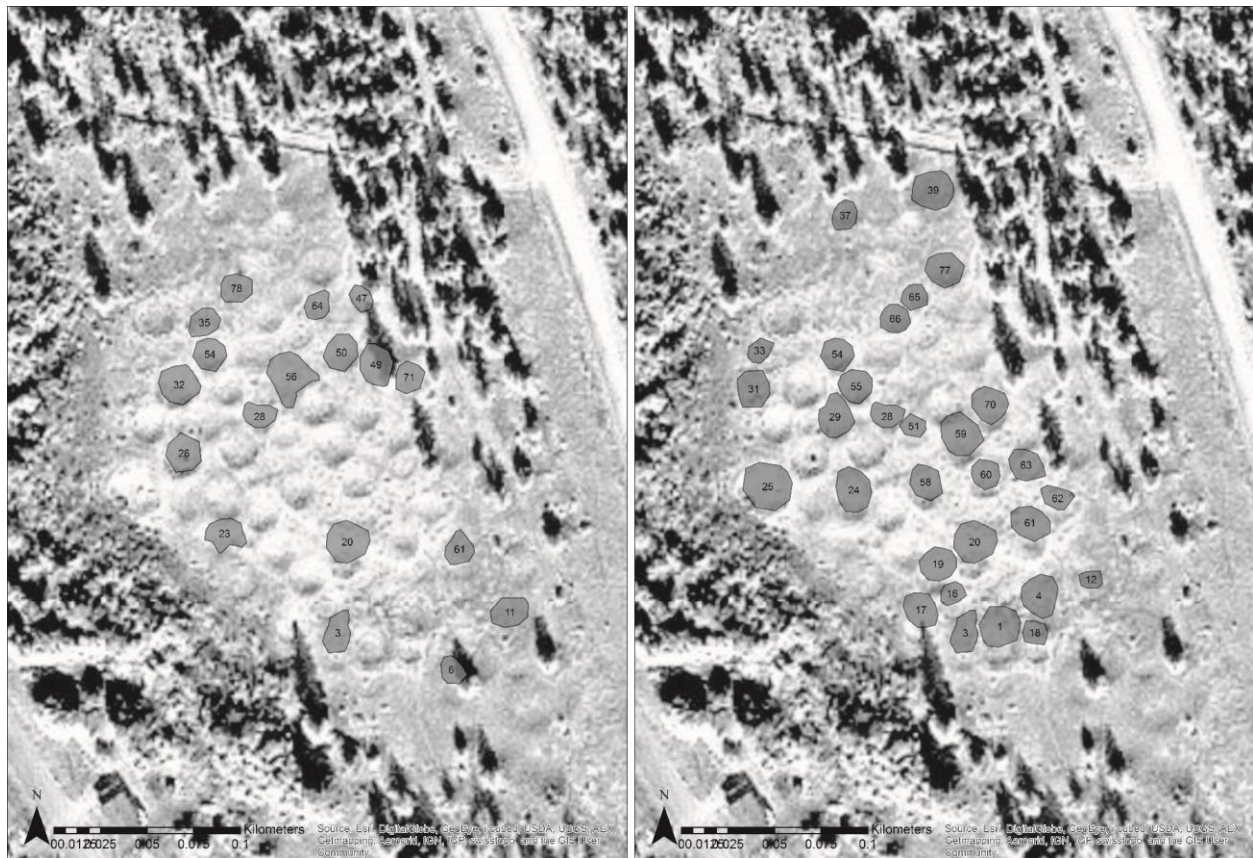
along the coast of northern California, see Broughton 1994). This research is valuable because its focuses on the reasons *why* prehistoric populations came to expand or decline over time, and *how* prehistoric peoples adapted to such changes while ultimately affecting (purposely or coincidentally) the resources around them. Examination of these questions has far-reaching implications for both archaeological interpretations of resource variability and population dynamics among hunter-gatherers reliant on anadromous fish. Throughout the late-Holocene prehistory of the Pacific Northwest it is generally accepted that salmon procurement became steadily more integral to the subsistence strategies of the region (as opposed to the possibility that salmon dependence underwent incremental increases that mirrored human population growth). However, salmon was just one important part of a complex subsistence strategy that varied seasonally between riverine and terrestrial animals and a diverse range of plant foods. This is not meant to downplay the well-established importance of salmon as a key resource in the aboriginal diet of the Plateau people during the late-Holocene (see Kew 1992: 193), but to question the assertion that intensification ala Boserup (1965), which was clearly concerned with increased yield per unit of land), is appropriate to fish-dependent foragers. More accurately, *intensification proper*, (ala Keiser and Voytek 1983; Morrison 1994, discussed below) provides an analytical framework from which to approach general subsistence trends as they emerged in the late-Holocene in the study area. Rather than simply being the product of economic intensification of salmon or particular terrestrial prey (deer or elk), changes in subsistence economy and strategies, adaptations, consequent hunter-gatherer population dynamics, and even the potential for salmon or any other resource to be utilized and relied upon, were affected by complex environmental factors that did not exist in a vacuum, perhaps least of all the pithouse

socio-economic environment itself. Thus, observations will be drawn from analysis of faunal remains from each of the BR2 and BR3 occupation floors at Housepit 54

The section that follows provides a description of the hypothesis to be tested and discusses the data to be applied in order to do so. Subsequent sections will present discussions of the necessary archaeological field methods and the analytical and theoretical frameworks proposed in order to quantitatively address questions regarding the dynamics between changing resource strategies and population dynamics.

LATE-HOLOCENE CHANGE AND ITS IMPLICATIONS

This research hypothesis concerns the relationship between subsistence decision-making and conditions of dynamic population growth and decline. Examining village size and proposed population densities over time, we see macro-scale fluctuations in village structure at Bridge River as households underwent change on a generational scale in response to varying conditions (Figure 3.1).



Prentiss et al. (2012) note that occupants at Bridge River “suffered some forms of subsistence stress between 1800 and 1100 cal. B.P.”, most notably during BR3 and to some degree during late BR2 occupations. This is juxtaposed by a notable decline in archaeological salmon remains between BR2 and BR3, suggesting reduced access to salmon during this span, but accompanied by population growth suggesting a period of continuously prosperous resource availability (Carlson 2010; Prentiss et al. 2012; Smith et al. 2010; Ward 2011). The period following directly after the onset of evident subsistence stress sees developments in the use of external cooking features (during BR3) suggesting a shift in subsistence economy toward

increased use of deer and some plant foods beyond the ubiquitous dried salmon that characterizes subsistence beginning around 4000 BP, and appears to persist more-or-less uninterrupted up until this point (Chatters and Pokotylo 1998: 76). Whatever resource stresses hindered earlier occupations appear to have declined during the span from BR2 to BR3, as steadily increasing populations suggest increasing food productivity and surplus potentials. Indeed, during the transitional phase between BR2 and BR3, population levels see a rapid and radical increase, giving rise to the possibility that (1) some sort of cultural adaptation(s) occurred that allowed for increasing food production, or (2) that changing environmental conditions allowed for a windfall of available food resources.

Around 1200 BP, the village population dwindled (Prentiss et al. 2011) coinciding with the initial onset of environmental change that would ultimately usher in the MWP and coinciding with a relatively shorter episode of punctuated colder temperatures in western North America 1200 BP and 1100 BP (Williams and Wigley 1983: 297). It is feasible that significant but short-term change in climate, affecting both terrestrial and pelagic temperatures, rapidly altered the ecology of key subsistence resources in the region causing substantial changes to local and regional plant and animal populations and likely caused significant difficulties for hunter-gatherers in the area (Alexander 1992b; Chatters et al. 1995; Finney et al. 2002; Patterson et al. 2005). The short-term cold spurt just before the MWP may have temporarily increased salmon productivity that allowed intense population growth, but that also put population growth on an unsustainable trajectory when the MWP set in. Where changing conditions occurred too rapidly for a growing population to adequately adapt as warming trends caused declines in previously extensive salmon populations, the effects of key resource decline would likely cause major

demographic fluctuations. Even a short-term drop in temperature prior to the MWP may have been a causal factor leading to population growth, as temperature change can signal rapidly stimulated productivity in salmon populations (see Beamish et al. 1997; for discussions on the effects of paleo-climatological disturbances on coastal environments and resource abundance see Mason and Jordan 1992; Mason and Gerlach 1995). Hunter-gatherers adapted to a salmon-dependent logistical resource acquisition strategy would have likely observed and quickly capitalized upon increasing numbers of fish, creating surplus potentials that could allow for rapid population increase and survivability (Chatters and Pokotylo 1998; Kew 1992: 180; for demographic implications see Lee and Tuljapurkar 2008; Puleston and Tuljapurkar 2008; Lee et al. 2009; Wood 1998). However, if conditions shifted in a manner that rapidly led to declines in salmon (or other resources), populations may have suffered dire consequences when suddenly faced with an inability to supply their expanded populations.

Colder temperatures during the LNG would have facilitated increased potential and success of anadromous fish populations throughout the region due to cooler oceanic temperatures in the Pacific resulting in increasing productivity of phytoplankton and major food webs, and cooler/drier inland conditions leading to generally colder and clearer waters throughout northwestern tributary systems, increasing spawning success of migrating salmonids (Rand et al. 2006). Although Chatters (1998: 46; see also Chatters and Pokotylo 1998: 79) suggests that “there is little evidence for major environmental change in the last 2,000 years”, even moderate temperature change can have far-reaching effects on localized conditions, as cooler temperatures in the intermontane, bunchgrass steppe, and mesic montane forest zones which surround the Mid-Fraser likely caused changes in vegetation regimes throughout the area at various times,

considerably effecting ungulate populations, as cooler temperatures tend to encourage the habitats of browsers (e.g. deer) as opposed to grazers (e.g. elk and bighorn sheep). There is considerable evidence that this cycle has occurred in the area to at least some degree throughout much of the late-Holocene (Alexander 1992b: 53; Chatters 1998; Lepofsky 1987: 18; Teit 1906).

This proposal develops research regarding changes in the subsistence practices of hunter-gatherers under variable conditions by examining the population dynamics and decision-making processes of prehistoric foragers at the Mid-Fraser Canyon winter pithouse village of Bridge River during the late-Holocene. This study will address how prehistoric foragers utilized the resources of riparian zones and adjacent forests during different periods and at different seasons in the face of environmental change and fluctuating ecological regimes. It will provide insights into the means by which complex hunter-gatherers cope with environmental fluctuations under conditions of rising population. It will examine the effects of human impacts on the biodiversity of insulated anadromous resources in microenvironments with particular attention to River Valley and River Terrace, Montane Forest, and Montane Parkland, and the seasonal availability of resources that those landscapes provide. It will also analyze human utilization of subsistence niches (with particular attention to the acquisition and storage of salmon and some terrestrial mammals) within seasonal cycles and the effects of environmental change on prey species and on subsequent human subsistence adaptations and decision-making. Excavations at Housepit 54, supplemented by previous excavations at other housepits at Bridge River, offer the potential to examine these complex questions at a site with exceptionally fine-grained, generational-scale resolution (Butzer 1982:24; Prentiss et al. 2008).

HYPOTHESIS - Resource Intensification and Malthusian Demographic Dynamics

Resource Intensification and Population Growth: Population sizes of forager groups utilizing the Bridge River site during late-Holocene were relatively small, but population underwent a dramatic increase during the period between BR2 and BR3, particularly during BR3 shortly before the site was abandoned circa ~1100 BP. The reasons for population increase and following decline and abandonment are as yet unclear, though changes in climate, physical geography, local ecology, and social structure have been suggested (Hayden and Ryder 1991; Kuijt 1989; Prentiss and Kuijt 2004; Rousseau 2004). Following a model suggestive of stochastic demographic equilibrium over time at Bridge River some event(s) (whether ecological, social, or a combination of both) led to the dismantling of previously-extant village social structure. Overall, changes in subsistence strategy during the Plateau and Kamloops Horizons are marked by increasing utilization of salmon in response to changing human populations and their food needs, contingent on stabilized (cooler) climatic conditions in addition to emerging innovations in human technological adaptation that allowed for increased procurement of salmon (i.e. intensification).

Inspired by Lee (1986) and Wood (1998), Lee and Tuljapurkar (2008), and Puleston and Tuljapurkar (2008: 156) illustrate that population growth is a product of demographic variables, decision-making, and environmental factors, that is regulated and determined by food acquisition. Population growth will tend to reach equilibrium in a given landscape in conjunction with food production and consumption ratios within the population. Although the above mentioned studies concentrate on preindustrial agricultural societies, the same logic may apply to

foragers simply by substituting productivity of foraging practices in place of agricultural strategies with the understanding that results will vary based on environmental and cultural factors. Under the most basic logic, changing subsistence strategies will have dynamic effects on the potential acquisition of food. Additionally, changing circumstances, such as basic resource availability, environmental fluctuations, demographics, and socio-economic factors, interact with human adaptations at various levels and under ideal conditions the interplay between foraging practices and their effects on the environments in which they take place tend to reach a level of stochastic equilibrium. In such cases, while conditions may be under constant flux, they tend to result in a dynamic web of push-pull relationships that counterbalance each other (Odling-Smee et al. 1996). In the case of demographics, if conditions cause too much of a swing in any direction, say ecological change resulting from drought or depletion of a depended-upon food resource, the shock to the overall system is likely to cause rapid and drastic consequences in the population and make recovery from those consequences difficult (Lee and Tuljapurkar 2008: 480). As foragers are directly tethered to their environment by nutritional obligation, any change that affects food availability will alter their demographic. In an environment prone to unstable conditions over time, such as those that may drastically affect anadromous fish productivity, human demography will be driven and regulated by those conditions (Wood 1998: 120). At Housepit 54, twelve occupation floors have been so far identified, representing what are assumed to be approximately 20-year intervals of more or less uninterrupted household occupation (referred to hereafter as the generational scale). Within these generational occupations demographic shifts may be inferred through observed changes in the archaeological faunal record as food procurement is a key economic factor that varies in response to human population dynamics as well as fluctuating circumstances.

Because population size for prehistoric groups on the Interior Plateau, and specifically those using the Mid-Fraser during the late-Holocene, was relatively small (Rousseau 2004) and variable in response to social and environmental constraints, it may best be illustrated by a model of stochastic demographic equilibrium driven by resource availability, adaptation to environmental perturbation, or a combination of both (for a discussion of demographic dynamics on the Pacific Northwest Coast see Ames 2006). In Malthusian terms as described by Lee (1986), and because local population was likely dependent largely on acquisition of seasonally variable salmon runs during much of the late-Holocene, any downward fluctuations in salmon productivity would have potentially drastic effects on populations at the community scale and would likely cause general populations at Bridge River to reach carrying capacity at relatively mid-range population densities with food productivity more-or-less in balance with consumption (Puleston and Tuljapurkar 2008: 156). Given dependable food resources, populations tend to increase at a fairly steady rate (a key assumption of Malthusian models), but under conditions where minor fluctuations in resource productivity regularly (but randomly) occur population may reach a fairly steady state of stochastic equilibrium in response to variable circumstances (Puleston et al. 2012; Lee et al. 2009). For any number of reasons, when conditions reach a point at which resources cannot support extant population levels, a Malthusian “Crisis” or “Ceiling” is reached and population declines rapidly in response to generally sub-optimal conditions of resource deprivation (e.g. starvation/malnutrition, disease/infections exacerbated by malnutrition, etc.) or may population may fluctuate at the edge of carrying capacity under conditions of moderate distress (Puleston et al. 2014; Wood 1998: 110).

Alternatively, Lohse and Sammons-Lohse (1986) and Cohen (1977) consider how gradual increases in population eventually lead to resource stress which itself alters population demographics and resource productivity. This gradual process of increased population density and eventual change is similar to that suggested under the model of Boserupian intensification.

Instead of a repeating cycle of population growth, eventual equilibrium, expected innovation, and resulting punctuated growth, it is possible that innovation was not the primary driver of population dynamics at the site, but instead innovations simply allowed foragers the flexibility necessary to maintain population levels more-or-less in stochastic equilibrium with available resources as conditions changed considerably through time (Rogers 1992). If this scenario adequately describes late-Holocene subsistence strategies at Bridge River it should be recognizable as a temporal trend towards gradually growing population, resource specialization, depression, intensification, or diversification in conjunction with some form of adaptation followed by stabilization of population levels and an eventual return to conditions of gradual population growth (for discussions on how population packing results in resource diversification see Galm 1985; Thoms 1989).

Hypothesis and Test Expectations

Population growth at Bridge River followed a pattern consistent with the Malthusian population dynamics model wherein steadily increasing human populations diminished local resources while continuing to grow at a rate unsustainable within the local environment. As resource stress increased at the household level, high-value but locally depleted resources such as

large game were acquired at greater distances from the village and were processed in such a way as to extract the greatest nutritional value from those animals acquired. Eventually, resource shortfalls could not keep up with rising population and the final occupants at Housepit 54 could no longer maintain the pithouse, either literally failing to survive or abandoning the village.

Fluctuating living conditions, based largely on the effects of increasing village population, local resource decline, and subsequent resource shortfalls dictated that semi-sedentary populations in the Mid-Fraser remained flexible to at least some degree in their mobility. Human populations during much of BR2 leveled out at a quasi-stable *Malthusian Phase*, of equilibrium between available resources and population size/growth (Lee 1986; Puleston et al. 2013: paper in the possession of the author). Sometime between 1300 and 1200 BP, the onset of BR3, conditions changed, and eventually reached a major state of disequilibrium with local resources ultimately driving population growth to levels that could not be sustained (the *Malthusian Ceiling*). Mid-Fraser populations were faced with abruptly altering their subsistence strategies to adapt to the surrounding environment in the face of growing population density, leading to a snowball-effect of resource depletion that ultimately resulted in site abandonment within only a few generations. In this scenario, adaptations would first be driven by external conditions (such as changing environment) coinciding with normal levels of population growth, followed by rapid growth and resource intensification, culminating in a widening of diet breadth as populations make a last ditch attempt to mitigate resource depletion brought about by excessive population.

Following the Malthusian model of demographic change we should see punctuated growth and packing as population levels increased to a point at which they exceed local carrying capacity. Signs of intensification, resource depletion/declines, possible extensification (use of larger foraging radii), and finally diversification (widening diet-breadth) should become evident toward the end of a relatively successful (i.e. stable) period of continued growth. The above processes should ultimately lead to a temporary reprieve from subsistence failure and a return to short-lived equilibrium, or resulting in a drastic decline in population as "collapse" occurs following the attainment of a Malthusian Ceiling.

- Foremost under the Malthusian model, there should be evidence of population growth. Demographic proxy data should indicate distinct changes in the frequency and/or density of materials in different floors. If population increased over time these proxy data should follow a trajectory from relatively low during earlier periods to increasingly higher as growth persisted.
- At some point significant population growth will be followed by an abrupt decline. This decline should show up in the material evidence of basically every aspect of household life. Evidence of changes in subsistence practice should be swift. This precipitous change will occur between only a few occupation floors or within a single occupation level. These changes will be closely followed (in few, if any, subsequent occupations) by evidence of resource depression and evidence for extreme population decline.
- As conditions became sub-optimal, villagers would have had to respond quickly, drawing on diverse local resources whenever encountered. We should expect evidence of variability in foraging behavior ranging from salmon and deer specialization during optimal periods and more diversified range of prey choices during sub-optimal intervals.

- Both salmon and deer will be intensely processed only under conditions of extreme resource stress at the apex of population levels as they teeter at the brink of the Malthusian Ceiling. Less-valued anatomical parts (pre-caudal and caudal elements [tails]) of salmon will be cached, and mammal bones will be highly fragmented as a product of rigorous processing as an emergency response to resource shortfalls and more mouths to feed.
- If high-ranked resources are comparatively common during certain years, extensive field butchery, long distance transport, storage of marginal portions, and intensive bone processing will be much less common, and only become evident during the final portion of the Malthusian Phase as population and resources approach the Malthusian Ceiling.

Null Hypothesis: Intensification of resources will not correspond to demographic change and vice-versa, and may follow any number of alternative scenarios but will mostly likely appear stochastic.

Field Methods

Field work was conducted during multiple summer field sessions, spanning 2012 to 2014. Although much of the housepit was excavated during this time, complete excavations were not possible. As part of the ongoing project, excavations will continue in 2016 with the aim of fully excavating areas that were not completed in previous years. Ultimately, ~80-90% of Housepit 54 will be excavated. The data analyzed in this dissertation do not represent the complete

assemblage, but this investigation assesses all the materials available at the time of this writing. Further data will greatly inform the research and conclusions outlined here.

The excavation of Housepit 54 was conducted using widely accepted techniques and practices common to archaeological excavations throughout North America (Maschner and Chippindale 2005). The housepit was divided into four Blocks (A, B, C, and D), each containing 16 one meter by one meter Units. Each Unit was sub-divided into four 50cm x 50cm Quadrants (Quads). Quads were designated as NE, SE, SW, and NW beginning in the top right corner and moving clockwise within each Unit. All sediments were systematically removed by sedimentary levels by hand with the aid of masonry trowels and hand-brooms. All archaeological materials larger than 3cm² were point-plotted (provenienced) *in situ* to from a datum established at the NW corner of Block C to provide detailed spatial information. All floors and features were mapped and photographed before being excavated. Features were excavated in arbitrary 10cm levels. Feature materials were collected for screening and flotation, and samples for radiometric dating were collected separately. All excavated materials were screened using 1/8" mesh. Floor and feature samples were sent to Simon Fraser University for macrobotanical analyses. Units were excavated by stratigraphically-discreet levels in 5cm increments and roof layers in 10cm increments based on natural/cultural stratigraphic layers. FCR was recorded and collected in the field and samples were submitted for various residue analyses. All recovered materials were collected in acid-free plastic bags, except FCR, which were stored in paper bags to facilitate residue analysis. Digital photographs and detailed illustrations were made of all Unit and sub-Unit profiles.

Faunal Analysis

Faunal materials were analyzed in Dr. Anna M. Prentiss' research laboratory at the University of Montana, Missoula. The Phillip L. Wright Zoological Museum and Montana Comparative Skeletal Collection provided comparative samples for taxonomic and element identification. All faunal materials were identified to the most specific taxonomic classification possible. Materials that could not be positively identified to taxon were subdivided into general size categories: small, medium, and large, based on the potential size of the taxa from which they originated, and further divided by animal type: mammal, bird, fish, reptile, and amphibian, where possible. Specimens were designated by age (juvenile/subadult/adult/mature adult) whenever possible and elements were designated by side (right/left), end (proximal/distal/diaphysis-shaft), and area (morphologically-identifiable sections of specific elements (e.g. "portion of femoral head featuring fovea capitis" or "posterior vascular groove of diaphyseal metatarsal", etc.). The entire assemblage was calculated to Number of Identifiable Specimens (NISP and %NISP), Minimum Number of Individuals (MNI and %MNI), and Minimum Number of Identifiable Elements (MNE). NISP was used to establish a fundamental "ordinal-scale measure of taxonomic abundance" from which to compare ratios of abundances within and between taxa (Grayson 1984; Lyman 2008: 78; Reitz and Wing 2005). MNI was to be used in determining basic taxonomic abundance/richness. The high frequency to which the mammal bone assemblage was fragmented made strata-scale MNI inconclusive (in no stratum was it possible to establish $MNI > 1$). Instead, taxonomic richness was inferred from an index comparing total number of represented identifiable taxa (NTAXA) against the NISP (Lyman 2008: 159). Relative abundances were calculated by comparing the %NISP of various taxa against one another (Grayson 1984: 116). For ungulate remains, MNE was used to measure skeletal part

frequencies (Lyman 2008: 232), and MAU were identified to infer (as with MNE) differential transport of animal parts by potential utility. Fragmentation intensity and extent was calculated by %NISP per taxonomic category for mammal bones assuming that higher ratios represent greater degrees of fragmentation. This suite of quantitative methods achieved the highest degree of analytical robustness from which to assess the animal bone assemblage and to testing the proposed hypotheses.

Basic taxonomic richness and evenness was used to infer prey diversity within and between strata with careful consideration to changing animal regimes and possible foraging strategies. Abundance indices were especially useful for determining the relative availability of different food resources exploited at the site during different housepit occupations. As Broughton (1994b) indicated, ratios between artiodactyls and other prey species provide evidence of intensification by widening diet breadth or by increasing foraging radii. Element distributions and degrees of bone fragmentation illustrate the extent to which certain elements were being targeted and processed, providing implications for decision-making such as the decision to increase foraging radii or to target alternate resources, etc. (see Binford 1980; Broughton 1994a; 199b; Lyman 2008; O'Connell *et al.* 1988; 1990).

Analyses was also undertaken to determine taphonomic processes figuring in to the deposition of animal remains at the site in order to get a clearer vision of material aggregation, post-depositional intrusion, and taphonomy (Behrensmeyer 1978; Lyman 1994). A spatial distribution of faunal materials was generated in Geographic Information System (GIS) software (ESRI ArcMap version 10.3.1) to visualize and assess distributions of faunal remains by taxon

and stratum (see Appendix A). Evidence of predator attrition such as gnawing, abrasion, and canine puncture marks was identified and analyzed to determine the degree to which predator intrusion may have occurred at the site, particularly in light of known presence of domesticated dogs within the pithouse. Modification of osteological remains through cut marks, crushing/impact/reduction (fracture morphology), and by fire/heat exposure, were identified to interpret the degrees to which resources were processed and at what proximity to the housepit they were disarticulated (Binford 1981; Buikstra and Swegle 1989; Grayson 1984; Johnson 1985; Klein and Cruz-Uribe 1984; Lyman 1994; Sakek-Kooros 1975; Shipman et al. 1984). These last two analytical observations were not used in the analyses presented here, but the data collected could provide insights into carnivore activity at the site or studies regarding cook techniques undertaken during the BR2-BR3 occupations.

All faunal remains from each stratigraphic layer spanning IIj-IIa were analyzed for diachronic and spatial trends and distributions in order to assess subsistence changes (such as decline or intensification of the resource base) that may have taken place within the pithouse between BR2 and BR3 (see Beaton 1991; Broughton 2002; Morrison 1994). Overall, these tests provide valuable information regarding the selective efficiency of hunter-gatherer-fishers at Housepit 54 thru time and provide a picture of intra-household economic activity (see Betts and Friesen 2004; Broughton 1994b). Changes observed in the faunal assemblage were correlated with changes in demographic indicators to infer relationships between village population dynamics and subsistence practices.

SUMMARY

Taking a holistic view of subsistence change undertaken by complex hunter-gatherer-fishers under conditions of fluctuating resource availability and demographic growth provide valuable insights into human decision making strategies and the environments in which they are made. Although their effects are often assumed in reference to studies of the North American Pacific Northwest region, *quantitative* analyses relating to changing subsistence practices have been, until recently, rare (see Betts and Friesen 2004, 2006; Butler and Campbell 2004).

Analysis of faunal remains and site features relating to household and village growth provide a window into how prehistoric people dealt with increasing population aggregation, possible changes in the local environment, and variability in subsistence resources under those conditions.

CHAPTER FOUR

ASSEMBLAGE AND ANALYSIS

Before moving to the analysis of data recovered at Housepit 54 it is necessary to first establish a clear understanding of what constitutes the faunal assemblage analyzed. The faunas assessed span the entirety of the BR2 and BR3 periods at Housepit 54 and contain the remains of numerous fish and mammals as well as some birds, all in various distributions and frequencies from floor to floor. Descriptions of the Housepit 54 faunal assemblage by floor, starting with the earliest identified BR2 floor (Stratum IIj) and working forward in time to the final occupation of BR3 (IIa) can be found in Appendix A. Stratum faunal assemblage contents and spatial distributions by Unit are summarized in Appendix B.

There are a number of analytical methods that can provide valuable information on changes in subsistence practice over time at the pithouse scale. Figures 4.3-4.12 show the identifiable elements present from artiodactyls from each respective strata, beginning with the earliest BR2 floor – Iij, and working up through time to the final BR3 floor - IIa.

As described above, the Central Place Foraging Model (and particularly the “Field Processing” Model therein), is applied to archaeological contexts to help explain situations in which foragers would be most likely to transport higher utility resources back to a “central place”, or base camp – in this case the village or pithouse. The model proposes that resources (or resource "packages" – see Metcalfe and Barlow 1992) of greater utility will be transported from greater distances rather than those packages of lesser value. The logic is relatively simple in that it assumes that foragers make the decision to transport various resources based on their potential

utility and that foragers will choose to bring back resources that provide the best payoff to effort spent (Bettinger 2009; Bettinger et al. 2006; Metcalfe and Barlow 1992; Schoener 1971; O'Connell et al. 1988; 1990; Orians and Pearson 1979). The more effort required, the more utility-driven the decision to transport a given resource is likely to be. In other words, the greater the distance from a "central place" that a resource is acquired, the more likely a hunter (for instance) is to choose to transport only the choicest selection(s) of the resource in question – in this case based largely on the meat-value or the nutritional content of the animal (or parts thereof) acquired and considerations of the distance and terrain that must be crossed to get back to camp. For instance, if a deer is killed far from the village, a conscious decision will likely be made to transport only those portions of the carcass that will have the best return for the effort spent in taking them back to the village – i.e. if a hunter(s) can't feasibly return with the whole animal, certain (low-utility) portions will be left behind while others (of higher-utility) will be worth the effort to transport back to the village even if it means a difficult journey.

It is also important to realize that in some situations hunters may be forced to transport as much material as possible regardless of being at an extended distance from a "central place". Binford (1978: 269) observed this in his comments on Nunamiut hunting strategies, postulating that when demand is high but animals are scarcer "we might anticipate that the hunters would expend greater effort in returning the maximum amount of usable material from any animal killed." With this consideration in mind – namely that the logic of the Central Place Foraging Model represents general all-else-being-equal logic – the model still provides valuable interpretive strength when looking at archaeofaunal assemblages with the aim of postulating on fluctuating hunting conditions/strategies over time.

The utility of the Central Place Foraging Model logic for this study is the observation that when prey is scarce and sought at distances beyond the regular foraging radius (often the result of local resource depletion due to over-harvesting or to declines resulting from ecological changes in the local environment), hunters should choose to transport only high-utility parts of larger animals like deer. Under such conditions hunters should be more likely (based on the model) to transport meat-rich portions of any animals captured, leaving or using lesser-utility bits at the butchery site and transporting (for instance) only muscle-rich upper-appendicular elements (see discussion below of the meat utility of ungulate parts). Alternatively, when large prey is locally available, complete skeletons (or at least a variety of skeletal elements representing more intact carcasses) are more likely to be present in the faunal assemblage. Thus, this logic allows us to infer whether local prey populations remained static, whether they had been adversely affected by over-hunting, or (with adequate comparable temporal data) whether they had locally rebounded from previous declines. We may also observe fluctuations in hunter decision-making regarding what portions were chosen for transport back to the pithouse and whether these changes represent some alteration from previous transport strategies.

Applying the Central Place Foraging Model

It can be surmised that prehistoric hunters at Bridge River practiced a variety of hunting strategies aimed at a number of prey species, including solo hunts, small-party hunts, and multiple cooperative strategies, especially when their intended target was the acquisition of larger prey such as deer or bear (Bouchard and Kennedy 1978: 52, 71; Teit 1906: 237).

Assumptions from optimal foraging theory are helpful when interpreting animal bone assemblages because the general logic of optimal foraging theory suggests likely behaviors based on reward-to-effort potentials as they relate to individual fitness, and dietary necessities are an obvious and major factor in that fitness. At the risk of repetition it is necessary to outline another way to explore fitness-related decision making - the application of aspects of “Central Place Foraging Models”, particularly those that explore the relationship between animal processing, transport, and subsequent frequency of parts represented in archaeological contexts such as the “General Field Processing Model” (Metcalf and Barlow 1992; see also Bettinger 2009). This model is useful for determining to what degree is it optimal to process a resource package (say a deer) at distance from where it will ultimately be used, or whether it is more advantageous to expend the time/energy necessary to transport the whole animal or larger bits thereof back to a base camp for further processing. The general assumption of the model is that hunters must determine what’s worth taking back to camp or not. If such decisions are being made, then certain higher utility skeletal parts (those with more intrinsic nutritional or other value) should be more frequently represented in bone assemblage contexts.

Usually, to apply this model a Minimum Number of Individuals (MNI) is generated using skeletal part abundances, assuming that each taxon type has a known number of singular or skeletally-symmetrical elements. Thus, one can determine how many individuals are represented in an assemblage given the knowledge that each individual has only a certain number of each bone(s) (Reitz and Wing 2008). However, due to the extremely high degree of fragmentation throughout the animal bone assemblage at every level of Housepit 54, the subsequent lack of

positively identifiable elements, and the difficulty that this dearth creates in identifying multiple specimens from the same elements that may represent more than one individual, mammal MNI for each Stratum cannot effectively be calculated as greater than $n=1$ for any identified taxa across each strata's mammal bone assemblage. MNI for fish remains occasionally indicated multiple individuals (for example, in Stratum IIf, the presence of eight atlas vertebrae in Level one is a clear indicator that parts of at least eight individual Sockeye were present), but this is of little use since it must be assumed that far more than eight fish were likely present simply based on the density of unidentifiable remains, regardless of their identifiability. Even without a robust MNI value it is still possible to observe variability in the animal parts represented from each floor.

What can be said about the mammal bone assemblage is that certain elements appear at differing frequencies in different strata, and that these changes may be indicative of variability in the strategies or necessities of subsistence hunting practiced during different occupation periods based on the underlying assumptions of the Central Place Foraging Model. To better understand this, it is helpful to know the various skeletal parts of animals commonly identified in the assemblage. Here I discuss the general utility of some parts or “packages” of artiodactyls – by far the most frequently identified type of mammal in the Housepit 54 faunal assemblage (followed by a more brief discussion of other animal types represented in the assemblage).

Metapodials

Enloe (1993: 93) suggests a possible relationship between higher frequencies of fragmentary metapodials and marrow-processing as opposed to direct consumption activities:

“Mass marrow-processing dump locations appear to contain more metapodial fragments relative to upper limb bone and unidentified element fragments than do immediate consumption middens.” This should make sense to anyone who has processed an ungulate carcass, as the lower limb areas beneath the knee possess very little meat but are still relatively dense bones. In fact, modern hunters often discard artiodactyl limbs from the proximal metapodials down, just as suggested early on by White (1953: 162). However, due to their general shape and density, which lends itself to comfortable handling, metapodials are uniquely useful in the manufacture of a variety of tools (Binford 1981: 74). The position of the distal condyles in both the metatarsals and metacarpals makes the elements particularly suited to hafting lithics and for splitting the bone lengthwise to fashion other implements. Metapodials were commonly split to make a variety of awls, needles, and other pointed implements, and used as handles for hafted tools. For this reason, hunters may have brought metapodials back with the butchered carcass more often than other elements commonly discarded prior to long distance transport, such as tarsals, carpals, and phalanges.

Axial Skeleton

White was one of the first to systematically discuss the finer points of differential carcass transport (1952), “arguing that the skeletal composition of transported assemblages showed more complete representation of smaller animals and a predominance of limb bones over axial elements of larger animals” (paraphrased in Bunn 1993: 161). White suggested that the limb elements (scapula, humerus, radius, and ulna of the forelimbs and femur and tibia/fibula of hind limbs) of large animals were more commonly transported at distance than the axial skeleton,

principally because the limb elements possess a greater amount of usable meat and extractible marrow. While the ulna and fibula are generally of low marrow utility, the process of removing them from existing skeleton is more time consuming than the effort necessary to remove them prior to transport. White's concept makes much logical sense – simply put, the effort spent in disarticulating smaller prey may be more efficiently done back at camp because the transportation costs associated with even a whole but much smaller/lighter carcass are significantly less than those of transporting a whole larger one.

In contrast, Perkins' and Daly's (1968: 104) "*Schlepp Effect*" suggests that hunters may abandon certain limb bones in favor of others in order to reduce the transport costs associated with more ungainly or nutritionally less-advantageous parts. Although the validity of their interpretations regarding hunting strategies at Suberde has come into question (see Arbuckle 2008), the *Schlepp Effect* still features prominently in the reasoning of resource transport studies. Under this logic, axial parts are arguably the first sections to be abandoned when something must be left behind. Meat-wise, the axial skeleton holds relatively little meat, apart from the backstrap and loins which are easily and quickly removable. Similarly, strips of meat flanked by the ribs are also relatively easy to remove from between the bones. Obviously, vertebral column, ribs, and cranial elements do have valuable meat (indeed, some parts that are considered by many cultures to be delicacies, particularly choice sections of the head such as the tongue, eyes, and brain) but given their bulk relative to potential kcal, they are theoretically far less desirable as food than more meat-marrow rich upper limbs. However, as described below in "Non-nutrient Considerations", meat utility is not the only reason to desire certain animal parts.

Forelimbs

The forelimbs (or, front shoulder) contain a fair amount of meat and long bones that can be processed for marrow, as well as bones (especially the humerus) with relatively large epiphyseal sections that can be boiled to produce bone grease. The scapula is surrounded by large muscles on either side of the bone, as is the humerus, and to a lesser degree the radius-ulna. The forelimbs are generally assumed to be a rich source of valuable meat that is relatively simple to detach from the rest of the skeleton and transport either on or off the bone. In regards to marrow and bone grease production, the humerus especially (and secondarily the radius-ulna) are valuable elements, and may be expected transport items. In the Bridge River assemblage, radius-ulna segments are rarely identified. This may be the result of them not being transported from the field with the rest of the carcass, or as a result of bone processing that renders element fragments unidentifiable. Identifiable humeri are similarly rare, but may also be broken up into significantly indistinguishable long bone fragments. The thickness of the cortical portion of the humerus diaphysis is similar to that of the large hindlimb bones. Thus, small fragments of relatively thick cortical bone with similar curvature may be from any of the larger appendicular bones. Scapulae (both complete and fragmentary) are present in the assemblage. The scapula is secured to the central part of the ungulate skeleton by large muscles and is not easily removed without considerable butchery. The scapula is not a particularly thick or heavy bone and was probably not removed prior to carcass transport because it actually helps hold together major forelimb muscle groups making them easier to carry. Additionally, the shovel-like shape of the scapula makes it a useful tool with little or no modification. The presence of a single whole scapula from the Block C Unit 14 assemblage may reflect either of these potential uses.

Hindlimbs

The hindlimbs (or, posterior elements) contain the largest proportion of concentrated meat available on ungulates as well as prime long bones that could be processed for marrow. This section also has bones (especially the femur and proximal tibia) with relatively large epiphyseal sections that may be used to produce bone grease. The femur in particular is surrounded by large muscles on all sides, as is the pelvis. The pelvis also supports particularly fat-rich portions present in the rump. The hind quarters are generally assumed to be the richest source of valuable meat (apart from the backstrap/loins) and are relatively simple to detach from the rest of the skeleton and transport either on or off the bone. In regards to marrow and bone grease production, the femur and proximal-diaphyseal tibia are valuable elements, and may be expected transport items. As with the humerus, small bits of relatively thick cortical bone may be assumed to come from the larger hindlimb bones, but are often indistinguishable without the presence of diagnostic features generally present in the proximal and distal ends.

Auxiliary Elements

Carpals, tarsals, dew claws, and phalanges are not uncommon in the assemblage. Their presence is potentially indicative of butchery strategies. The logic behind long distance carcass transport generally assumes that sections of an animal (like phalanges) that do not have a high meat/marrow utility (Binford 1978: 30) are likely to be discarded in the field prior to transport simply as a means of lowering the weight of the package to be transported. Under this logic,

these elements should be uncommon in the assemblage if animals were being harvested at significant distances from the village. However, Yellen (1978: 28) observed that among the !Kung, whole astragalus and calcaneous elements were specifically included in stews, thus the value of these elements to the subsistence practices of hunter-gatherers should not be discounted out-of-hand.

Non-nutrient Considerations for Transport

Many animal parts have non-nutrient uses to consider such as those that can be used for tool making or can be put to other uses. Depending on the season male deer, elk, and moose, and both male and female bighorn sheep, mountain goats, and caribou possess antlers or horns, which may be fashioned into any number of durable tools, ornaments, or other implements. Apart from their potential nutrient utility, bone was used in much the same way as antler, as were the teeth of beaver, deer, and other animals. The claws of bear and mountain lion were also used. Hides and furs were important commodities for making clothing, blankets, containers, and shelters, and likely had a myriad of other uses. Teit (1906: 203) provides a broad description of material artifacts made from animal by-products. For instance: twisted hide and sinew were valuable as all-purpose cordage materials, used in the manufacture of everything from bows to snowshoes (Teit 1906: 224- 234) to war-clubs. Sections of antler served as hammers, flint-knapping billets, wood-cutting wedges, foreshafts, and tool handles. Many parts of a variety of animals possess potential utilities far beyond their value as foodstuffs and it is important to understand and recognize this when evaluating archaeofaunal materials. Thus, some parts of some animals evident in an assemblage may represent much more than their basic (or assumed)

subsistence worth. Indeed, the non-nutritional value of some faunal materials undoubtedly played a role in the need to transport them to the site (as described above of metapodials). However, without evidence of alternate uses, it must be assumed that faunal remains at the site are, by and large, food related. Elements that exhibit advanced stages of attrition (such as excessive breakage, fragmentation, and/or burning or calcinization), and that do not show patterns of use-wear or intentional modification, are likely the result of their use as food items or as the by-products of food production.

Transport of Bird (*Avian*) Parts by Element/Section

Bird elements in the assemblage are restricted to limb bones and some cranial and synsacrum fragments, most commonly (of 28 bird bones, $n=7$) the carpometacarpus (wrist bone) of grouse/pheasant-sized animals. The lack of other bird bones in the assemblage is somewhat curious. Based on general size, birds brought to the house as food would presumably be brought back whole or mostly whole. Were this commonly the case, axial elements from birds should be present in at least some frequency. The absence of major bird bones suggests that birds were not a significant contribution to diet, despite their minimal presence in the assemblage. Being toward the end of the wing, the carpometacarpus is not a meat-rich element. Thus, many of the bird bones evident in Housepit 54 suggest that bird wings may have been used as personal ornaments or attached to fishing implements, similar to observations made by Teit (1906: 218, 280). It is also possible that birds may have been generally hunted during excursions well outside the village, such as summer gathering camps, but were not a significant winter food source.

Transport of Fish (*Salmoninae*) Parts by Element/Section

Sockeye salmon were dried and stored with vertebral columns intact. Other salmon available in the immediate vicinity of the Bridge-Fraser confluence (i.e. Chinook and Coho-Speller et al. 2005) may not have been similarly processed. Few positively identifiable non-Sockeye salmon bones are present at Housepit 54. In some floor deposits articulated columns of Sockeye vertebrae were recovered. Much larger Chinook bones recovered are rare and never articulated with other vertebra. This suggests that Sockeye were brought into the house with spines intact but other fish were not. Ethnographic processing techniques support this strategy, suggesting that Sockeye had been dried using similar butchering techniques for a very long time. Alternatively, Chinook brought into the house was likely removed from the spine (fileted) outside the house and brought in off the bone at filets.

Salmon bones representing the entire skeleton were recovered, including most of the cranial elements, thoracic, pre-caudal, and caudal vertebrae, and caudal (tail) bones (similar studies have made use of like separations of salmon units/sections – Hoffman et al. 2000). Priede (2002: 9) states that Atlantic salmon have 59-60 vertebrae. Beacham (1985: 99) notes that Fraser River Sockeye salmon possess an average of 65.8 vertebrae each. Despite these observations, no data are currently available on the variability in relative numbers of thoracic, pre-caudal, or caudal vertebrae present in individual salmon of any Pacific stock (my own personal observations suggest that roughly 20 vertebrae are present in each position, but this number varies by individual, likely as a result of age and conditions of growth). What can be observed is that thoracic vertebrae are adjacent to the meatiest portions of fish. Proportion of

meat to bone reduces progressively from the head to the tail. The presence of a high frequency of thoracic vertebrae to others may indicate that the meatier portions of the fish were present. This would only apply to fresh or whole fish, as the drying process almost always separates the spine from the flesh, thus removing the association of the bone to its adjacent parts.

Unfortunately, within the Housepit 54 assemblage, even where many different element specimens can be identified as salmon, positively identifying them to species and/or establishing a MNI that is interpretively robust is extremely problematic. For example, even in Stratum IIa, where 2650 fish specimens were recovered, only 116 Sockeye vertebrae were in a condition that allowed them to be positively identified to axial position. Of the vertebrae, 60 were thoracic, 21 were pre-caudal, and 35 were caudal (Figure 4.1). 408 specimens were of cranial elements – over 75% of the Sockeye bones in the IIa assemblage.

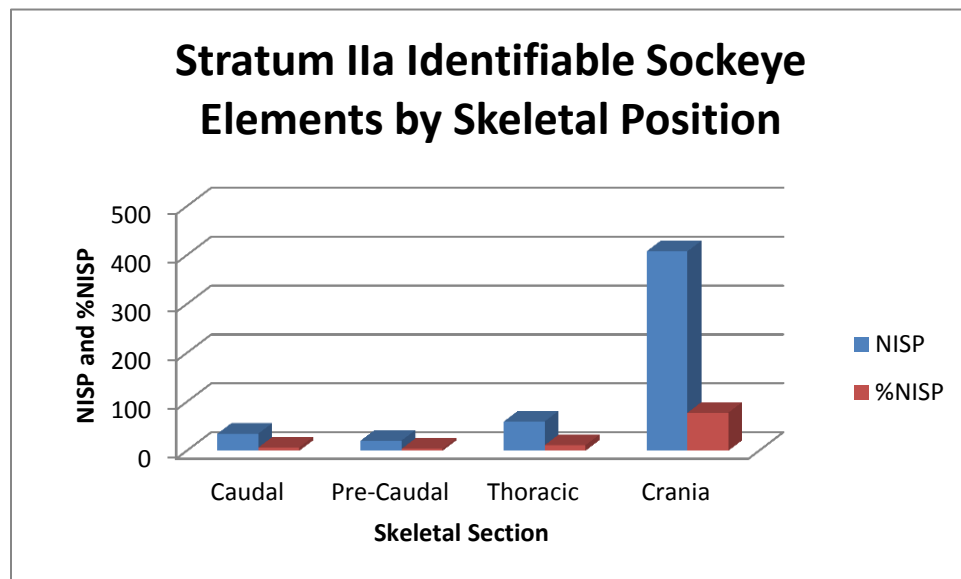


Figure 4.1. Stratum IIa Identifiable Sockeye Elements by Section/Position.

If it is assumed that an individual Sockeye possesses only 20 thoracic vertebrae, this leaves a hypothetical MNI of only three fish – dramatically less than expected were consumed in the pithouse during the IIa occupation period. Even with a dramatically higher frequency of cranial bones, considering that salmon cranial consist of over 50 major elements, even a base MNI based on identifiable cranial bones provides and MNI of eight – again, clearly far less than the number of fish that most conceivably been consumed during the roughly 20-year occupation period and likely less than could have potentially been consumed in a few days. This illustrates the general difficulty of accurately assessing subsistence practices within the pithouse without relying on relative measures.

To gain a more accurate view of salmon part representation by stratum I calculated the NISP of Sockeye salmon elements by axial section/position – i.e. cranial, thoracic, pre-caudal, and caudal – effectively dividing the salmon skeleton into four sections – head, upper body, mid-lower body, and tail. Because the NISP varies fairly drastically between strata I calculated each section as a percentage to the total identifiable Sockeye assemblage, thus illustrating how much of the salmon assemblage by strata is represented by each section. These results are shown in Table 4.1 and Figure 4.2.

Sockeye NISP by Skeletal Section	IIj %NISP	IIi %NISP	IIh %NISP	IIg %NISP	IIf %NISP	IIe %NISP	IId %NISP	IIc %NISP	IIb %NISP	IIa %NISP
Caudal	11.63	6.25	27.55	18.06	5.49	13.95	43.75	20.50	23.12	6.68
Pre-Caudal	32.56	29.17	10.20	8.33	14.63	16.86	3.75	12.00	9.33	4.01
Thoracic	37.21	39.58	29.59	30.56	42.99	36.05	42.50	38.50	29.82	11.45
Crania	18.60	25.00	32.65	43.06	36.89	33.14	10.00	29.00	37.73	77.86

Table 4.1. %NISP of Sockeye Sections by Strata.

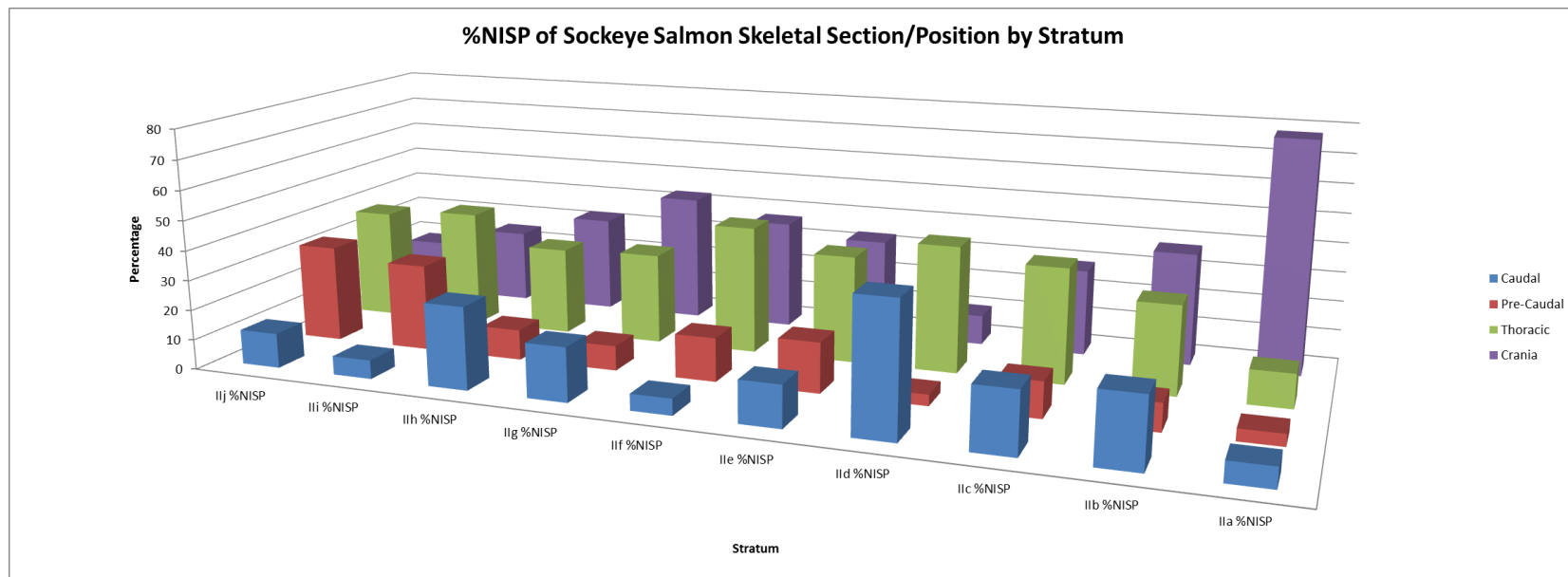


Figure 4.2. %NISP of Sockeye Sections by Strata.

What becomes clear from this analysis is that the most represented sections (or Minimum Animal Units: MAU) of Sockeye salmon in the assemblage based on identifiable elements are head and thoracic portions. This makes a fair amount of sense simply based on the fact that the thoracic portion of the salmon is the thickest section of meat. Cranial elements are almost equally common – fish heads appear to have been popular during most occupations at Housepit 54, only appears to fall out of favor during IId. Relative to their size fish heads contain a surprising amount of fat, and were evidently brought into the pithouse for consumption fairly regularly. Interestingly, the frequency of fish heads appears to steadily increase towards the apex of both BR2 and BR3, particularly during IIa. Elsewhere at Bridge River (Housepit 24 – see Prentiss et al. 2008) large accumulations of cached fish heads have been suggested to possibly represent feast-related surplus and further analyses should consider this possibility as new materials are unearthed. Pre-caudal and caudal segments appear to fluctuate in frequency but also suggest an inverse relationship between the presence/absence of lower body to tail sections.

Mammal Skeletal Parts Distribution

Understanding the ways in which parts of large-bodied terrestrial mammals (here I examine artiodactyl remains) may have been used allows us to infer a number of decision-making behaviors based on the distribution of different elements at different strata, providing a picture of possible change in predation strategies over time. Because various elements are surrounded by more-or-less muscle tissue (meat), the distribution of certain animal parts in an archaeological assemblage may be used to infer the overall utility of those various parts. Tabulations of this nutritional potential are often referred to as a “Utility Index” or “Meat-Utility

Index” (see Binford 1978; Blumenschine and Caro 1986; Blumenschine and Madrigal 1993; Brink 1997; Diab 1998; Friesen et al. 2001; Lupo 1998; Lyman et al. 1992; Madrigal 2004; Metcalfe and Jones 1998; O’Connell 1995; Outram and Rowley-Conwy 1998; Savelle and Friesen 1996; Savelle et al. 1996). With this information one can make assumptions about dietary choices made by hunters based on the utility (basically the nutrient potential) of different animal parts. The general assumption (as with aspects of the Central Place Foraging Model) is that parts of higher utility are more likely to be coveted. Thus, given a choice between one part or another hunters should favor the part with greater utility, so those parts are more likely to be represented in the archaeological record, especially if animals are sought at a distance from the place of consumption because the choice in the field should be to bring more valuable parts back while foregoing transport of less value parts.

Below are provided diagrams for each stratum showing artiodactyl elements that could be identified. Elements present in the assemblages are highlighted in red. In no stratum were multiple demonstrably-sidable elements, thus Minimum Number of Elements (MNE) is not given or discussed for the assemblage – highlighted elements simply represent which elements were present and do not suggest which side the element was from. Vertebrae were ubiquitously unpositionable relative to the actual location (e.i. C1, C2, etc. in common terminology). Thus, vertebrae indicated are simply meant to show the general location (cervical, thoracic, lumbar, or caudal), and are not meant to indicate exact spinal position.

As detailed in the stratum narrative above, artiodactyl elements identified from Stratum IIj included lumbar and thoracic vertebrae, metatarsal, a left pubis, and ulna.

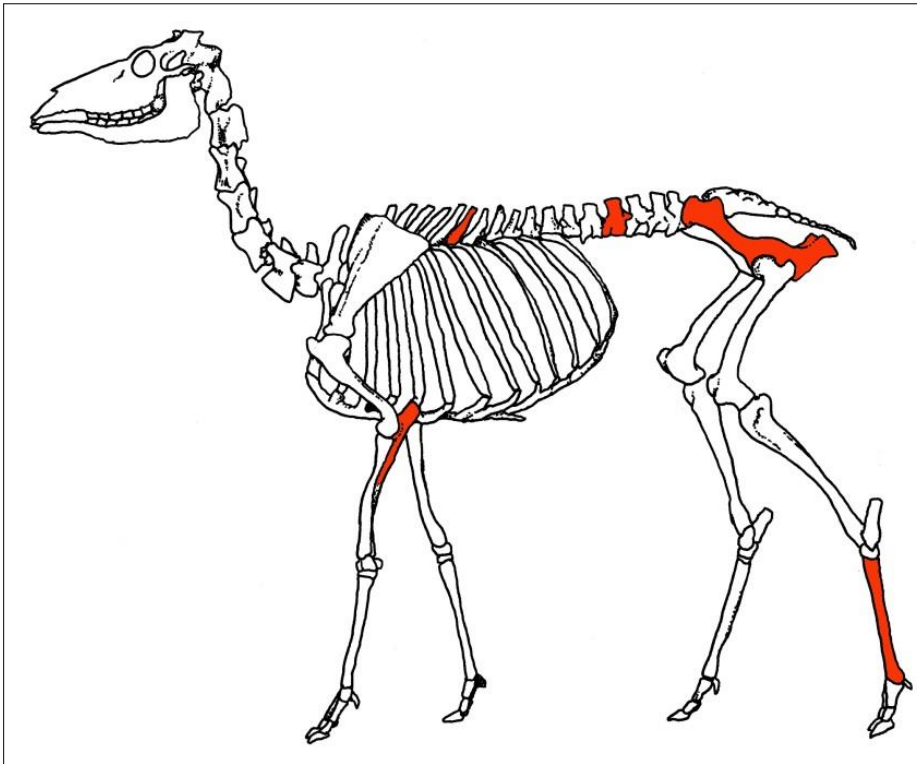


Figure 4.3. Artiodactyl Skeletal Parts Represented from Stratum IIj.

Artiodactyl elements identified from Stratum Iii included a left calcaneus, a left astragalus, a fragment of the left pubic synthesis, rib fragments, a thoracic vertebra, scapula, and multiple lumbar vertebrae.

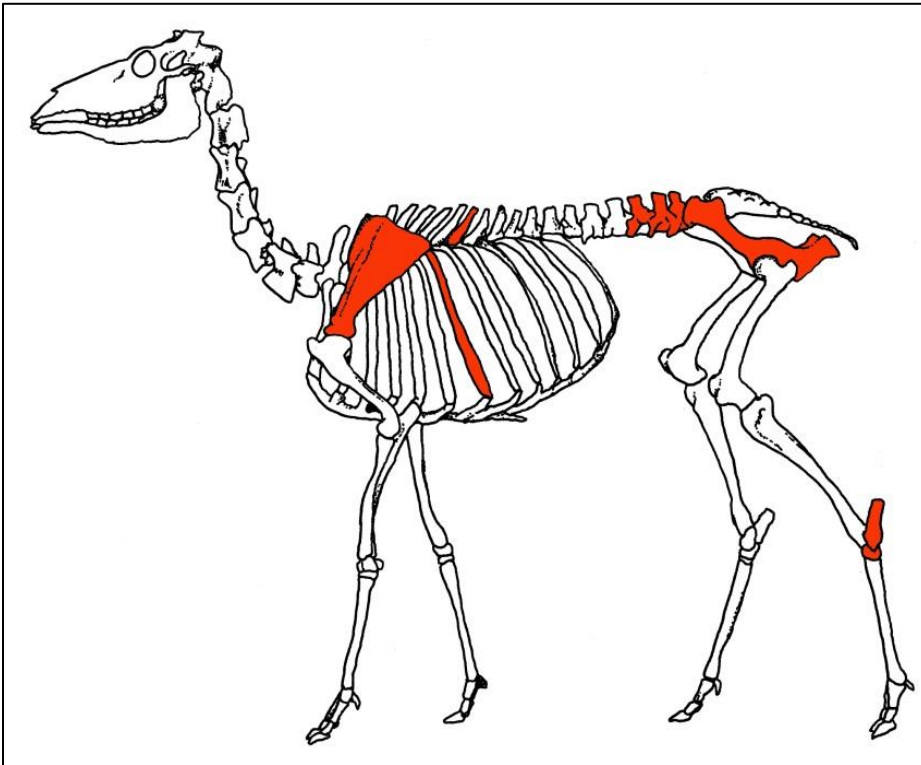


Figure 4.4. Artiodactyl Skeletal Parts Represented from Stratum Iii.

Artiodactyl elements identified from Stratum IIIh included specimens identified as lumbar, thoracic, and cervical vertebrae, a cranial fragment, mandible fragments, a pubis, a rib, a right radius, a phalange, and a right tarsal.

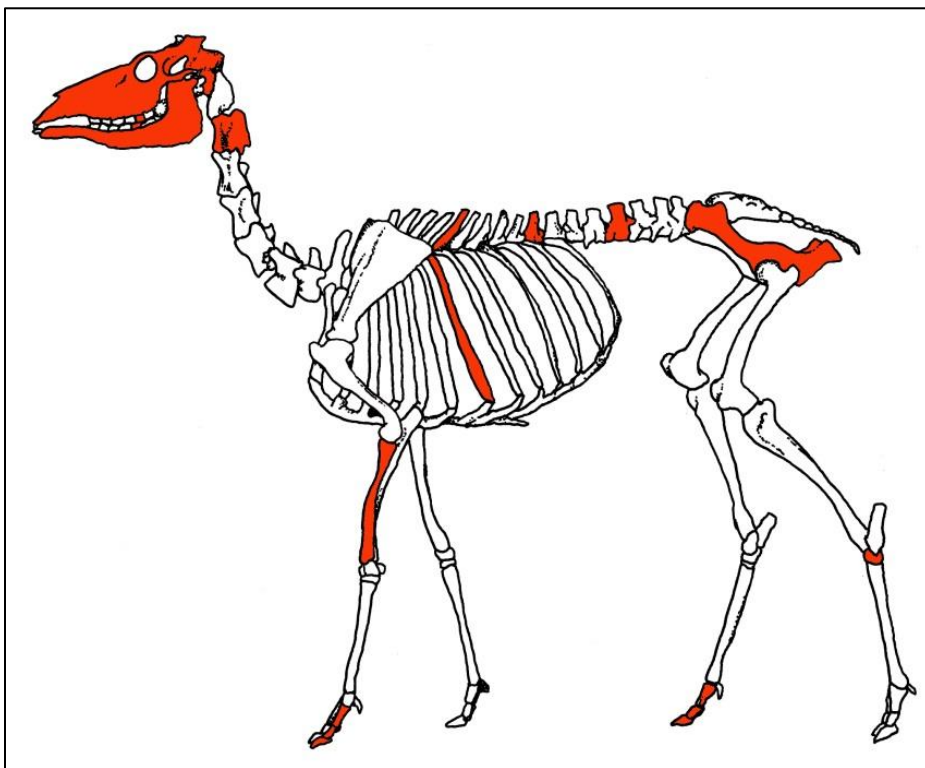


Figure 4.5. Artiodactyl Skeletal Parts Represented from Stratum IIIh.

Artiodactyl elements identified from Stratum IIg comprised much of the appendicular skeleton, including specimens identified as carpals, cervical vertebra, femur, humerus, left ulna, mandible, radius, ribs, right metacarpal, scapula, tarsals, tibia, ulna, and a fragment of a pubis.

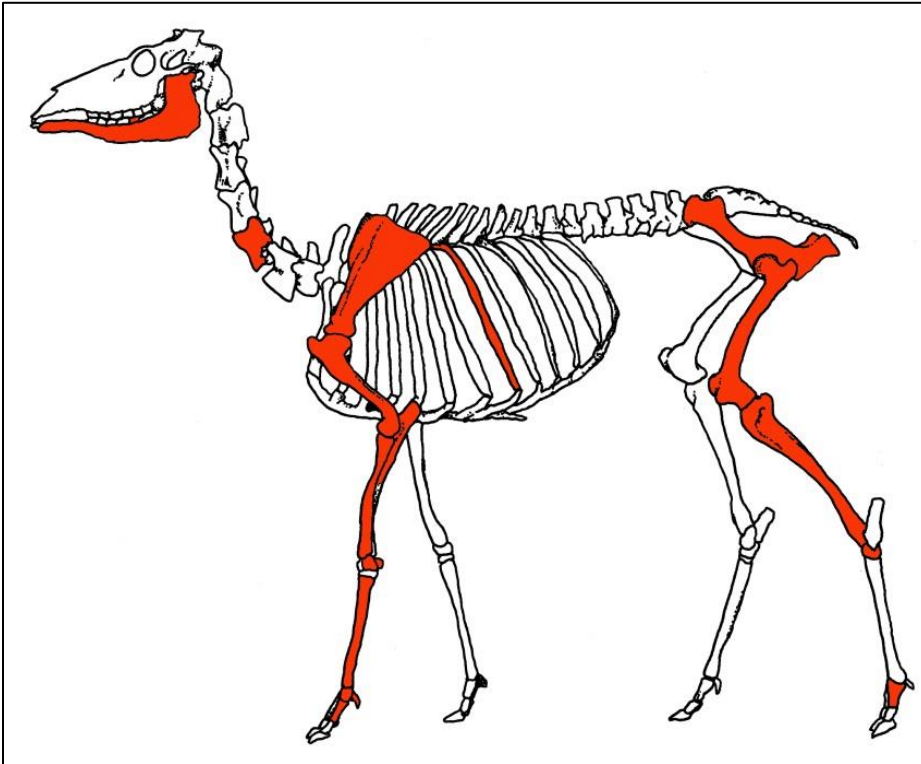


Figure 4.6. Artiodactyl Skeletal Parts Represented from Stratum IIg.

Artiodactyl elements identified from Stratum II_f consisted of calcanei, a carpal, femur, humerus, lumbar vertebrae, mandible, metapodials, metacarpal, metatarsals, and fragments of pelvis, phalanges, ribs, one sesamoid, and a left tibia.

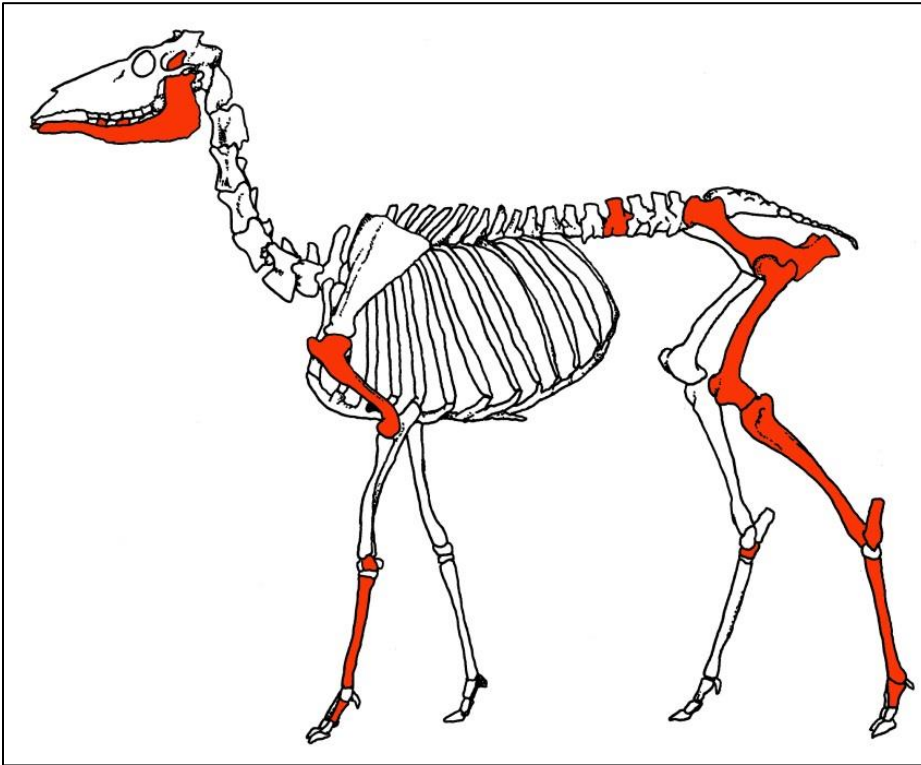


Figure 4.7. Artiodactyl Skeletal Parts Represented from Stratum II_f.

Artiodactyl elements identified from Stratum IIe were comprised almost exclusively of elements from the appendicular skeleton, including specimens of carpal, cervical vertebra, humerus, femur, metacarpal, metapodial, metatarsal, tibia, and radius.

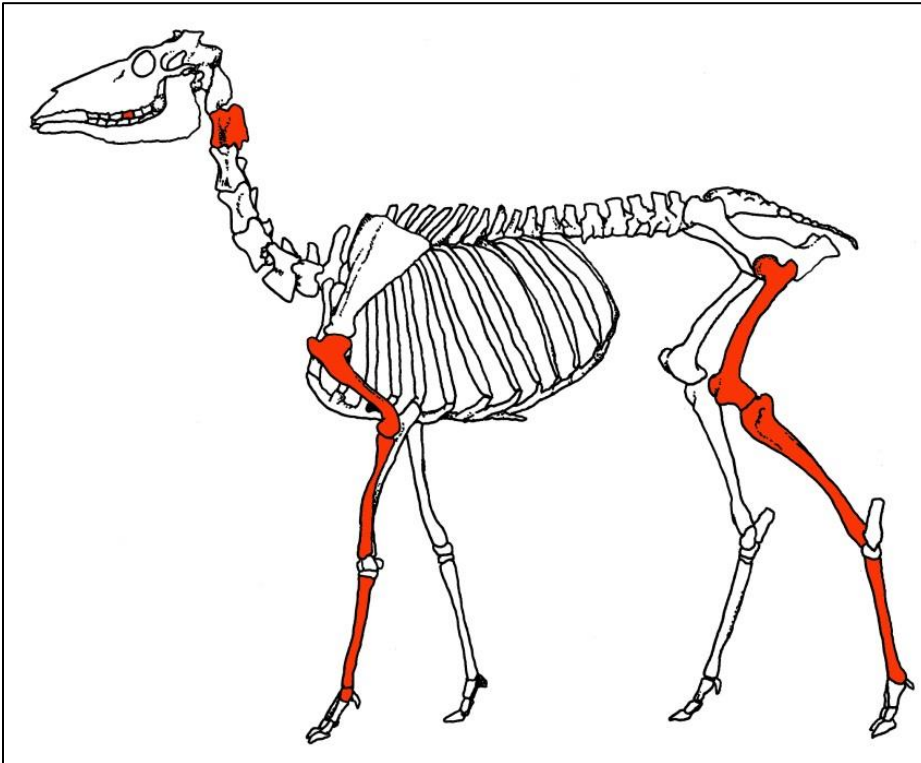


Figure 4.8. Artiodactyl Skeletal Parts Represented from Stratum IIe.

Similar to those recovered from Ile, artiodactyl elements identified from Stratum IId were comprised almost exclusively of elements from the appendicular skeleton, including specimens of femur, lumbar vertebra, metatarsal, radius, and tibia.

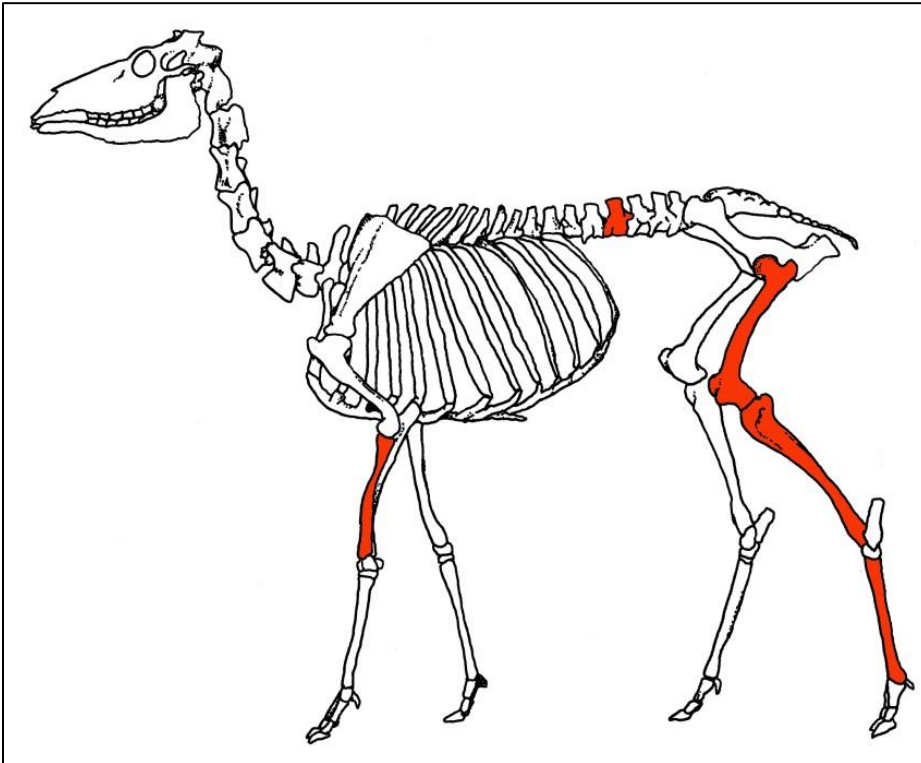


Figure 4.9. Artiodactyl Skeletal Parts Represented from Stratum IId.

Artiodactyl elements from IIc consisted of specimens identified from various elements, many that suggest the presence of at least one intact or complete forelimb, including specimens of carpals, a radial carpal, a left trapezoid magnum carpal, and a uniciform carpal, crania, fibula, humerus, lumbar and thoracic vertebrae, mandible, metatarsals, pubis, radii, ribs, tarsal, and tibia.

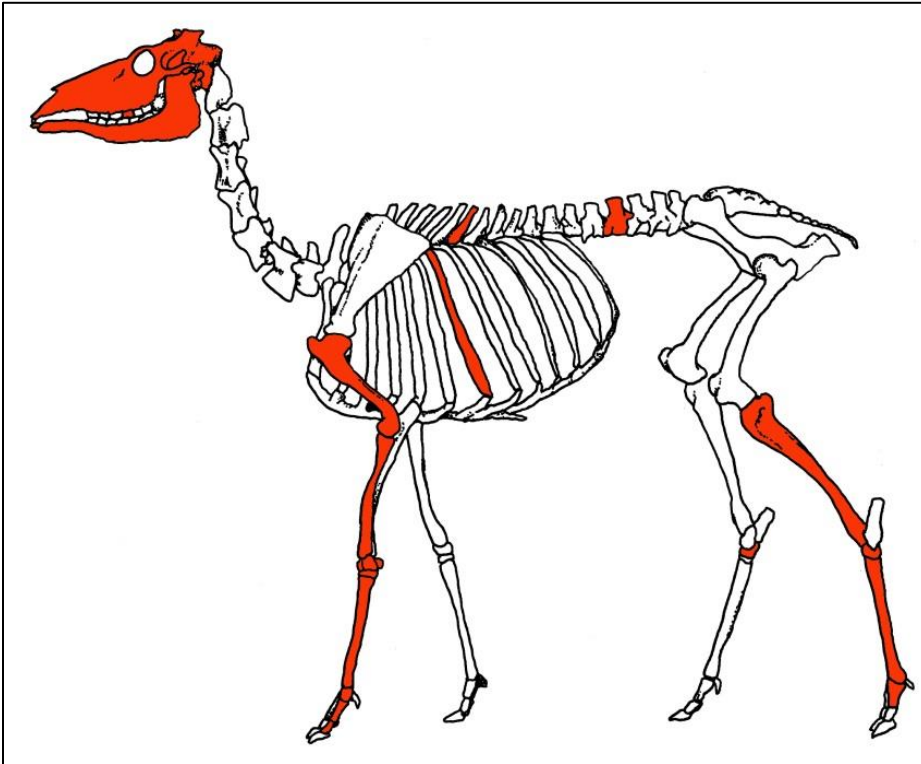


Figure 4.10. Artiodactyl Skeletal Parts Represented from Stratum IIc.

Artiodactyl elements from IIb consisted of a range of skeletal parts, many represented by multiple specimens, including carpals, cervical vertebra, crania, dew claw (vestigial metapodial – not pictured), femur, humerus, lumbar vertebra, a left metacarpal, a left metatarsal, other fragments of metatarsal, phalanges, radii, ribs, tibia, a portion of sacrum, vertebra, and a nearly complete left scapula.

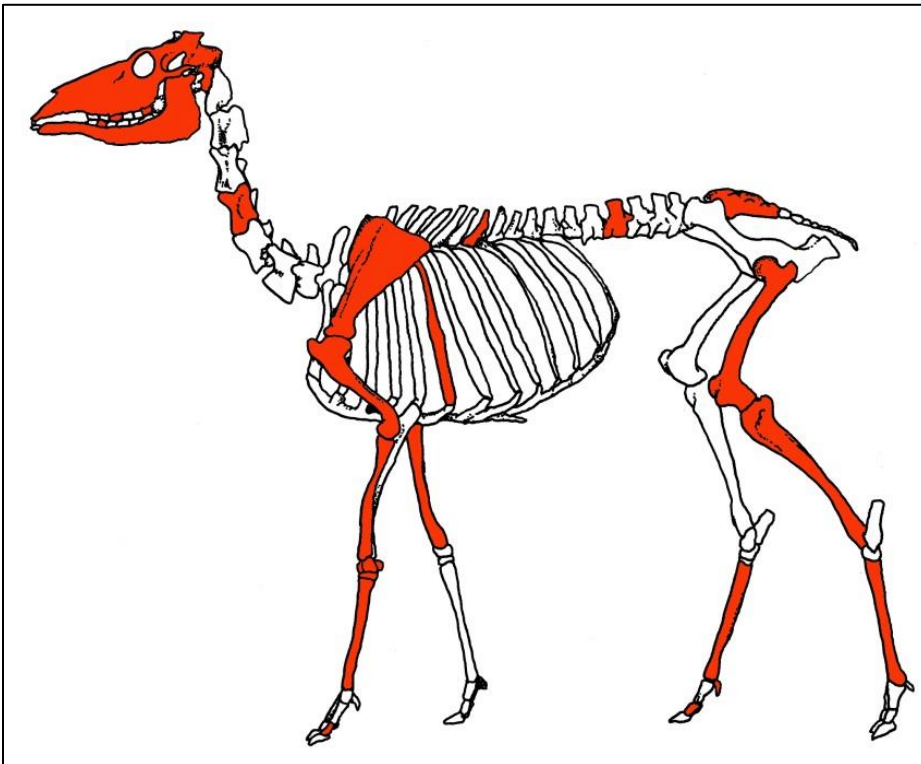


Figure 4.11. Artiodactyl Skeletal Parts Represented from Stratum IIb.

Identifiable artiodactyl remains from IIa also illustrate a wide range of skeletal elements, including specimens from cervical vertebra, dew claw, femur, a right humerus, lumbar vertebra, mandible, metacarpals, metapodials, metatarsals (including a left), a right metatarsal, phalanges, pubis, a left radius, multiple ribs, scapula, thoracic vertebra, and tibia.

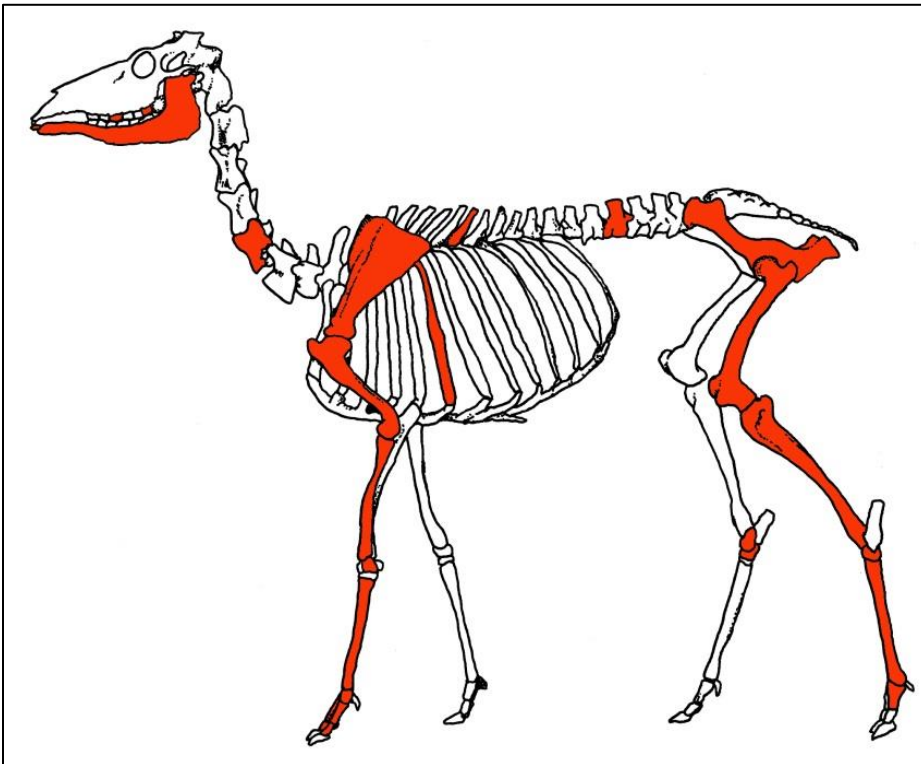


Figure 4.12. Artiodactyl Skeletal Parts Represented from Stratum IIa

The picture that emerges when looking at skeletal part distributions across strata is one in which axial and relatively low-utility elements are more common in the earliest strata of BR2 (IIj-IIh). From the perspective of the General Field Processing Model this suggests that access to artiodactyls during early incarnations of the pithouse may have been relatively free and locally realized. This could also be the result of meat being removed from the bone, either in the field or not, with bones being discarded or processed elsewhere, thus not making it into the Housepit 54 assemblage. However, the presence of pelvic, lumbar, thoracic bones (and cervical and cranial-mandibular elements in IIh) in these earlier strata suggests that animals were likely acquired relatively close to the village and brought back to the house whole or nearly intact, as such axial portions are generally more difficult to disarticulate and remove meat from, and are otherwise rather heavy and not likely to be transported more than a relatively short distance.

During Stratum IIg there is a notable increase in appendicular elements, including representative specimens from more-or-less the entire forelimb and much of the back haunch and upper-hind limb. This may indicate transport of high utility parts into the house from a greater distance – perhaps as a result of local resource depression forcing hunters to acquire artiodactyls farther afield. Given the continued presence of some axial elements, this may also just be a result of taphonomy. However, considering the distinct increase in the presence of high value limb element representation from that of previous BR2 floors, I feel it is safe to suggest that some change in hunters' decision-making processes and/or strategies was taking place during IIg occupations.

In Stratum II_f, the trend begun during II_g continues with higher frequency of appendicular limb bones than earlier occupations during BR2, including specimens representing much of the fore limb and all of the haunch-hindlimb. Again, this points to the possibility that towards the end of the BR2 period, population within the village was beginning to increase and local artiodactyl prey was becoming scarce, forcing hunters to hunt farther afield and return with only high utility portions of ungulate meat.

The transition from BR2 to BR3 continued the late BR2 trend that suggests hunters were concentrating efforts on high value animal parts (at least of artiodactyls). Strata II_e and II_d both exhibit assemblages nearly void of axial specimens, with II_e having more-or-less complete fore- and hind-limbs represented, and II_d having nearly exclusive representation of hind limb parts and some from the mid-upper forelimb. As will be presented in greater detail in the discussion on relative abundance indices, during Stratum II_d, identifiable artiodactyl remains reach their lowest frequency across the entire assemblage, which is suggestive that during this time of considerable village growth (see Prentiss et al. 2014) local artiodactyl populations had probably been depleted and that mass-acquisition of anadromous salmon was paramount to the subsistence strategy.

Stratum II_c – representing the living floor of the pithouse possibly at the height of village growth and expansion – shows a minor increase in axial elements (including crania and mid- and posterior-body vertebrae) and continued presence of appendicular fore- and hind-limb elements. This suggests that artiodactyls were probably still being sought at distance from the village (and high utility parts transported back), but also presents the possibility that local populations may have begun to rebound, allowing hunters to bring back more of the animals than would have been desirable to transport from longer distances. Alternatively, this could be an indicator that as village population increased hunters were simply required to transport lesser utility parts, as they

could not afford the luxury of waste with increasing numbers of mouths to feed. Whichever was the case, this stratum marks the beginning of a trend that continued into later occupations.

Taken together, the animal parts distributions from Strata IId-IIc likely reveal the immediate effects of the Malthusian Ceiling being reached during BR3 - suggesting that as population levels reached their peak, hunters struggled to meet growing food demands under increasing scarcity of locally-available ungulates. Greater bone fragmentation also evident during IId-IIc supports this finding and suggests that mammal bone was being processed intensively – presumably to extract every bit of nutritional value possible from acquired bones.

Strata IIb and IIa evince an increase in artiodactyl skeletal parts represented. In fact, these strata exhibit the greatest frequencies of element distribution of any strata (n=15), including sections representative of every part of the artiodactyl body. This suggests a similar two-part interpretation as I have made for Stratum IIc, but different in the sense that it is likely that artiodactyls had once again become increasingly locally available following earlier declines, possibly as the village began to experience gradual population declines (as predicted by the concept of a Malthusian Ceiling) toward the end of the IIb occupation and then exponentially as the IIa occupation came to close.

The general trend across BR2 and BR3 occupations appears to be one in which artiodactyls were initially abundant and whole animals were brought back to the pithouse. As time progressed, local ungulate populations declined (likely due to over-hunting and/or loss of

habitat), and hunters acquired animals at greater distances. By the time the village reached its demographic apex, hunters appear to have been almost exclusively bringing back high utility parts. This is suggested by the observation that appendicular elements generally increase in frequency as time progresses as the village grew in size and population. In the final phases of the BR3 period, skeletal distributions suggest a return to the presence of whole animals. Whether this final change is reflective of rebounding ungulate populations as the village experienced declines, or whether it is the product of hunters realizing the necessity to bring back every bit of food possible cannot be definitively stated. Nevertheless, changes in artiodactyl element distributions provide valuable insights into patterns of predation across time at the pithouse level.

Mammal Bone Fragmentation

One way of inferring processes of intensive use of animal bones is by looking at the degree of attrition visited on bones during processing – particularly to the degree that bone has been broken down in order to extract nutrients. Bone from the Housepit 54 assemblage – especially the mammal bone assemblage – is highly fragmented. Frequently, zooarchaeologists assess fragmentary assemblages by developing ratios between NISP and Minimum Number of Individuals (MNI) or NISP and Minimum Number of Elements (MNE) (Klein and Cruz-Urbe 1984). Both ratios (NISP:MNI and NISP:MNE) may effectively allow for the determination of what *proportion* of an assemblage is fragmented and to what degree, and what *elements* are fragmented and to what degree, respectively. Both offer a quantitative assessment of what elements may have been particularly singled out for more intensive purposes (such as marrow and bone grease processing) or to what extent taphonomic processes may have altered bone

composition, especially that of larger elements that, as they break apart, may still be identifiable. However, when the extent of fragmentation is to such a degree that MNI and/or MNE cannot positively be calculated beyond $n=1$, as is the case with the Housepit 54 faunas, these ratios become analytically unproductive. Lyman (1994) addressed this issue with the term “intensity of fragmentation” – a measure that recognizes that smaller fragments may in fact be fragments of fragments. This creates a dilemma regarding what useful information can be gleaned from intensely fragmented assemblages where large percentages of faunal remains have been broken up into indistinguishably small parts. For the Housepit 54 assemblage, where 3825 of the 4365 mammalian faunal specimens is a fragment and 80.73% of those fragments are less-than 2cm in their greatest dimension, what can we say that is analytically valuable about the treatment of bone at the site?

Clearly, it is difficult to come to any definitive conclusions based on the amount of destruction visited on bones at Housepit 54, but it is possible to surmise some behaviors that may have led to such attrition. Table 4.13 provides data on the fragmentation of mammal bone from each floor. Fragmentation, while often part of the taphonomic process leading to bone deposition, is also often associated with the processing of long bones for marrow. Yellen (1976: 28) notes that among the !Kung that “... longbones (*sic*) are then carefully broken into fragments and the marrow is removed and set aside. The bone fragments then are placed in the pot with the other meat and water, a stew is made.” Binford (1978: 147) refers to such fragments as “marrow splinters”. Given the small size of the vast majority of bone fragments (Figure 4.13) and their accumulation on the occupation floors, it is highly likely that marrow processing (or at least the actual breaking of the bones) occurred within the pithouse. Binford (1978: 155) notes that

despite the daily cleaning of processing areas “small chips (<1.3cm in length) remain in fair numbers although larger splinters and articulator ends are commonly removed to a dump.” In the case of pithouse life, larger splinters and such were likely discarded on the roof or perhaps at some short distance from the pithouse so as not to attract pests.

One helpful way of illustrating the degree to which mammal bone is fragmented in the Housepit 54 assemblage is by looking at bone fragmentation indices (Table 4.2). These show the relative frequency of extremely-fragmented mammal bone specimens (size category 1 - specimens sized 1-9mm and size categories 1 and 2 encompassing specimens in the size range 1-19mm, respectively) compared to the range of fragmented specimens for each floor. The results show that on average 48% of all bone fragments fall below one centimeter in greatest dimension and over 80% (avg.) is similarly less-than two centimeters in greatest dimension. This provides evidence for mammal bone fragmentation across the Housepit 54 assemblage, suggesting that bone fragmentation was not only a common occurrence throughout the life of the pithouse but also that bone fragmentation was practiced to such extremes as to regularly reduce bone to nearly-constituent size categories. Of particular note (see the above discussion of IId-IIc – p. 133) is the higher degree of Category 1-sized fragmentation during IId-IIc, suggesting that mammal bone processing was intensified during this pivotal phase of household growth and the likely approach and attainment of the Malthusian Ceiling.

Strata	Size2 (10-19mm)	Size1 (1-9mm)	All Fragments	Frag. Size Category 1 Index	Frag. Size Categories 1 & 2 Index
IIj	14	62	85	0.729411765	0.894117647
IIi	15	33	63	0.523809524	0.761904762
IIh	21	23	72	0.319444444	0.611111111
IIg	302	267	662	0.403323263	0.859516616
IIf	171	227	499	0.45490982	0.79759519
IIe	119	111	292	0.380136986	0.787671233
IId	73	148	270	0.548148148	0.818518519
IIc	152	327	562	0.581850534	0.852313167
IIb	234	317	660	0.48030303	0.834848485
IIa	302	266	660	0.403030303	0.860606061

Table 4.2. Bone Fragment Size Category Indices by Floor showing the relative abundances of the two smallest fragment categories.

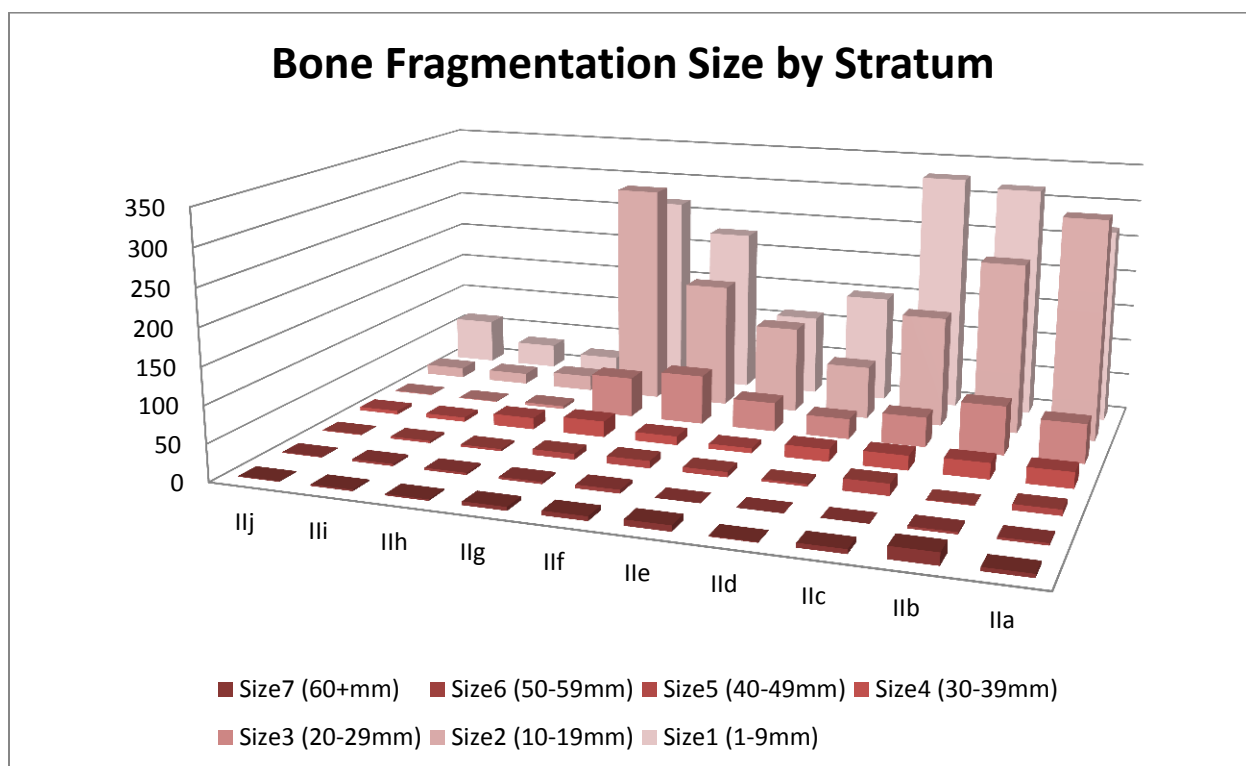


Figure 4.13. Bone Fragmentation Size by Stratum for Floors IIj-IIa.

While cut marks are evident on numerous samples from the Housepit 54 mammal bone assemblage, in almost all cases the fragments on which they are present are too small to positively identify to element or taxon, thus they do not provide a clear picture of butchery techniques in use at the location. Lyman (1978) has suggested that carcass disarticulation elsewhere in the Interior northwest may have involved little or no cutting of either tissue or bone, but rather was accomplished almost entirely by processes of bone breakage. If such were the case - even in part at Bridge River, it may help explain the extensive degree to which bones in the assemblage have been fragmented.

Nevertheless, it appears that within Housepit 54, processing of animal remains was a task commonly undertaken inside the house and was likely facilitated by both cutting of muscle and connective tissue and bone breakage to varying degrees. At the assemblage level, just over 83.24% of bone fragment specimens are less than 19mm in their greatest dimension and nearly half of those (46.56%) fall within the 1-9mm category. Clearly, bone attrition within the overall assemblage was extremely high.

The BR2 floors (IIj-IIf) do exhibit less overall fragmentation than subsequent BR3 floors (Figure 4.13), with the final occupation of BR2 showing increasingly reductive fragmentation of bone. However, this may be a result of sample size and the areas from which current mammal bone samples were acquired, since to date Ili, IIj, and IIh in situ samples come exclusively from Block A. The first BR3 floors (IIe and IId) appear to show a reduction in the degree of bone fragmentation from the immediately previous occupations, but this is merely a reduction of relative sample size, as the percentage of highly fragmentary specimens from both floors is still around 80% (see Table 4.2 above).

Ultimately, the degree to which bone was fragmented within Housepit 54 elucidates a subsistence strategy that appears more-or-less common throughout occupations. Namely, that animal bone was processed extensively, regardless of other conditions. This suggests a possible degree of heritability in processing strategies, as the practice persisted through every occupation.

Assemblage-Wide Structure Indices

A number of indices have been used to help zooarchaeologists assess change and diversity in assemblages over time. As has been shown, logic borrowed from Optimal Foraging Theory can aid in the way we interpret changes in predation of certain animals (here artiodactyls) between strata, and assessing patterns of bone fragmentation can provide insights into the possible persistence of some processing strategies and to the intensive nature of nutrient extraction. Other ways of think about the faunal assemblage allow us to make more broad observations regarding the relationships between various animal predation strategies between strata. These assemblage-wide structure indices (Lyman 2008) include indexes to measure taxonomic richness and heterogeneity, overall assemblage composition, and relative abundances between taxa.

Taxonomic Richness

Taxonomic Richness (also referred to as “NTAXA” or the number of different taxa evident in the assemblage) is one of the most basic indicators of variability in predation practices

within an assemblage and it allows the opportunity to comment on resource exploitation patterns and dietary scale (Lyman 2008). Here I will use the terms “broad-spectrum” and “specialized” to describe how the occupants of Housepit 54 practiced either a wide diet-breadth consisting of relatively numerous prey species, or narrow diet-breadth consisting of fewer species, respectively (Flannery 1965; see also Kelly 2007).

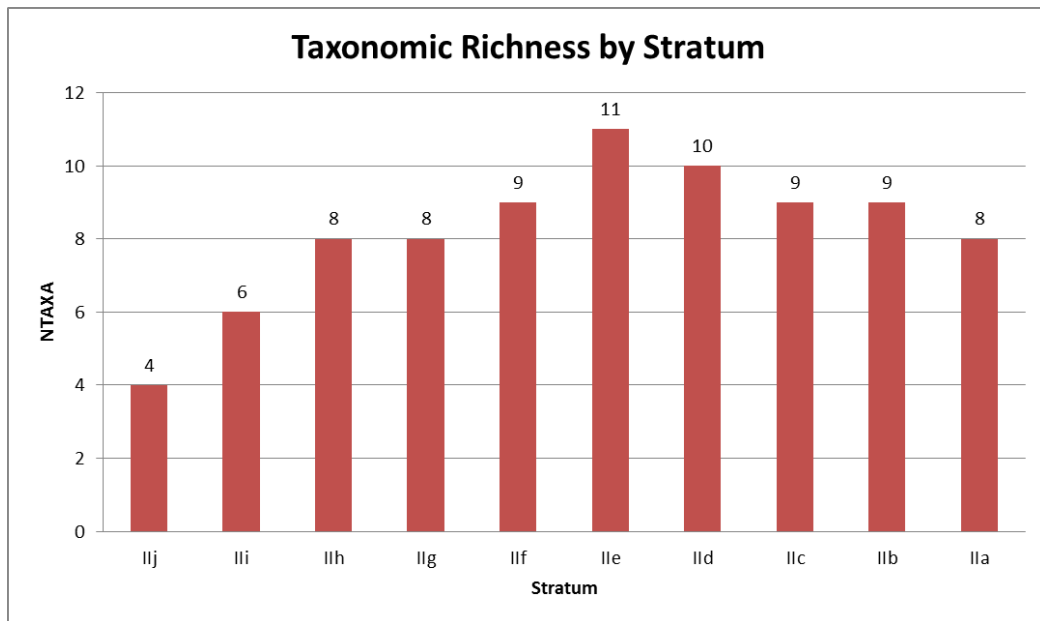


Figure 4.14. All Fauna Taxonomic Richness by Stratum.

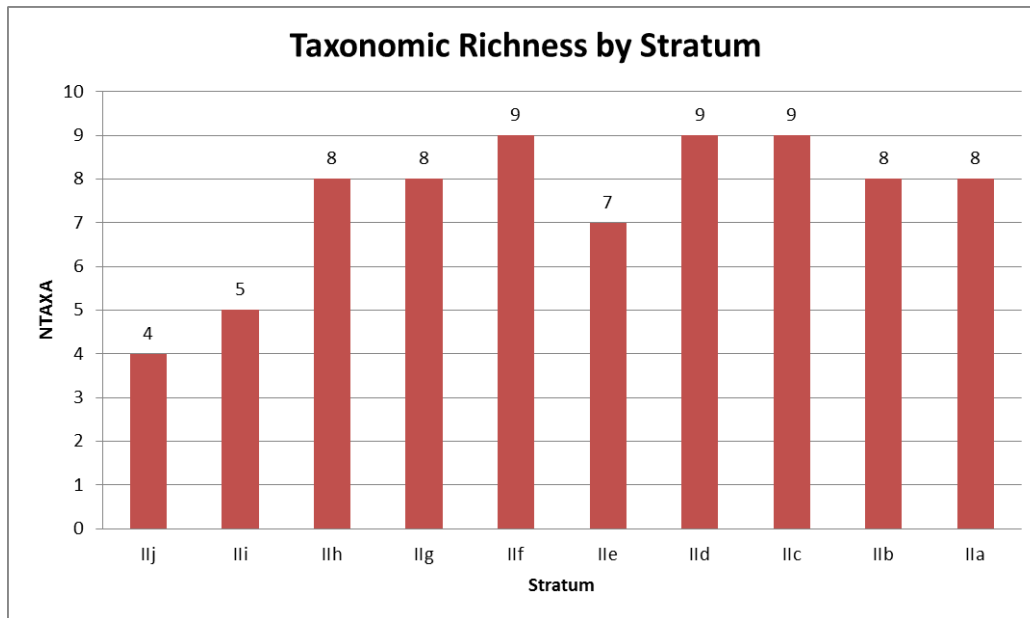


Figure 4.15. Taxonomic Richness by Stratum without Tiny Rodents.

As is evident from Figures 4.14 and 4.15, taxonomic richness at Housepit 54 follows a somewhat static pattern across strata – the major difference being between the first two incarnations of the pithouse and all subsequent occupations. Earliest incarnations of the household appear to have practiced a more specialized diet, concentrating on medium- and small-sized salmonids (including larger salmonids during IIh, IIg, and IIf), artiodactyls, dog, and beaver. With the onset of the BR3 period at Stratum IIe, diet-breadth initially appears to become more broad-spectrum (Figure 4.14). However, when it is considered that the IIe NTAXA value is bolstered by four species of small- to tiny-sized rodents that are not likely to have played a major role in dietary diversity, the pattern becomes one in which diet-breadth actually narrows slightly (Figure 4.15). Village growth during BR3 does not seem to have drastically altered the taxonomic richness in any significant manner. Strata IIf, IId, and IIc exhibit the greatest richness, all in large part due to the presence (as described in the stratum narrative) of a few stratigraphically unique specimens such as grizzly bear in IId and various sub-species of grouse

and the presence of oyster elsewhere. Overall, taxonomic richness at Housepit 54 appears remarkably homogenous following the initial BR2 occupations, especially considering the variety of species available in the surrounding environment. If greater fluctuations were seen in taxonomic richness between strata, it may be safe to assume that conditions warranted changes in predation strategies over time – as it stands, the taxonomic richness observed indicates a fairly stable, somewhat mid-range diet-breadth that, while dominated by fish and ungulates, was not limited to them. As observed in the discussion on bone fragmentation, and given that a wide variety of animals could potentially be acquired in the region but appear to have not been included in the diet, this may be the result of a persistence of knowledge and practice between households reoccupying the pithouse over generations.

Taxonomic Heterogeneity (Diversity)

Understanding the diversity inherent within faunal assemblages is important because it allows a relative measure from which to view variability between different assemblages that may otherwise appear taxonomically similar, but that may ultimately be very different in composition. The most commonly used index of taxonomic heterogeneity (or diversity) used in zooarchaeological contexts is borrowed from information theory and ecology studies and is referred to interchangeably as the “Shannon Index” or “Shannon-Wiener” Index (Lyman 2008; Reitz and Wing 2008). As Reitz and Wing (2008: 111) explain: “These measures combine data on numbers of categories (taxa) and abundance within each category to describe the heterogeneity of a system.” The function is:

$$H' = -\sum (p_i) (\ln p_i)$$

where H' = the information content from the given sample;

p = the proportion of individuals of a given species divided by the total number of individuals;

\ln = the natural log;

and Σ = the sum of calculations and s = the number of species

Here I calculated the Shannon-Wiener Heterogeneity Index for each stratum and for the total faunal assemblage based on identifiable taxa (NISP). The results are given below in Table 4.3 and Figure 4.16.

Stratum	Shannon-Wiener Diversity Index
IIj	0.308143302
IIi	0.225985871
IIh	0.298698925
IIg	0.378392322
IIf	0.444167902
IIe	0.322121543
IId	0.363551306
IIc	0.34844711
IIb	0.565616931
IIa	0.56825172
Total Ass	1.407805876

Table 4.3. Shannon-Wiener Diversity Indices by Stratum.

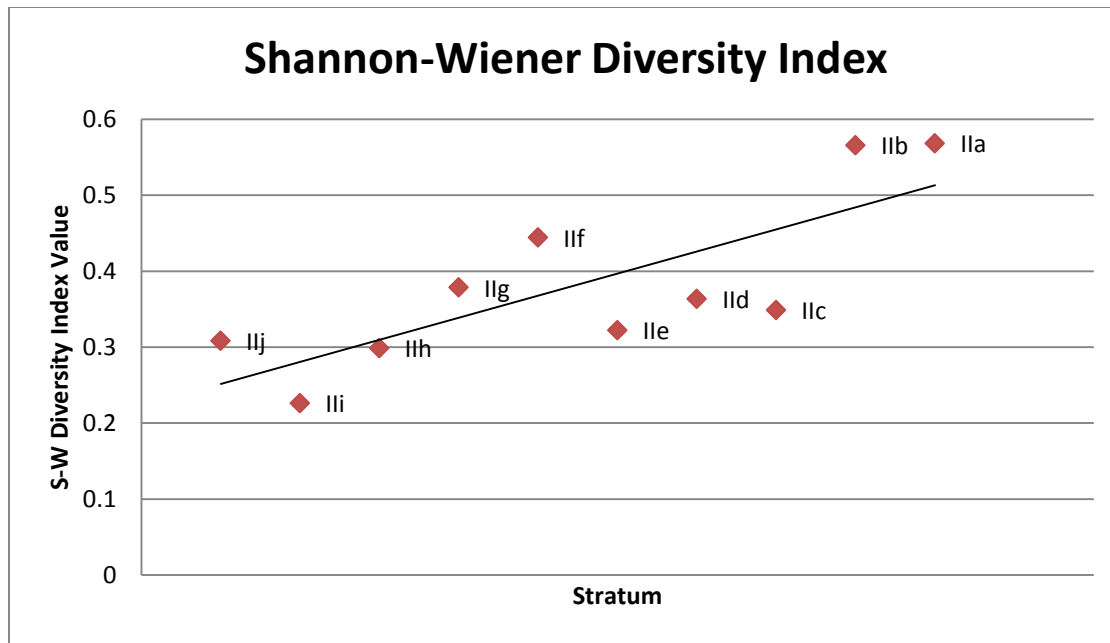


Figure 4.16. Shannon-Wiener Diversity Indices by Stratum showing increased diversity over time (linear R^2 value = 0.6122).

Applied to ecological contexts, the Shannon-Wiener Index generally produces values from 1.5 to 3.5, with greater values indicating greater diversity within the dataset (Magurran 1988). With this in mind the Housepit 54 faunas do not represent a robustly diverse assemblage (S-W value: 1.4). Regardless, relatively speaking the results show a pattern of gradually increasing overall diversity within the whole assemblage over time. The taxonomic diversity evident in the final occupation levels of the house (IIb and IIa) shows a marked increase over that from all other floors. Interestingly, the next closest index value to those final floors is from Strata Iig and IIf – the final BR2 floors, both of which also show a marked increase over previous floors. This suggests that assemblage diversity increased towards the end of BR2 and again towards the end of BR3. This could be in response to population increases – at the end of BR2 as the village began to feel the population pressures that would eventually herald the

extensive growth of the village and the onset of BR3, and at the end of BR3 as population size reached its zenith and additional resources were likely sought to meet growing demands.

Taxonomic evenness is another useful metric for understanding the overall scope of diet-breadth in archaeological contexts. In theory, greater taxonomic evenness within an assemblage is an indicator of resource specialization (concentrating on bulk acquisition of few key resources), while unevenness is indicative of a generalist strategy wherein a greater variety of resources are utilized (Reitz and Wing 2008). The Shannon-Weaver (1949) Evenness Index is calculated as:

$$V' = H' / \log_e S$$

where H' is as above;

and S is the number of identified taxa in each assemblage.

Equitability (i.e. evenness) scores are thus given as a number between 1 and 0 with a score of 1 signifying a completely even distribution and 0 denotes an entirely uneven taxonomic distribution.

The evenness results by stratum at Housepit 54 are given in Table 4.4 and illustrated in Figure 4.17 below.

Stratum	Shannon-Wiener Diversity Index	log Richness [ln(S)]	Shannon Evenness
IIj	0.308143302	1.791759469	0.171978051
IIi	0.225985871	1.791759469	0.126125116
IIh	0.298698925	1.945910149	0.153500883
IIg	0.378392322	2.079441542	0.181968242
IIf	0.444167902	2.302585093	0.192899669
IIe	0.322121543	2.397895273	0.134335117
IIId	0.363551306	2.302585093	0.157888326
IIc	0.34844711	2.197224577	0.158585114
IIb	0.565616931	2.302585093	0.245644312
IIa	0.56825172	2.197224577	0.258622503

Table 4.4. Shannon Evenness scores by Stratum.

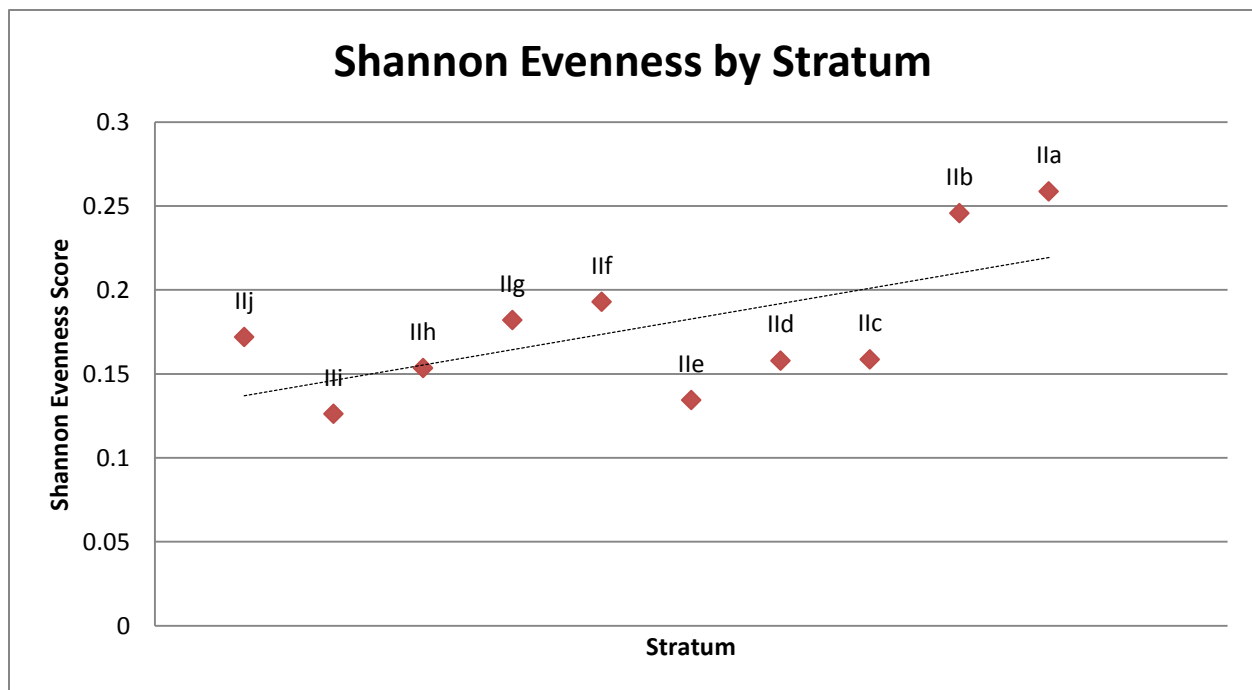


Figure 4.17. Shannon Taxonomic Evenness by Stratum.

The results of the Shannon Evenness test suggest that the Housepit 54 faunal assemblage is consistently uneven, averaging only 0.178 across all floors. However, the assemblage does show that diet was most even approaching the BR2-BR3 transition (IIg-IIf) and again at the end

of BR3 (IIb-IIa). As a measure of diet-breadth, this suggests that minor changes in the utilization of animals occurred during these two spans, but the assemblage is still uniformly uneven overall, suggesting that as human populations fluctuated during the two phases in question a slightly more specialist strategy at least appears to have emerged – a strategy particularly dominated by salmon and ungulates. However, due to relatively low evenness scores overall, this interpretation remains nebulous given current data on taxonomic evenness.

As noted above, this research is based on incomplete data from only the currently excavated portions of Housepit 54. Many occupation strata have simply not yet been fully excavated. Thus, any interpretation must take in to account the potential for sampling biases. Incomplete samples may significantly alter the interpretive power of the current data. Further compounding the issue of sample size is the extensive degree of fragmentation throughout the assemblage, and sample size inflation due to this is impossible to ignore. Herein I have generally utilized measures based on the numbers of *individual* rather than on *identifiable* specimens, mainly because of issues stemming from the differential identifiability of salmon bones versus those of highly fragmented mammal bone, as discussed above. This has been undertaken by necessity rather than choice, given the nature of the assemblage, and I have approached all analyses with the understanding that “specimen counts simply do not support as many analytic techniques as the minimum number of individuals” (Grayson 1984: 23). Grayson (1984) further suggests that sampling bias may be quantitatively observed by plotting NISP against taxonomic richness, but notes that numerous “authors have concluded that the use of the number of identified specimens leads to difficulties ‘in statistical treatment caused by sample inflation’” (1984: 22).

If significant sampling bias exists, the plot of NISP/richness should show greater diversity in floor assemblages with greater NISP, simply because more samples to draw from offerings greater probability for diversity to emerge. These results are given in Figure 4.18.

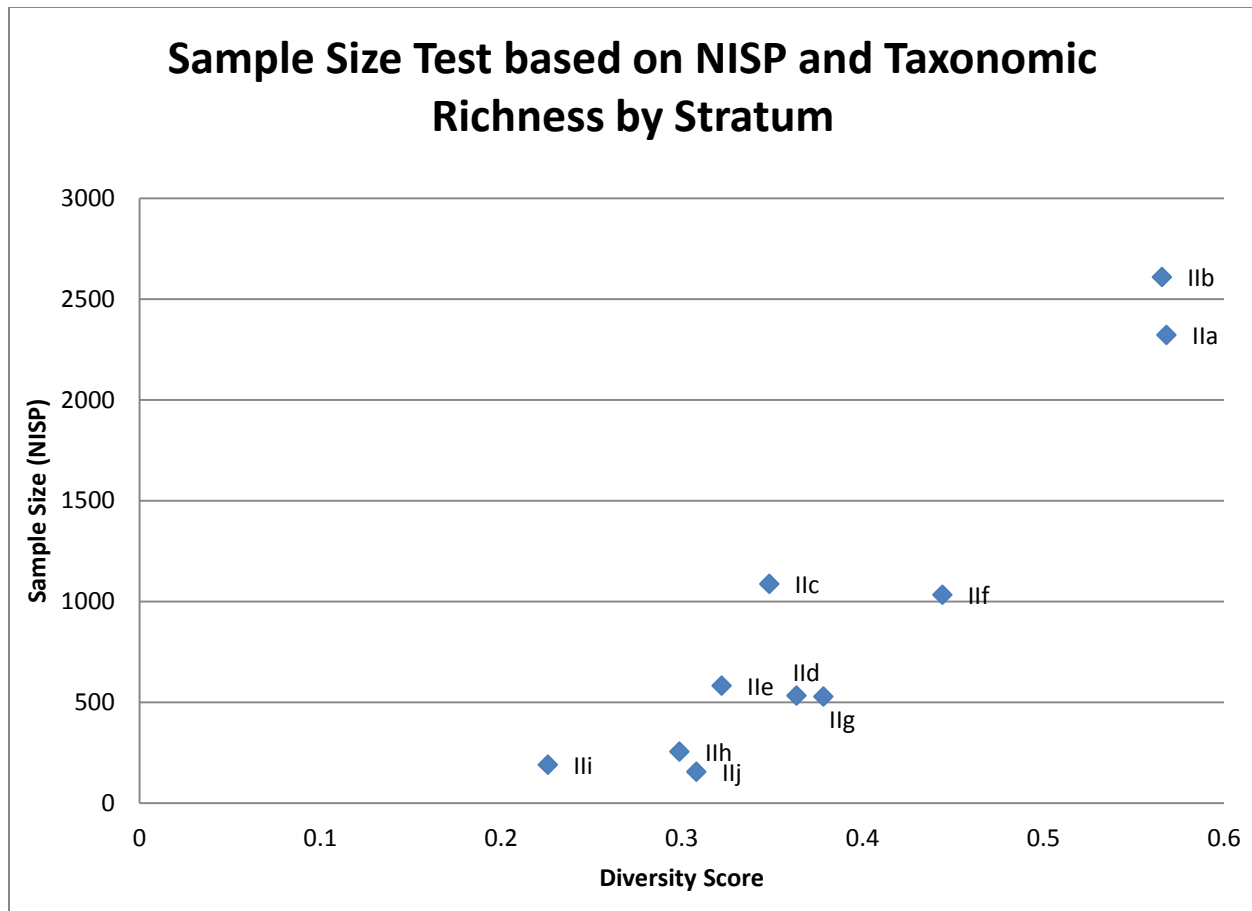


Figure 4.18. Sample Size (NISP) Plotted Against Diversity Scores (Shannon-Weaver).

These results (Figure 4.18) clearly show that sampling bias may likely play a role in the diversity of the various floor assemblages as outlined here (correlation coefficient equals a weak positive correlation with a Pearson's $R = 0.3823$ and a statistically insignificant P-value of 0.275599). The two most completely excavated strata (I Ib and I Ia) exhibit the greatest taxonomic diversity probably due to their status as complete stratum assemblages. However,

other strata do not correlate so distinctly, indicating that observed patterns between strata may not be affected drastically by sample size.

Because they are incomplete, the current data are not ideal for formal statistical tests, but a Pearson's R-score correlation coefficient generated for the Shannon-Weaver Diversity and Shannon Evenness values show that NISP and diversity and evenness strongly correlate: $R=0.9413$ and $R=0.9001$, respectively. P-values for each (diversity = <0.00001 and evenness = 0.000386), show these results to be significant at all levels (P-value < 0.10 , 0.05 , and 0.01). This indicates that sample size is statistically a major factor in the taxonomic diversity results and their interpretive merit should be considered accordingly (see Appendix C for values).

Assemblage Composition

Lyman (2008: 186) outlines two similar and “exemplary” indices for use in measuring taxonomic composition of archaeofauna assemblages. These nominal-scale indices are the Jaccard Index (a measure of differences between faunas) and the Sorensen Index (a measure of similarities between faunas). They are calculated as:

Jaccard = $100C/(A+B-C)$ – where A is the total taxa in assemblage A, B is the total taxa in assemblage B, and C is the total number of taxa common in A and B.

and:

Sorensen= $100(2C)/(A+B)$ – where variables A, B, and C are identical to those in the Jaccard Index.

Here I generated a Jaccard index and a Sorensen index for each set of adjacent strata with the aim of identifying any major compositional similarities between potentially concomitant occupations. The results are summarized below in Table 4.5.

Relationship between Strata	Jaccard Index	Sorensen Index
IIj & Iii	28.57	44.44
Iii & Iih	44.44	61.54
Iih & Iig	60.00	75.00
Iig & Iif	54.55	70.59
Iif & Iie	60.00	75.00
Iie & Iid	45.45	62.50
Iid & Iic	50.00	66.67
Iic &; Iib	54.55	70.59
Iib & Iia	77.78	87.50

Table 4.5. Jaccard and Sorensen Indices between adjacent strata.

These results initially seem somewhat anomalous, because given that each of the sets of strata compared is adjacent to one another, one might assume both indices to generate much higher similarity values. However, this is likely due to a relatively low range of diversity extant in the overall assemblage due to sample size (see Lyman 2008: 189). Significantly, floors Iih and Iig, Iif and Iie, and Iib and Iia are the most similar pairs of strata as regards their taxonomic assemblages. As one might expect, Iih and Iig both represent mid-BR2 occupations – perhaps (even likely) a reoccupation by individuals from, or some permutation of, the previously occupying household. Thus, it is safe to consider that individuals living, learning, and subsisting together previously within the house might continue to utilize successful subsistence practices,

targeting the same species that they always had, regardless of the new roof overhead. Similarly, faunal remains from IIb and IIa are of similar taxonomic composition – likely for similar reasons and suggestive of similar conclusions. However, the high rate of similarity between IIc and IId is most intriguing. As these strata represent the transition from BR2 to BR3 (admittedly a heuristic division based on empirical changes in village size, structure, and assemblage contents) these results may support that the family(ies) occupying Housepit 54 at both ends of the BR2-BR3 transition was the same or at least composed of some of the same individuals. If this was indeed the case and the household was maintained more-or-less unbroken during this time of dramatic changes in village size and composition, it may be strong support that some pithouses were maintained from generation to generation by the same families or household units (Prentiss et al. 2008; 2012; 2014; Prentiss and Kuijt 2004).

Relative Abundance Indices

Relative abundance indices have become common in zooarchaeological analyses, largely due to their utility in providing easily interpretable results from a variety of taxonomic values. Frank Bayham's (1979) initial use of relative abundance indices successfully illustrated how archaeological patterns of abundance in one taxon may actually be indicative of declines in another. Works in the mid-1990s by Jack Broughton (1994a, 1994b, 1995) and Joel Janetski (1997) refined this method as a staple analytical tool for assessing resource depression, intensification, and subsistence change within archaeological research. Subsequent studies have further developed the application of various relative abundance indices for use in archaeological

investigations (see Butler 2000, 2001; Dean 2001; Grayson and Delpech 1998; Lyman 2003a, 2003b, 2004; Nagaoka 2001; Stiner et al. 1999).

Generating relative abundance indices between various faunas (or taxonomic classes) from different strata makes it possible to track changes in the frequencies of animal resources relative to other animal resources over time. All relative abundance indices are determined using the following basic equation:

$$\sum A / \sum (A+B)$$

where $\sum A$ = NISP of the taxon for which the index is meant to provide a relative abundance of; and B is the NISP of the taxon (or taxa) against which A will be weighed.

I generated relative abundance indices on a number of scales based on both identifiable taxa and relative taxonomic categories across strata in order to assess temporal patterns in prey acquisition over time. For example, at the most taxonomically-specific level, identifiable animal remains at Housepit 54 are most commonly represented by two genera/species: Sockeye salmon and artiodactyls (most commonly deer). Thus, a floor-by-floor Artiodactyl index was calculated as:

$\sum \text{Artiodactyls} / \sum (\text{Artiodactyls} + \text{Sockeye})$ (see results in Table 4.6)

Artiodactyl Index by Stratum			
Strata	Sockeye NISP	Artiodactyl NISP	Artiodactyl Index
Stratum IIa	742	108	0.127058824
Stratum IIb	1035	89	0.079181495
Stratum IIc	380	46	0.107981221
Stratum IId	181	15	0.076530612
Stratum IIf	248	41	0.141868512
Stratum IIg	387	64	0.141906874
Stratum IIh	138	38	0.215909091
Stratum IIi	131	21	0.138157895
Stratum IIj	110	16	0.126984127
Stratum IIk	63	11	0.148648649

Table 4.6. Artiodactyl Relative Abundance Index based on NISP of Artiodactyl vs. Sockeye.

These results illustrate variability in the amounts of identifiable artiodactyl remains to those of Sockeye at Housepit 54 over time (Figure 4.19). According to these results artiodactyls make up a significantly low proportion of the Housepit 54 faunal assemblage, although they are by far the most identifiable mammalian class represented. As a measure of relative dietary contributions, the inverse of the Artiodactyl Index – the Sockeye Index (simply the inverse of the values presented in the “Artiodactyl Index” column of Table 4.6) suggests that salmon were disproportionately important to the prehistoric diet at Housepit 54 across strata, averaging nearly 90% of the relative contributions between the two categories.

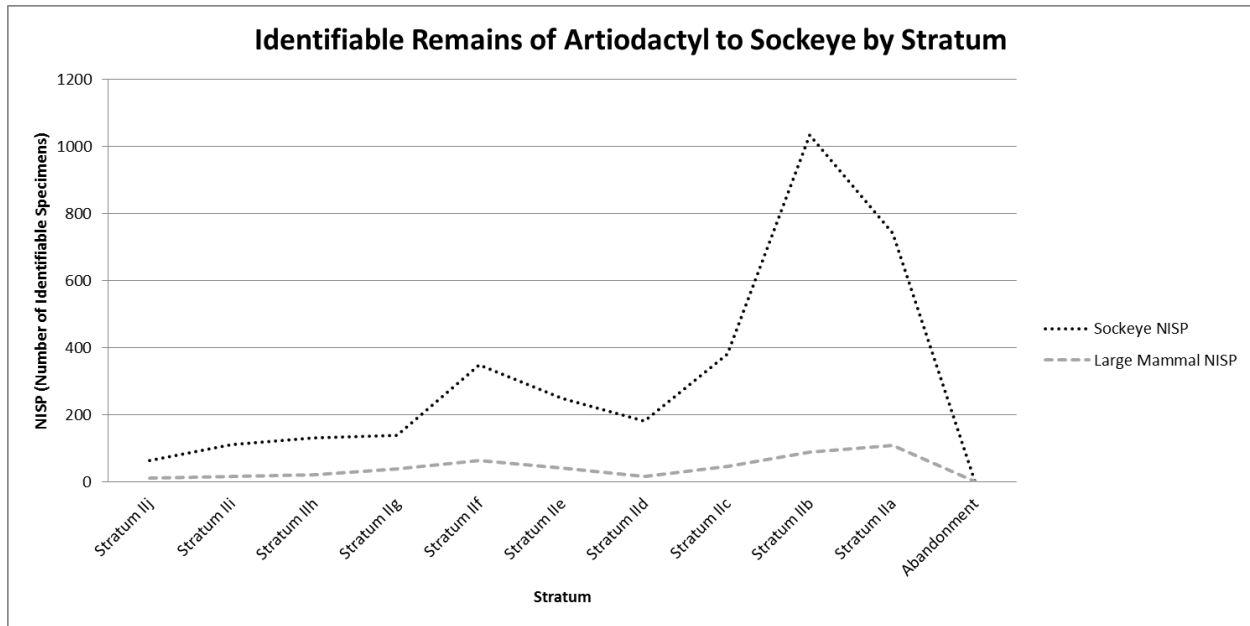


Figure 4.19. Artiodactyl and Sockeye NISP by Stratum.

Further, these results show distinct increases in Sockeye over time during mid- to late-BR3 and very little increase in artiodactyls (Figure 4.20). Ultimately, the Artiodactyl Index suggests a decline in artiodactyls over time (Figure 4.21) based solely on the Artiodactyl Index values, but this is likely due to an inordinate amount of large mammal bone (that most likely belongs to artiodactyls) that is too fragmentary to positively identify.

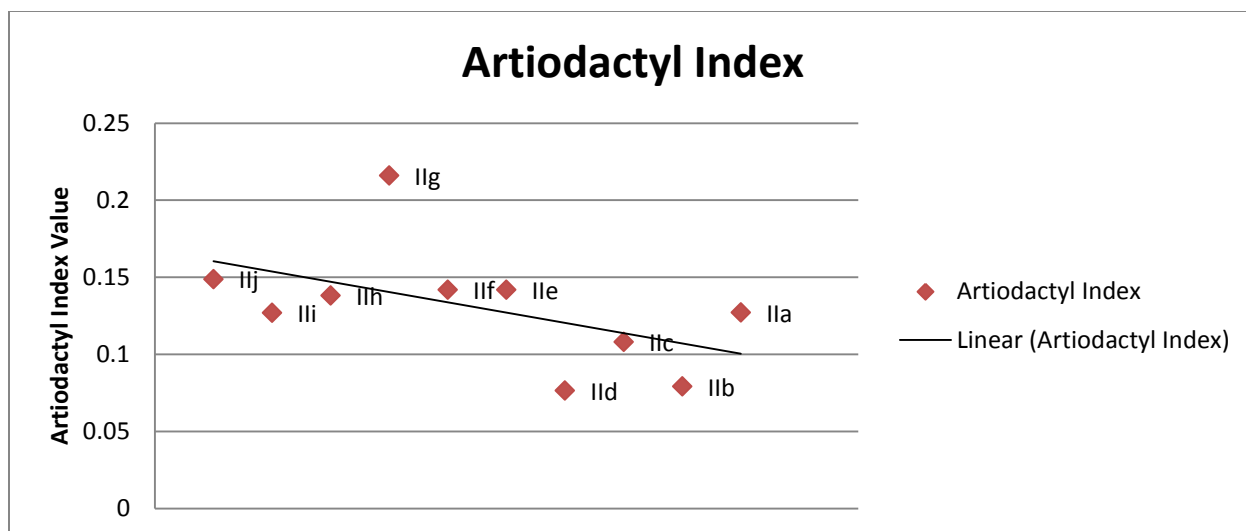


Figure 4.20. Artiodactyl Index Values Over Time Based on Table 4.6.

Clearly, based solely on the general numbers of specimens recovered, relying on NISP based specifically on genera/species provides an unrealistic picture of the probable dietary range enacted at Housepit 54. This is largely due to the fact that mammal bone specimens in the assemblage are fragmented to such a degree as to cause intact or mostly-intact fish bones to be positively identified at a much greater rate. Thus, it is necessary to examine patterns in the assemblage at a more generalized but more illustrative scale that takes into account the available evidence of terrestrial mammal predation as well as that of fish accumulation.

To achieve this more generalized representation I calculated relative abundance indices for two very general resource categories: marine resources and terrestrial resources. This generated two gross relative abundance indices – one for fish and one for mammals – both based on relative size categories. The fish index was produced using NISP based on relative size following Huber et al.'s (2011) findings that salmonid archaeofaunas can be identified to three

basic size categories: small (trout-sized), medium (Sockeye¹-sized), and large (Chinook-sized).

Because medium-sized fish are very clearly the most abundant size category throughout the assemblage, the general fish index was calculated as:

$\Sigma \text{Medium-sized Fish} / \Sigma (\text{Medium-sized} + \text{Trout-sized} + \text{Chinook-sized Fish})$ (see results in Table 4.7 and Figure 4.21)

Medium-sized Fish Index			
Strata	All Fish NISP	Medium-sized Fish NISP	Medium-sized Fish Index
Stratum IIa	818	742	0.907090465
Stratum IIb	1080	1035	0.958333333
Stratum IIc	386	380	0.984455959
Stratum IId	186	181	0.97311828
Stratum IIe	251	248	0.988047809
Stratum II f	412	387	0.939320388
Stratum IIg	139	138	0.992805755
Stratum IIh	135	131	0.97037037
Stratum IIi	110	110	1
Stratum IIj	70	63	0.9

Table 4.7. Medium-sized Fish Index.

¹ Huber et al.'s (2011) findings indicate that two basic medium-sized categories exist among Pacific salmonids. These include one category that consists of Pink and Sockeye, and another category that consists of Chum, Coho, and Steelhead. For simplicity, both of these medium-sized categories are combined here into a single "Sockeye-sized" or "Medium-sized" category.

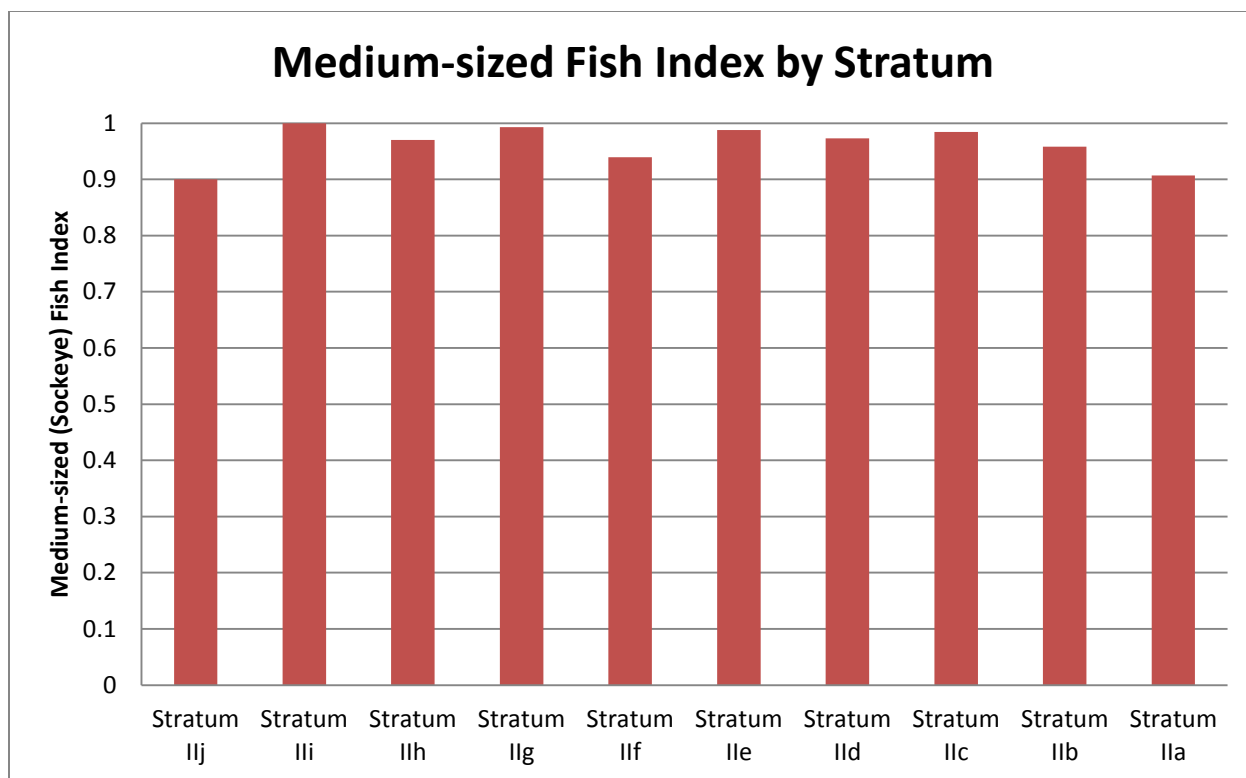


Figure 4.21. Medium-sized Fish Index by Stratum based on Medium-sized Fish Index in Table 4.7.

The mammal index was generated similarly, but with additional categories representing greater variability in terrestrial mammal bone morphology: small-, small- to medium-, medium-, medium- to large-, and large-sized mammals as described in the Methods section detailing the faunal identification process. As with the fish bone assemblage, among the mammal bone specimens bones attributed to animals within two size categories are by far the most common – those belonging to medium- to large-sized animals and those from large-sized animals. Because bones attributed to medium- to large-sized animals is a somewhat indefinite category that invariably includes bones belonging to both medium- and large-bodied animals, I generated a

relative abundance index based solely on large-sized mammals and one inclusive of medium- to large-sized and large-sized mammals. These are (respectively) calculated as:

$$\sum \text{Large-sized Mammals} / \sum (\text{Small} + \text{Small-Medium} + \text{Medium} + \text{Medium-Large} + \text{Large Mammals})$$

(Table 4.8). Likely intrusive rodent bone specimens ($n < 5$) not included.

and

$$\sum \text{Med-Lrg} + \text{Lrg-sized Mammals} / \sum (\text{Small} + \text{Small-Medium} + \text{Medium} + \text{Medium-Large} + \text{Large Mammals})$$

(Table 4.9 and Figure 4.21)

Large Mammal Index			
Strata	All Mammals NISP	Large Mammal NISP	Large Mammal Index
Stratum IIa	967	187	0.193381593
Stratum IIb	653	219	0.335375191
Stratum IIc	570	350	0.614035088
Stratum IId	238	71	0.298319328
Stratum IIe	306	76	0.248366013
Stratum II f	533	179	0.335834897
Stratum IIg	259	96	0.370656371
Stratum IIh	73	25	0.342465753
Stratum IIi	63	17	0.26984127
Stratum IIj	79	14	0.17721519

Table 4.8. Large-sized Mammal Index.

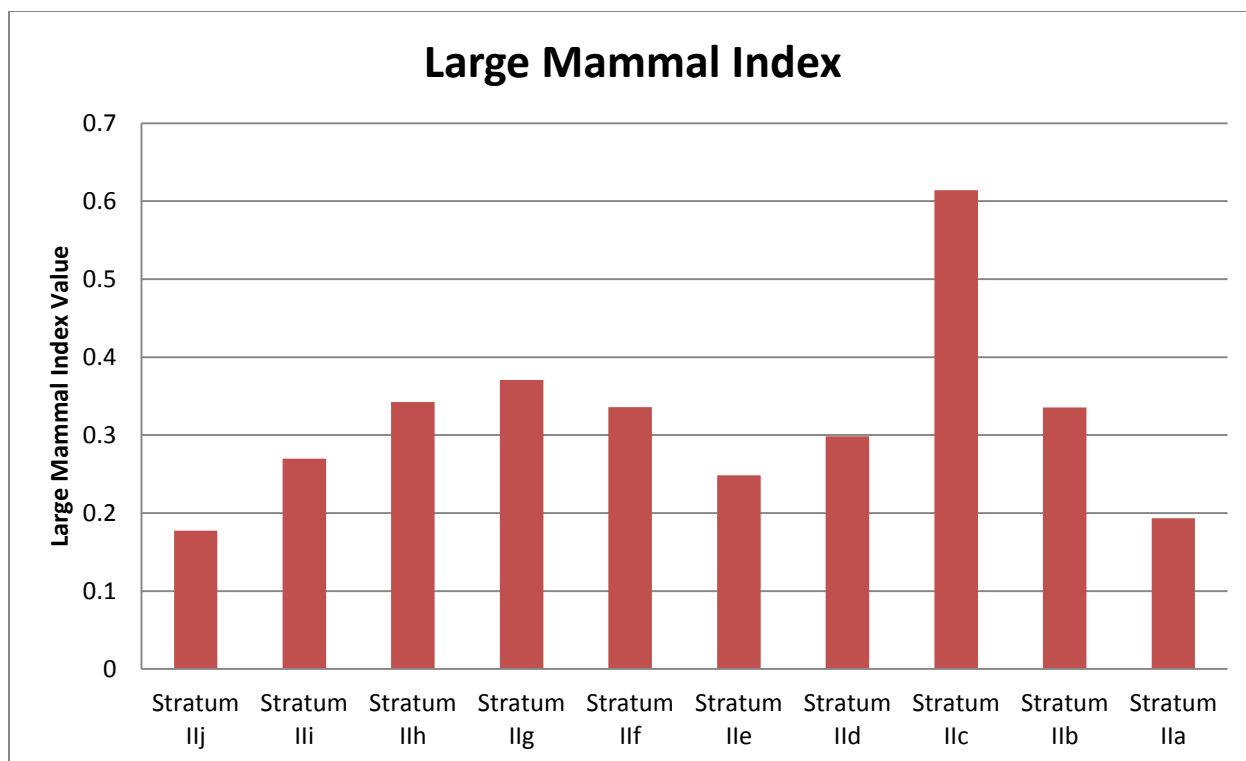


Figure 4.22. Large Mammal Index by Stratum based on results in Table 4.8.

Med-Large Mammal Index			
Strata	All Mammals NISP	Med-Large Mammal NISP	Med-Large Mammal Index
Stratum IIa	967	910	0.941054809
Stratum IIb	653	548	0.839203675
Stratum IIc	570	483	0.847368421
Stratum IId	238	118	0.495798319
Stratum IIe	306	247	0.807189542
Stratum II f	533	473	0.887429644
Stratum IIg	259	226	0.872586873
Stratum IIh	73	58	0.794520548
Stratum Ili	63	29	0.46031746
Stratum IIj	79	70	0.886075949

Table 4.9. Medium- to Large- and Large-sized Mammal Index.

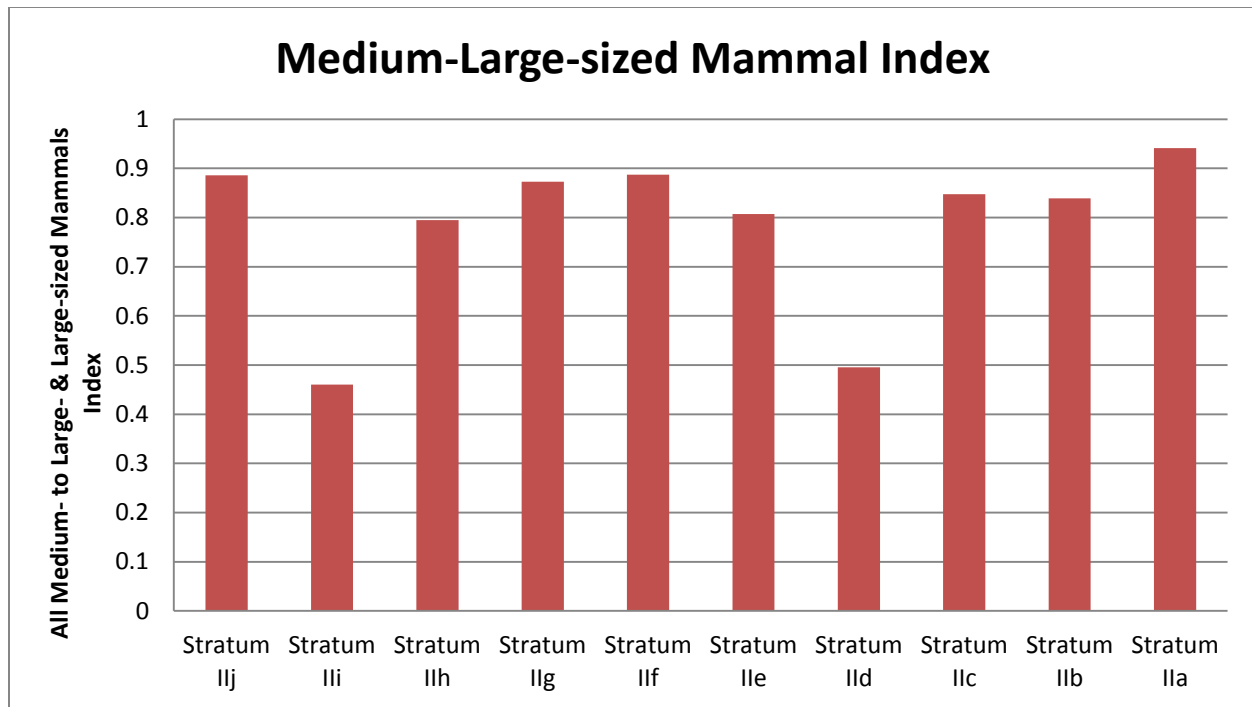


Figure 4.23. Medium- to Large- *and* Large-sized Mammal Index based on results in Table 4.9.

The results of these various indices offer a number of conclusions about size-based taxonomic variability within the assemblage. First, clearly “Medium” or “Sockeye-sized” salmon dominate the fish bone assemblage across all strata (Table 4.7). Second, Medium- to Large- and Large-sized mammals dominates much of the mammal bone assemblage, even though much of that assemblage cannot be positively identified beyond size category. Strata Ili and IId both show greater size variability in terrestrial faunas, Ili exhibiting a higher amount of unidentifiable bone from medium-sized mammals, and IId having a greater amount of bone attributed to small- to medium-sized mammals. Nevertheless, the overall trend is one in which a significant amount of bone can be attributed to larger terrestrial mammals, suggesting that hunting (of whatever large-bodied species) was a common undertaking and played a substantial role in subsistence practice at Housepit 54.

With this in mind, what can be said of the relative abundances between the two most basic taxonomic categories of subsistence resources represented within the pithouse? At the most general level, diet at Housepit 54 can be observed to have consisted primarily of terrestrial animals and fish (notwithstanding a considerable contribution from wild plants, berries, and geophytes that is beyond the scope of this analysis). Thus, a floor-by-floor Mammal/Fish index for terrestrial mammals vs. fish was calculated (Table 4.10).

Mammal Index by Stratum			
Strata	Fish NISP	Mammals NISP	Mammal Index
Stratum IIa	1055	1260	0.544276458
Stratum IIb	1880	721	0.277201077
Stratum IIc	478	604	0.558225508
Stratum IId	235	278	0.541910331
Stratum IIf	272	306	0.529411765
Stratum IIg	488	542	0.526213592
Stratum IIh	149	375	0.715648855
Stratum IIi	134	120	0.472440945
Stratum IIj	114	75	0.396825397
Stratum IIk	71	84	0.541935484

Table 4.10. Mammal/Fish Relative Abundance Index.

Charted out, these results illustrate variability in the amounts of terrestrial mammals vs. fish consumed at Housepit 54 over time and show a far more complex relationship between terrestrial and marine resource contributions to the diet (Figure 4.24).

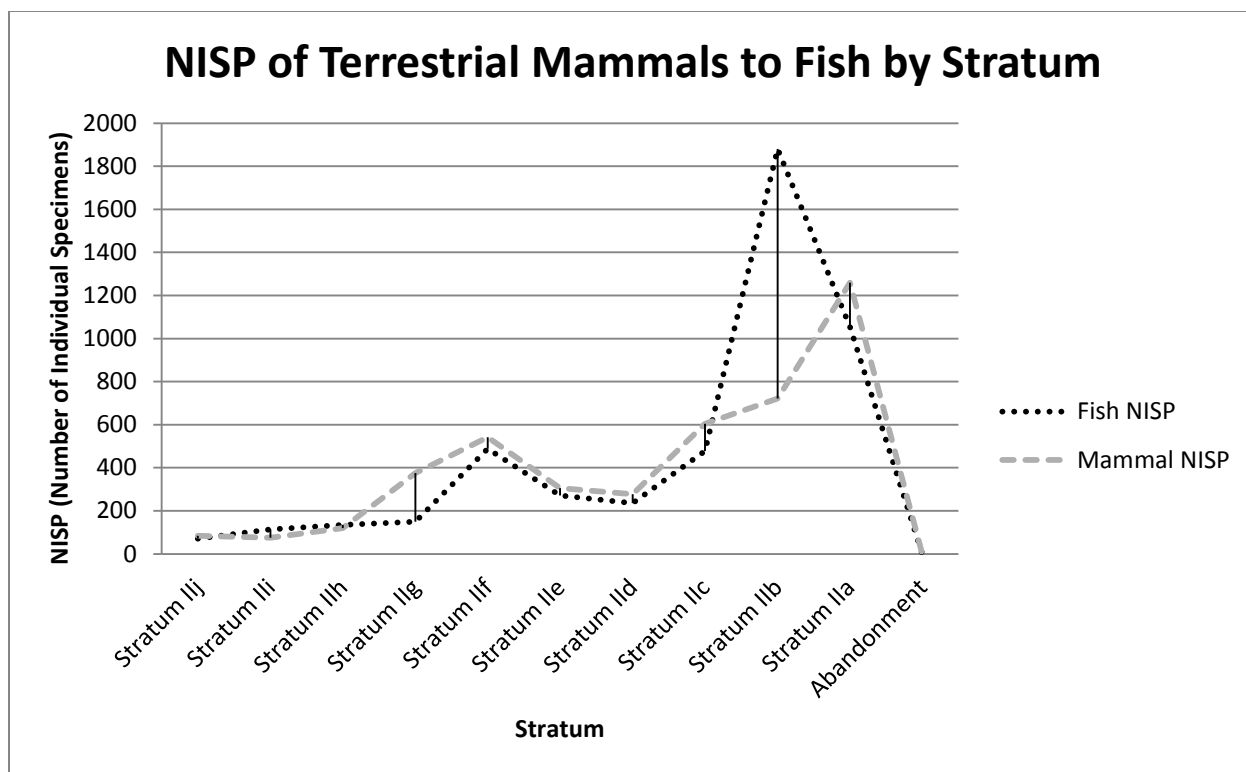


Figure 4.24. NISP of Terrestrial Mammals to Fish, from the data presented in Table 4.10.

At this most general of taxonomic levels the relative mammal index indicates that the portion of animal proteins consumed at Housepit 54 consisted of, on average, about 50% terrestrial mammals and 50% fish (Avg. of the above Mammal/Fish Index = 0.51 or 51%), considerably different than if we look solely at specimens positively identifiable to genera/species. Overall, this represents a balanced contribution between terrestrial animals and fish. Clearly, the relative contributions fluctuated, as is also clear from the Mammal/Fish Index. As this includes fragmentary mammal bone specimens, it may indicate simply a greater degree of bone processing taking place during IIe and IIb-IIa resulting in higher counts of fragmented bone. A summary of subsistence trends based on the Mammal/Fish Index may be considered as follows: house occupations during IIj utilized both fish and deer seemingly in equal proportions.

During IIIi fish became more prevalent but not drastically so. During IIIh the diet once again evened-out to a relatively equal distribution between mammals and fish. During IIg terrestrial mammals became prevalent and, as we have seen from the distribution of identified elements from this occupation period, high-utility appendicular elements were commonly brought into the pithouse, suggesting the transport of these valuable parts from outside the immediate local vicinity, possibly in response to local resource depression (Broughton 1994b). During IIf the dietary ratio again appears to even-out even as overall numbers of animal remains increases fairly dramatically, suggesting a notable increase in the amounts of animals brought into the house; this provides for the possibility that during this stratum the household itself increased in number, necessitating the acquisition of greater numbers of animals, both mammal and fish. During IIe the overall numbers of animal remains decreases from that of the previous IIf occupation but nevertheless remains significantly higher than those of the early- and mid-BR2 strata. Interestingly, the difference in the Mammal/Fish ratio between IIf and IIe is only 0.003 despite a considerable difference in overall NISP numbers – strongly suggesting that the subsistence strategy in place during the BR2-BR3 transition was extremely consistent. This presents the possibility that the transition occurred during a time of developing social cohesion, or at least of increasing persistence in subsistence practices from one incarnation of the house structure to another. Faunal remains from strata IId and IIc continue the trend of increased remains overall (both double) and slightly greater frequency of mammal remains to those of fish. However, the relative abundance of mammals to fish remains close to 50-50, showing the clear importance of both resources to the local diet during these periods. During IIb - the penultimate occupation stratum – mammal bone frequencies continue to increase but evidence of fish remains skyrocket to nearly 400% that of the previous stratum. Since relative numbers of faunal

remains are a direct indicator of a community's most basic dietary needs (Reitz and Wing 2008: 6), an increase of such magnitude suggests that population densities, at the pithouse level at least, increased dramatically during the later occupations of BR3, likely fully realized during the occupations of the Stratum IIb floor. Coupled with the element distribution data presented earlier (Figure 4.11) that suggest that both high- and low-utility parts of artiodactyls were once again being transported into the pithouse, the picture of IIb subsistence practices is one in which large amounts of mammals and relatively vast amounts of fish were required to meet the overwintering needs of pithouse occupants. Also, fragmentation of mammal bone intensified during this time, resulting in an increase in fragmentary specimens and a decrease in overall fragment size – both suggesting greater degrees of bone processing. At this time fish came to dominate the dietary protein consumed within the housepit, eclipsing mammal by nearly 3 times. This fairly sudden and extreme reliance on fish suggests a major event for life at Housepit 54 and likely the entire village. Given that mammal remains also continue to rise in frequency this event does not appear to represent any significant catastrophe within local biotic regimes, but instead appears to be a simple matter of increasing numbers due to increasing needs, but to what exact degree is unknown. As the size of the pithouse did not change during this time, this dramatic increase in food production also suggests the possibility of population packing. It is at this time that residents of the village likely had to struggle to keep up with growing economic demands. A striking contrast occurs between the IIb and IIa strata. While overall numbers of both mammals and fish continue to be present well beyond those of all earlier strata, fish remains drop by nearly half and mammal remains nearly double between IIb and IIa. Due to this reversal in relative abundances, mammal and fish come close to evening-out during IIa although the NISP for each is greater than at any other incarnation of the pithouse (apart from the greater

numbers of fish remains in IIb from IIa). As in IIb, artiodactyl element distributions during IIa suggest that complete or nearly complete animals were being brought into the pithouse *and* that the bones of large-sized mammals were being left on the occupation floor at greater frequency than any other time in the history of the house – assumably due to increased amounts of meat being brought in. We know that the village was abandoned after this occupation, sometime around 1100 BP (Prentiss et al. 2012; Prentiss and Kuijt 2012), so it is conceivable that this pattern is indicative of some causal factor(s) leading to village abandonment. The apparent decline in fish and increase in mammals, considered with the relatively high amounts of remains from both during this final occupation suggest that a fish-specialized subsistence strategy undertaken during IIb was not enough to support the growing population. To cope with this one of two strategies can be interpreted from the data – either a subsistence strategy equally dependent on both terrestrial and marine resources was re-established, or intensification of large-mammal bone processing increased - but ultimately neither could support the increased population extant at the village toward the end of BR3 and village cohesion broke down (further data will be necessary to determine which strategy was introduced). In addition, comparative failure of the local fishery during such a critical state of population growth may have necessitated the intensified processing of large game observed leading up to abandonment.

Measuring Pithouse Demography through Proxy Data

Modeling housepit demographics is accomplished in two ways in this research. The first is a bottom-up approach intended to provide a basis for understanding housepit population demographics based on available pithouse space. The second is a top-down approach that looks

at archaeological material frequencies as proxies for relative household densities from each occupation stratum – assuming that greater densities of certain materials – fish and mammal bones, FCR, lithic debitage, and certain features – accumulate in greater numbers as the number of people cohabitating in the pithouse increased.

To really understand the relationship between the Housepit 54 household(s) and their resource base it must first be determined what the base household population may have consisted of. What are the likely population sizes and population demographics at the household level during the periods in question (BR2 and BR3)? At the household level how much labor would have been available in order to meet catchment, preparation, and storage demands? The first demographic model seeks to address these questions.

First, it is useful to observe the general trend of growth within the village as a whole. Harris (2012) developed a cumulative probability distribution derived from all radiocarbon dates acquired at the Bridge River site. Using the Calpal calibration program, this distribution provides a trend in the frequency of radiocarbon dates at the site over time, using radiocarbon dates as a proxy to illustrate overall village demographic growth and decline. Harris' results are given in Figure 4.25.

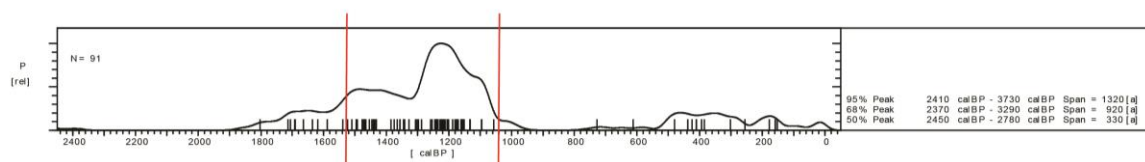


Figure 4.25. Cumulative probability distribution of all radiocarbon dates from the Bridge River winter pithouse village, generated in Calpal (from Harris 2012: 271).

What this distribution suggests for the BR2 and BR3 periods (encapsulated between red lines) is a pattern of growth, virtual equilibrium and then slight decline, followed by substantial growth over a relatively short time, and a subsequent rapid decline prior to the extended desertion of the village after the end of BR3. Harris' proxy data provide a valuable picture of what the general trend of population growth and decline may have looks like at a village scale.

While it is impossible to establish exact numbers of individuals living in a prehistoric pithouse at any one time, it is possible to estimate the likely maximum number of individuals possible in a given space from proxy data. Previous studies have shown house area to be “potentially the most accurate” method for determining prehistoric populations (Casselberry 1974: 120). To establish baseline potential populations (and to estimate the potential workforce), I first determined the maximum available living space available in Housepit 54 based on housepit diameter. To determine possible in-house demographics I applied four separate measures of suggested individual living space requirements based on studies of hunter-gatherers (Casselberry 1974; Chamberlain 2006; Hayden et al. 1996; Naroll 1962; Teit 1906). Naroll (1962) suggested a necessary living space of roughly 5.3m² per person based on ethnographic data from a sample of various indigenous societies. Chamberlain (2006) suggests 2m² floor area per person for some above-ground occupations on the Pacific coast. James Teit (1906) observed that roughly 3m² was allocated per family unit within late Upper Lillooet pithouses. Hayden et al. (1996: 158-159) determined living spaces of 2.8-3.8m² per person for the largest pithouses at nearby Keatley Creek. Hayden's findings were based on the logic that smaller houses could feasibly rely on body heat to maintain warmth and that larger (presumably wealthier) houses

expended more effort keeping warm, by either “procuring warmer clothes, or using more fuel.” Subsequently, Hayden (1997: 47) used Teit’s ethnographic observations and similar proxy data to estimate populations at Keatley Creek. These later findings suggest that an area of 2.5m² per person in larger pithouses, and 2m² per person in smaller houses, best approximated pithouse population densities. Hayden assumed greater population densities for smaller houses (thus less space per person). I infer that the 2.5m² (or 6.25m) per person theorem best complements similar studies of household densities in the Pacific Northwest, and fits well for estimating the household population density of a medium-sized pithouse like Housepit 54. The resulting estimated Bridge River populations based on housepit area (Table 4.11) correspond closely to known ethnographic data for the region (Teit 1906; Kennedy and Bouchard 1978). To simulate conditions of population packing as suggested for smaller houses by Hayden et al. (1996; and Hayden 1997) this study considers both 2.5m² and 2m² per person at a medium pithouse like Housepit 54.

HP	Diameter (m)	Size	Radius (m)	Radius ²	Area (m)	2.5m ²	5.3m ² PP	2m ² PP	3m ² PP
54	12.2	M	6.1	37.21	116.8986	18.7	4.161574	29.225	12.989

Table 4.11. Housepit 54 Size figures and In-house Population Estimates based on Estimated Living Space per Person as determined from ethnographic data.

At Housepit 54 the estimated household size suggests a maximum of 29 individuals and more conservatively between 18-19 individuals. Since the housepit size does not observably change during the period BR2-BR3, the average potential household population remains effectively the same over time, though the household size may have changed dramatically at

times. These numbers closely match results based on demographic proxies used elsewhere: density of fire-cracked rock (FCR) and frequency of hearth clusters, both of which suggest relative population numbers at a household average of around ten individuals (or two families) during BR2 and around 20 individuals (perhaps four families) by BR3 – a scenario illustrating fairly extreme population packing during the BR3 Period (Prentiss et al. 2012; 2014).

Next, I generated percentages for age groups in four year increments using published data from four hunter-gatherer groups: the Northern Ache of Paraguay (Hill and Hurtado 1995), Casiguran Agta of the Philippines (Headland 1989), Eastern Hadza of Tanzania (Blurton Jones et al. 1992), and the Dobe !Kung of Botswana (Howell 1979), all summarized by Chamberlain (2006). Although each of these groups is far removed from this study area, the data here provides a reference point for determining general trends in hunter-gatherer demography. Using these data I generated a hypothetical demographic model of age distributions based on the maximum population possible as suggested above by housepit area (Table 4.11). From this, I determined the potential workforce available for salmon harvesting, assuming a general division of labor based on sex and age where half the household population between the ages of 15 and 49 years old would be actively acquiring fish from the river at any given time. It is assumed that the opposing half of this age range would be actively hauling, cleaning, processing, and drying salmon as they were brought out of the water. Surely, individuals in older and younger age groups participated in the salmon harvest in a number of ways that are not easily quantified. Certainly, during the height of the large spring and summer runs catching and preparing salmon was an activity that made demands on the entire household. In fact, salmon procurement during this pivotal time likely involved the vast majority of the community to varying degrees. Within

the model for Housepit 54, the household consists of ten individuals aged 0-14 years, 15 aged 15-49 years, and four aged 50+ at the 2m² household density. The household workforce would have consisted of between 14 to 16 people. At 2.5m² the household decreases to seven individuals aged 0-14 years, 11 aged 15-49 years, and just three aged 50+. The household workforce would be roughly 11 individuals. As mentioned above, the total household workforce would be divided roughly in two, assuming that half would be processing and drying fish while the other half caught them. Teit (1900, 1906) observed that among the Lillooet most activities were strictly dictated by gender roles. However, when it came to fishing, but both men and women shared the tasks of cleaning and processing salmon, attesting to the cooperation imperative for ensuring that there was adequate food to last out the winter. For non-fish-related food acquisition this same division of labor may be considered standard with the assumption that men were generally responsible for hunting and women were generally responsible for the acquisition of plants, geophytes, and berries – all of which likely had profound impacts on nutritional contributions.

This first line of demographic inquiry has provided a number of points to consider: 1) the likely household population can safely be considered to have been somewhere around 20-24 or so individuals – probably averaging close to 20 or slightly less; 2) at least half of the household would have been in an age range capable of contributing to subsistence; thus 3) acquiring the necessary nutritional needs of the immediate household under favorable conditions may not have been relatively that difficult given adequate hunting/fishing/gathering opportunities. Clearly, the picture provided by this initial bottom-up approach is one of a pithouse household of

around three to four family units (assuming an average family unit of between 5-7 individuals) that could likely have tended to their own subsistence needs given generally free access to do so.

The second means of modelling pithouse demography builds on a model developed by Prentiss et al. (2014). This model assesses household demographics on a relative basis generally unconcerned with actual population numbers but with indicators of overall population variability. In order to gain perspectives on household demographic patterns over time, an assortment of density-related proxy data was looked at. These included: density of salmon remains and mammal remains (respectively) by volume of excavated soils, density of fire-cracked rock (FCR) by volume of excavated soils, and lithic debitage by volume of excavated soils. These values were calculated by dividing the number of specimens of each type by the total volume (m³) of sediments excavated per stratum. The results of these calculations are presented in Table 4.12 and Figure 4.28.

Stratum	Excavated Volume (m ³)	Salmon Density	Terrestrial Mammal Density	FCR Count	FCR Density	Debitage Count*	Lithic Debitage Density*
IIj	0.161	441	521.7	105	652.1739	0	0
IIi	0.297	382.83	252.53	258	868.6868	0	0
IIh	0.375	357.3	320	323	861.3333	0	0
IIg	0.6	248.3	625	623	1038.3333	80	133.3333
IIf	0.7207	677.11	752.04	1229	1705.2865	162	224.7814
IIe	0.7341	370.52	416.83	1399	1905.7349	223	303.7733
IIId	0.8	293.75	347.5	996	1245	194	242.5
IIc	1.004	476.09	601.59	1217	1212.1513	344	342.6294
IIb	0.908	2084.33	969.56	1438	1583.7004	269	296.2555
IIa	1.65	966.069	1243.32	2782	1686.0606	324	196.3636

Table 4.12. Archaeological Material Densities by Excavated Volume by Stratum.

* Zero values for lithic debitage are due to unavailable data, not actual counts.

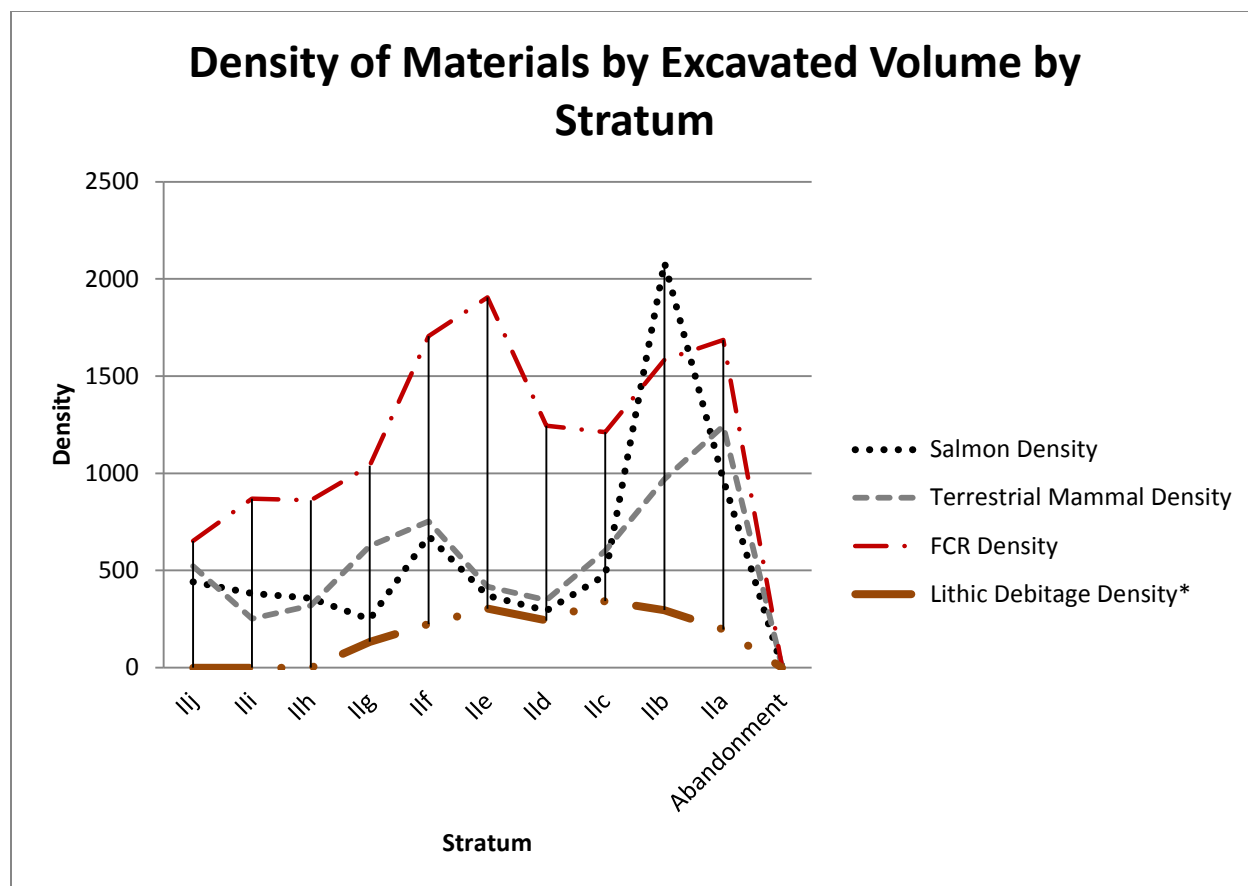


Figure 4.26. Archaeological Material Densities by Excavated Volume by Stratum.

Discussing the utility of density-dependent frequency analysis of archaeological materials Kuhn and Clark (2015: 10) point out that “all other things being equal, the frequency with which artifacts are deposited in sites should reflect the number of person-hours spent at the location.” Working from this logic, greater relative deposition of materials that are directly reflective of subsistence (bones) and those reflective of subsistence-related activities (FCR and debitage) should be valuable indicators of occupational intensity.

Converting the data presented in Table 4.12 to stratum-frequency percentages evens out the degree of variation in the overall numbers while maintaining the relative frequencies of the

proxy materials (Table 4.13 and Figure 4.27). This provides a somewhat clearer illustration of the pattern of fluctuation.

Stratum	% Salmon Density	% Terrestrial Mammal Density	% FCR Density	% Lithic Debitage Density
IIj	7.003002398	8.623040725	5.111697249	0
IIi	6.079273034	4.174001293	6.80871149	0
IIh	5.673861127	5.289195001	6.751075228	0
IIg	3.942960307	10.33045899	8.138389889	7.664434495
IIf	10.75238765	12.4302694	13.36592634	12.9211706
IIe	5.883792401	6.889672351	14.93702806	17.46188356
IId	4.66469831	5.743735196	9.758230244	13.93969372
IIc	7.560225424	9.943521315	9.500764238	19.69545937
IIb	33.09879363	16.0255997	12.41294228	17.02973581
IIa	15.34100572	20.55050603	13.21523497	11.28762244

Table 4.13. Relative Percentages of Demographic Proxy Data from Table 4.12.

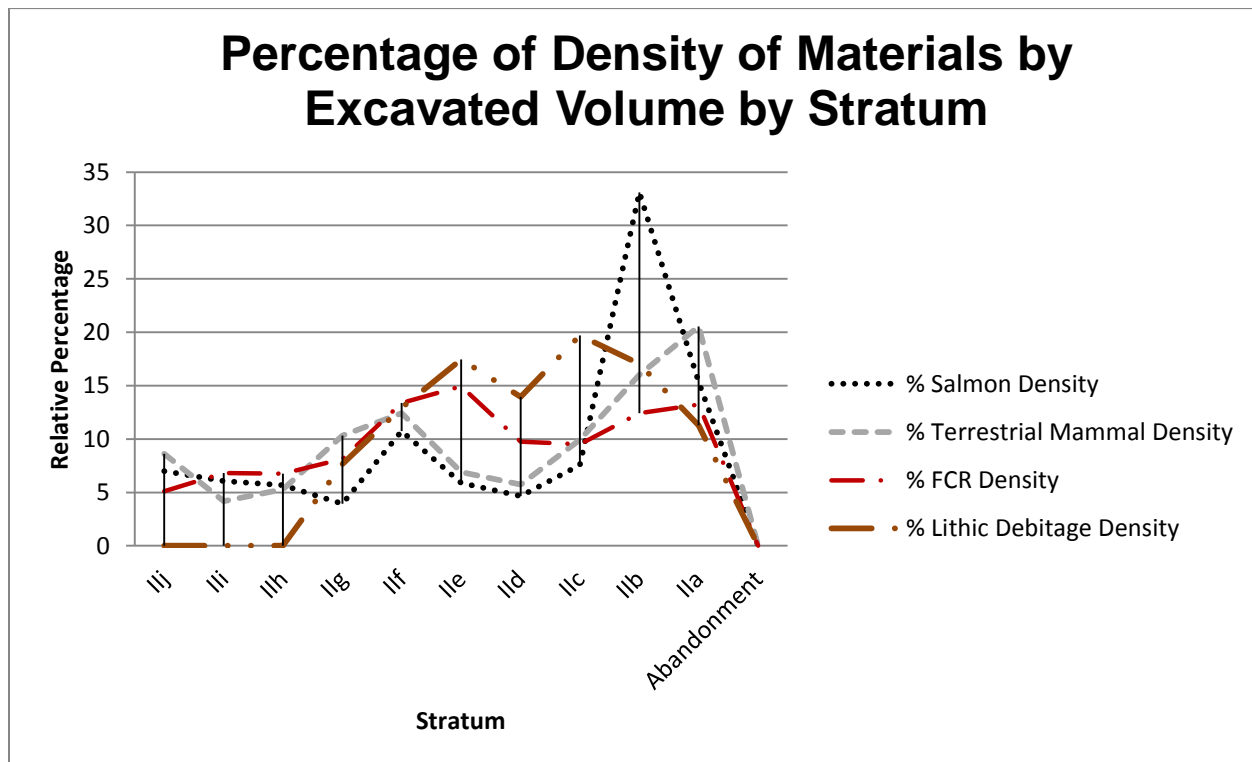


Figure 4.27. Data From Table 4.13 Converted to Relative Percentage.

As proxy data for determining relative pithouse demographics, faunal remains, FCR, and lithic debitage are all well-suited because each is indicative of greater or lesser human activity within the limited confines of the housepit. These trends also closely match those suggested by Harris' (2012) probability distribution using radiocarbon dates as proxy data for village demographic change. While the numerical value of each proxy varies – the relationship over time between proxies is interesting. What emerges is a picture of fluctuating demographic indicators within the Housepit 54 over time that suggests periods of household growth, equilibrium, decline, and (at II_f and partially at II_a) signs that as food resources decline, debitage and FCR appear to overshoot – indicating that although relative food levels appear to crash, population indicators concurrently persist, only to mirror the resource declines later.

The earliest BR2 occupations (II_j-II_i) show somewhat conflicting results that are likely the result of limited sample sizes to date – further excavation will certainly make this pattern clearer. What can be observed is that as the density of terrestrial mammals initially decreases it then begins a gradual upturn that will continue thru to the end of BR2; density of salmon bones during this phase stays more-or-less static throughout the earliest incarnations of the house following a gently decreasing trend thru II_h; density of FCR increases and then levels out. As it becomes available, expanded data, including lithic debitage counts will further inform these results.

During II_h all the proxies see an increase, except density of salmon remains, but this very slight increase in material density is not likely indicative of a significant growth event within the

household. Instead, these insignificant variations in proxy materials probably indicate a period of household equilibrium across these early incarnations of the house. Introduction of lithic debitage data may considerably alter this interpretation.

During the deposition of Stratum IIg all proxy data experience significant increases – likely representing the first major growth event within the population of the pithouse. Density of terrestrial mammals continues to gently increase during this time while the relative density of salmon remains nearly triples and FCR and lithic debitage densities both double from that of the previous stratum.

From IIg to IIe (the BR2-BR3 transition) the proxy data implies a period of demographic growth that ends sometime within or between IIe-IIId. Element distribution data suggests that ungulates were locally available during IIg-IIf and that there was a decline in local artiodactyl populations during IIe-IIId – both trends that are supported by the demographic proxy data.

FCR and lithic debitage densities suggest a period of demographic equilibrium during IIId thru IIc. The transition from IIc to IIb appears dramatic and proxy data suggests that during IIb there was a major increase in fish acquisition, a significant rise in terrestrial mammal hunting and FCR generation – implying more cooking activities.

The IIa fauna data suggests a dramatic decline in fish numbers but a consistently increasing density of mammal bone before village abandonment. Following the overshoot trend seen after the IIc faunal declines, where a delayed decline in FCR and lithic debitage are not

evident until IIe. Similarly, after IIa all materials cease as the pithouse was abandoned following the razing of the Va roof over the final floor of BR3.

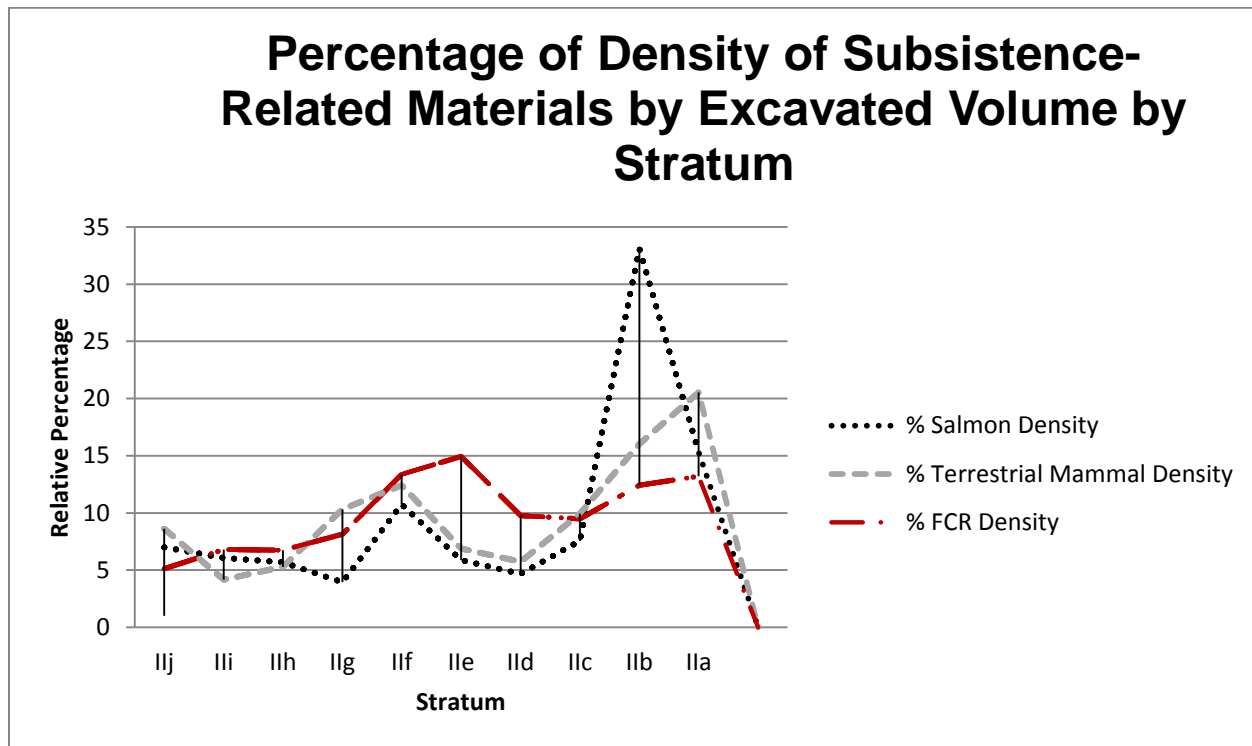


Figure 4.28. Percentage of Subsistence-Related Materials. Note the Extrapolation of the BR3 abandonment Following IIa.

If we divide out only subsistence-activity proxies (Figure 4.28) we see an interesting pattern thru time. These proxies indicate a distinct increase in subsistence activity beginning gradually in IIh and increasing between IIg and IIf. At IIf these practices reach an apex and relative animal bone frequencies plummet during IIe and into IId. Relative FCR density overshoots the animal bone declines but appears to follow close behind. This matches a Malthusian Crisis scenario occurring at the end of BR2 in which food acquisition declined but cooking practices continued unabated for a while because there were still many mouths to feed.

As the population felt the deleterious effects of the resource shortfalls, population would decrease, requiring less cooking, which would require less boiling, which would produce less FCR. Although the above graphs all end at Stratum IIa we must consider that at the drastic end of BR3 abandonment event this pattern should actually look like Figure 4.28, illustrating a complete absence of archaeological materials following IIa.

In order to get a similar final picture for household demographics I calculated two additional proxies to supplement the lithic debitage density measure – percentage of hearths per stratum and percentage of cache pit volume by volume excavated (Table 4.14 and Figure 4.29). Based on these results we can infer that household demographics fluctuated over time. Despite considerable stochasticity, cache pit volume shows an overall decrease over time while hearth density remains relatively even and lithic debitage increases slightly. These results suggest a number of possibilities: 1) maintenance of hearth features and increasing debitage indicate a general trend of population growth over time; 2) variation in the frequency of cache pits may indicate more or less storage during some occupations or that alternative storage methods were being used. Taken together these proxies suggest relatively increased population densities during IIg, IIe, and IIb.

Stratum	% Lithic Debitage Density	% Hearth Density	% Cache Pit Density
IIj	0	8.108108108	2.60690281
IIi	0	2.702702703	1.326820877
IIh	0	13.51351351	31.33252624
IIg	7.664434495	16.21621622	23.4240322
IIIf	12.9211706	8.108108108	11.96920403
IIe	17.46188356	13.51351351	27.01439528
IId	13.93969372	2.702702703	0
IIc	19.69545937	8.108108108	2.066272424
IIb	17.02973581	10.81081081	11.98317147
IIa	11.28762244	16.21621622	0.234335521

Table 4.14. Percentages of Additional Demographic Proxies by Stratum.

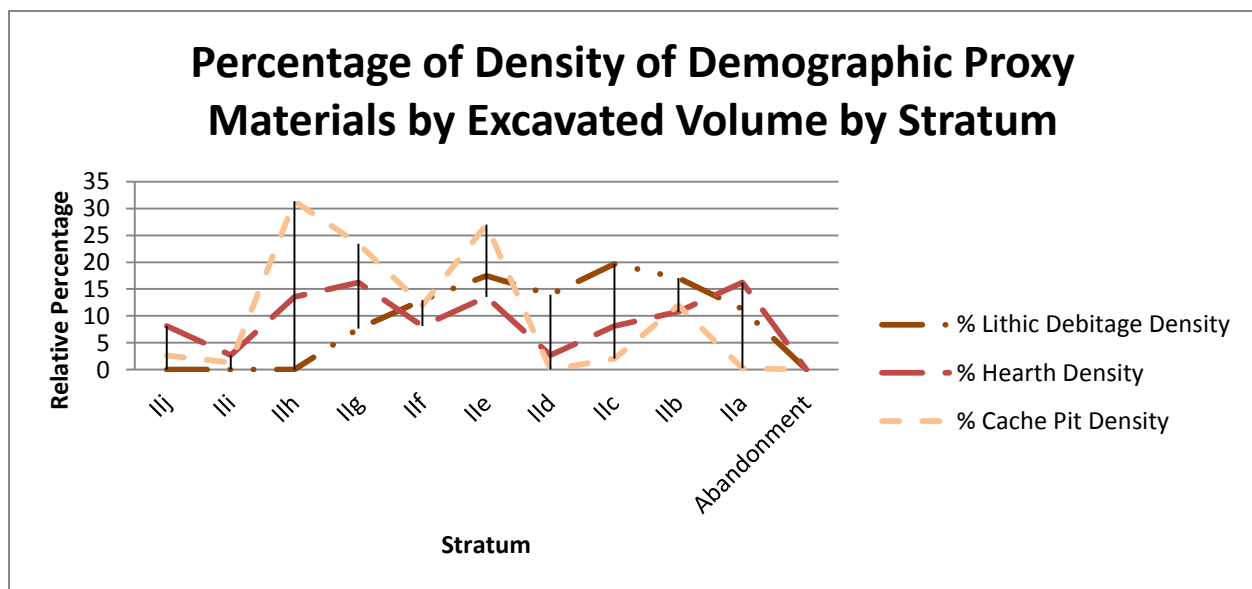


Figure 4.29. Additional Demographic Proxies by Stratum. Note the Extrapolation of the BR3 abandonment Following IIa.

Finally, I developed a dataset of the average of the three subsistence-related proxies and the average of the three demographics-related proxies (Table 4.15 and Figure 4.30).

Stratum	Demographics-Related	Subsistence-Related
IIj	3.571670306	6.912580124
IIi	1.343174526	5.687328605
IIh	14.94867992	5.904710452
IIg	15.76822764	7.470603061
IIf	10.99949425	12.18286113
IIe	19.32993079	9.236830938
IId	5.547465475	6.72222125
IIc	9.9566133	9.001503659
IIb	13.2745727	20.5124452
IIa	9.24605806	16.36891557

Table 4.15. Averages of Subsistence- and Demographics-Related Proxies over Time.

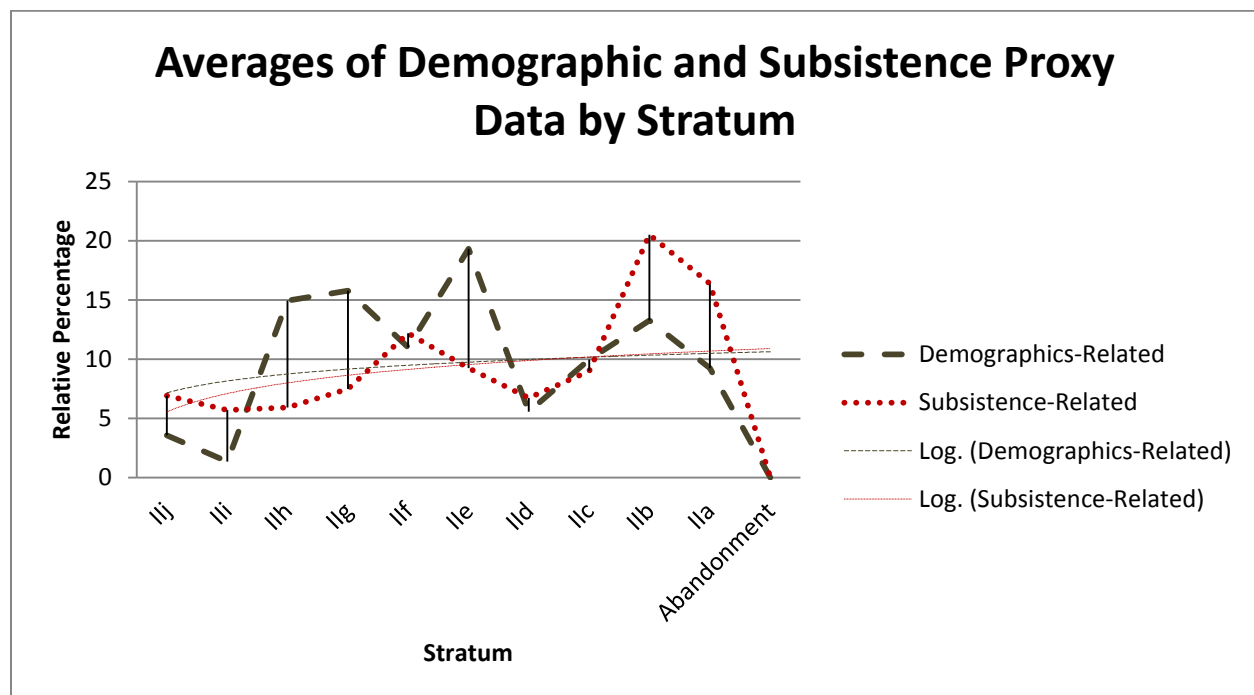


Figure 4.30. Average Demographics and Subsistence Proxies over Time.

This final heuristic analysis shows a scenario in which relative abundances of food resources rise and fall as do demographics. However, a logarithmic trend line shows slight increases in both over time.

Demographic proxy data based on the densities of various subsistence- and activity-related materials suggests two phases of village growth and decline – one during the BR2-BR3 transition from IIf to IIe that pithouse occupants obviously weathered, and another during the later occupations of BR3 that appears to have been accompanied by a massive increase in both marine and terrestrial mammal intake during the final two occupation floors. This final growth period was followed by the abandonment of both the pithouse and ultimately the entire village.

SUMMARY

Evidently, the relationships between animal classes represented in the faunal assemblage from Housepit 54 are complex. Stratum by stratum analyses of the faunal remains show an assemblage that is highly variable in numbers and diversity of specimens but is also observably patterned. Examined from the logic of the General Field Processing Model of Optimal Foraging Theory, changes in element distributions by stratum display a pattern of ungulate predation that is suggestive of possible local resource declines as village size increased over time and hunters were forced to seek artiodactyls at greater distances. The degree of mammal bone fragmentation shows an assemblage that has been almost entirely processed down into exceedingly small constituent pieces. Similar widespread breaking-down of mammal bones is often associated with marrow and bone grease extraction, both of which are intensive strategies for nutrient extraction from bones. The slight but observable increase in bone fragmentation from early BR2 to increasing degrees during later occupations may indicate a response to persistent resource stress, but may also be evidence of a continuous tradition of bone processing passed from generation to

generation. Analysis of taxonomic richness among the Housepit 54 faunal assemblage elucidates a fairly static system of predation indicative of a generally narrow- to mid-ranged diet-breadth that was occasionally widened by the inclusion of non-ubiquitous salmon (e.g. rainbow trout and Chinook salmon as opposed to Sockeye) and medium mammals such as dog and beaver, and the infrequent grouse-sized bird. Assessment of taxonomic diversity in the Housepit 54 faunas indicates a relatively homogenous set of taxa utilized despite a theoretically wide-range of prey available (see references in the Background Chapter). The Jaccard and Sorensen Indexes used to assess assemblage composition both suggest some degree of continuity between some adjacent house floors. Whether either is indicative of genuine continuity of traditions or is rather based on limited sampling or the above-mentioned limited heterogeneity of the assemblage is difficult to determine. Finally, relative abundance indices provide means of examining relationships between key resources over time. These results offer considerable analytical merit that suggests that, at the level of species-specific NISP dietary variability within the pithouse would seem remarkably fish-centric. However, when viewed from a broader perspective based on relative size categories it appears likely that diet was far more complex and much more inclusive of both terrestrial and marine resources than previously thought. For example, as populations within the village and the pithouse rose during the BR2-BR3 transition and during the final phase of BR3, processing of mammal bone, while practiced previously to a considerable degree, was further exaggerated – possibly as a means of coping with increased food stresses during times of population packing and/or resource scarcity. Finally, while we can estimate possible pithouse demographics, proxy data indicate patterns of change in pithouse demographics that regularly show activity-related materials (FCR and lithic debitage) following upturns in densities of subsistence resources. This same pattern is inversely mirrored by declines in activity-related

materials following after resource materials experience shortfalls, but delay. Such delays are likely indicators that existing populations persisted during resource shortfalls but felt their effects shortly after.

CHAPTER FIVE

DISCUSSION AND CONCLUSION

The goal of this research has been to examine patterns of subsistence and demographic change within a single pithouse that was re-occupied consistently for a period of roughly 250 years, circa 1400 cal. BP to 1150 cal. BP. During that time frame, no less than ten separate occupation floors were lived on by multiple generations of people practicing a complex collector subsistence strategy. From generation to generation people living in the pithouse that would become Housepit 54 left material remains that would reflect their daily activities, most frequently the remains of animals commonly brought into the pithouse as food. Multiple generations lived together within the pithouse. It is easy to imagine that many individuals were probably members of the household across multiple adjacent occupation floors. The stratigraphic layers examined here form a sequence of floors whose use-life ranged from about 20-25 years of perennial occupation. At times, the end of one occupation and the beginning of another was punctuated by the razing of the old house roof and the rebuilding of the semi-subterranean structure. Many people likely lived out their entire lives as members of the Housepit 54 household, and this is evident in the observation that between occupation strata there appear to be activity areas that persist from one incarnation of the house to another, suggesting a memory or shared logic relating to specific activities undertaken within the house. At times overall patterns in the archaeological materials deposited suggest that living conditions were good and conducive to household and village growth, other times were not so productive and not so forgiving.

This research tests the hypothesis that growth (at least at the pithouse scale) increased over time to a point at which the food demands of the population, when extrapolated to the village scale, exceeded local carrying capacity. Signs of intensification, depletion, extensification (widened diet-breadth), and diversification of the food resource base should become evident toward the end of a more-or-less stable period of continued growth. Proxy data should indicate that at some point the household at Housepit 54 experienced short-term periods of growth and decline (stochastic equilibrium) followed by a period of rapid growth. Populations developing during this period of rapid growth could not be supported – even with increased production of resources and especially if resources could not be produced to meet increased needs. Eventually, the village reached a Malthusian Ceiling scenario during which the household (and presumably the entire village) experienced declines in population as the village system unraveled.

Under the Malthusian dynamics model, it must first be established that population growth is observable at the pithouse scale. All the proxy data examined show marked increases during a number of occupation floors. These data suggest that the village experienced not just one, but at least two events of growth – one toward the end of BR2 and another toward the end of BR3 (which was likely just a recovery to similar household population levels that had been reached during IIe just prior to the initial Malthusian event). While more complex than expected, the evidence points to successive growth events at the pithouse scale and presumably at that of the village, as well.

Now that it has been quantitatively established that population growth occurred, the next test of the Malthusian dynamics model involves the expectation that population growth met with an abrupt decline as conditions of growth could not keep up with resource demands as resources declined at the local level. Relative abundances based on %NISP between terrestrial mammals and fish indicate steadily increasing frequencies of subsistence resources in two basic stages, both ending in declines. These occur at the IIf-IIE transition from BR2 to BR3 and again at the IIb-IIa/IIa-Collapse occupations during the final phase of BR3. When examined with the addition of proxy data for subsistence-related activities (FCR and lithic debitage) we see a pattern in which food resources appear to crash from IIf to IIE but cooking and tool manufacture carry on unabated, only to fall off as the effects of resource scarcities became realized. I interpret this as clear evidence of a population over-shoot event wherein a major decline affected the household population but its effects aren't realized for a generation or so. The overall picture of BR2 is one of a copial phase during the earliest occupations (IIj-IIg) that climaxed during IIf; a short-lived transitional phase between IIf and IIE, and an extended Malthusian phase into IID. Demographic proxy data (lithic debitage, hearth density, and cache pit density) show fairly dramatic declines during IID as well. After IID conditions improved, the pithouse population experienced another copial phase thru IIb, followed by a transitional phase from IIb-IIa where conditions once again became sub-optimal (the Malthusian Ceiling was about to be fully realized). It seems likely that the entire occupation period represented by Stratum IIa was in the midst of a full-blown Malthusian phase coupled with (and perhaps heralded by) declines in fish acquisition. Additionally, when we look at the percentage densities of lithic debitage between IIc-IIa and particularly between IIb and IIa, although the relative frequencies of terrestrial mammal remains and FCR continued to rise, tool production declined. This may illustrate the

loss of inter-generational tool-making knowledge that could potentially result from a loss of knowledge-bearing elders as the most vulnerable age groups bore the brunt of increased mortality felt during the Malthusian phase leading up to village abandonment (p.77).

As with the preceding test expectation, proxy data indicate a relatively rapid decline following the population over-shoot at the end of BR2 and of course the massive decline at abandonment after IIa. Again, these suggest that the pithouse experienced not one, but two events of significant growth and subsequent decline. Again - more complex than expected - the evidence points to successive growth and decline events at the pithouse scale, both apparently following resource shortfalls.

Next, I proposed that as conditions became sub-optimal, villagers would have had to respond quickly, drawing on diverse local resources whenever encountered. Evidence of variability in foraging behavior should be expected, ranging from salmon and deer specialization during optimal periods and more diversified range of prey choices during sub-optimal intervals. I assess this expectation in two ways. First, the taxonomic richness results indicate that species richness nearly doubled toward the end of BR2 but then remained relatively static across later occupations. The taxonomic richness observed across strata after the BR2 apex and throughout BR3 indicates a relatively stable diet-breadth that was not limited to fish and ungulates but was certainly dominated by them. Assuming that a wide variety of animals could potentially be acquired in the region but appear to have not been included in the general diet, this may be the result of emerging specialization and reliance on salmon and artiodactyls, but may also indicate

the persistence of knowledge and practice between reoccupations of the pithouse over succeeding generations, suggesting generational continuity between occupations.

Second, the Shannon-Wiener Index suggests that the genera/species represented in the faunal assemblage do become more diverse over time, but the taxonomic richness test results suggest that the Housepit 54 household did not utilize a remarkably diverse array of dietary options. Thus, sample size is likely the prime mover in the Shannon-Wiener Heterogeneity Index supporting increased overall diversity. The Jaccard and Sorensen indices also suggest that assemblage-wide, taxonomic composition is rather homogenous. Overall, these results do not provide evidence of widening diet breadth over time within the pithouse. In fact, taxonomic richness and diversity drop during occupations occurring in Stratum IIe just after the transition from BR2 to BR3 when the village began experiencing the initial growth that marks the beginning of the BR3 period. Taxonomic richness does go up and levels out in the following occupations, indicating that sample size and the generally-low diversity in the assemblage overall is likely the result of the IIe anomaly and overall the assemblage diversity after mid-BR2 remained relatively homogenous and centered around salmon and medium/large- and large-sized ungulates.

The next test expectation proposed that intensive processing of animal remains should have occurred specifically at times of greatest potential for food stress. All else being equal, food stress should have been at its greatest during times when the village population was highest – with more mouths to feed, the greater potential for food shortfalls and a need for greater degrees of processing. Lesser-utility parts of salmon should become more common and mammal

bone destruction should increase throughout the assemblage during times of population growth. In the mammal bone assemblage, intensive fragmentation is the rule rather than the exception throughout. One pattern that emerges is an increase in the frequency of the smallest bone fragments categories during IIg-IIf and again during IIc-IIa – both occupation sequences that appear to have relatively greater population levels than immediately previous periods. This, at least in part, supports that fragmentation occurred at a greater rate during strata that appear to have elevated populations. However, since the degree of fragmentation is extreme in all strata, it appears most likely that excessive fragmentation of medium- and large-sized mammal bones was the norm, not the exception.

The frequency of Sockeye head sections mirrors this rise towards population increase during both BR2 and again toward the apex of BR3 (Table 4.2 and Figure 4.3). I interpret this as suggesting that the thoracic section was generally the most valuable section regardless of conditions given its high meat to bone ratio and that there was a greater need for the production of high-energy fats during times of greater population densities. Contrary to test expectations, the presence of combined pre-caudal and tail sections tends to remain relatively low throughout the assemblage over time, but especially low during IIg, IIc, and IIa. These strata also exhibit the greatest %NISP of fish heads. This may be an indicator that high-fat heads were favored against low-utility tails and lower body sections with less nutritional potential (see Hoffman et al. 2000; Prentiss et al. 2013). While this goes against the initial test expectations, upon further assessment of the value of fish heads these results may indicate a logical intensification solution during times of greater pithouse population developing, but they may also be the result of a sampling bias based on differential preservation of different fish parts. Both possibilities are

plausible and further analysis is needed to shed light on the subject (Lubinski 1996). A further consideration is that the increased frequency of fish heads during this late phase of village development may be evidence of feasting activities occurring during population peak or growth periods. Further consideration of this possibility will benefit from more comprehensive data collection to further compare salmon head frequencies between earlier and later occupations.

The final test of the Malthusian intensification model expects that if high-ranked resources were comparatively common during certain occupations, then extensive field butchery, long distance transport, storage of marginal portions, and intensive bone processing should not have been necessary. But, if resource declines occurred due (presumably) to population growth-inspired over hunting of local prey, the above evidence for declines should only be evident during the final portion of the Malthusian Phase, as the relationship between population and available resources approached beyond carrying capacity toward the Malthusian Ceiling.

So, is there evidence for extensive or differential butchery, transport of high-utility animal parts, storage of marginal portions, and/or extensive bone fragmentation at greater rates during the end periods of BR2 or BR3, at which times it appears that population had significantly increased relative to previous occupations? As we have seen, skeletal parts frequencies appear to change at the IIg-IIf interface as high-utility appendicular elements of ungulates became more common. From the assumptions of the Central Place Foraging Model, this may be an indicator to local resource declines forcing hunters to travel farther afield and to bring back only the most valuable parts of larger animals. However, in both strata axial elements (i.e. mandible, pelvic, and vertebra) are still represented, so perhaps hunters were just beginning to feel pressures to

move farther in search of some but not all prey. In contrast, strata IIe and IId evince a stark difference in skeletal elements represented, suggesting extensive field butchery and long distance transport of artiodactyl limbs, almost exclusively. Interestingly, strata IIc-IIa return to a pattern that suggests whole animals being brought back to the pithouse - especially during IIb and IIa prior to village abandonment.

Artiodactyl skeletal element distributions suggest that toward the end of BR2 and during the earliest occupations of BR3 hunters were acquiring ungulate prey at distances greater than during previous times, suggesting that local ungulate populations had been stressed during this early growth phase. Toward the end of BR3, as village population is assumed to have been in some degree of decline (as supported by the demographic proxy data), skeletal parts represented show a shift towards whole animals again. This may be the result of local prey populations rebounding as the village population began to decline (which may not show up in the demographic proxy data trend under conditions of overshoot observed during the BR2-BR3 transition as discussed earlier [p. 223]). This may also be the result of hunters still seeking prey at distance, but being forced to transport whole, field-dressed animals back to the pithouse in order to meet food demands. Whichever situation was the case, the current data suggest that prey declined during and immediately following the BR2-BR3 transition and then seem to return to the earlier pattern of presumably whole or mostly-whole carcasses of large-bodied animals being brought into the pithouse.

Storage of marginal portions may be tested with both mammal and fish remains. As mentioned above, low- or marginal-utility parts of mammals increase toward the end of BR3 –

perhaps indicating that hunters were obliged to transport even marginal parts back to the pithouse. Fish parts represented suggest that fish tails were more common during the mid- to late-BR2 (IIh-IIg) phase (and then again during mid-BR3 (IIId), but that fat-rich fish heads were also fairly common (except during IIId). Presence of fish heads increased steadily during mid- to late-BR3, skyrocketing during the last occupation before abandonment. While this evidence does not support the test expectation, this result probably indicates a flaw in the logic of the expectation itself. Greater storage of high-fat fish heads increasing toward the end of the village may equally indicate a process of intensification but the opposite strategy than envisioned in the initial test expectation. While it is not storage or marginal portions, the apparent increasing number of fish heads brought into the house has a similar connotation, namely that low-utility parts were not stored as food stress increased, but that instead high-utility fish parts in fact were stored at a much greater rate.

Finally, bone fragmentation does not notably increase *per se*, given that the practice appears to have been ubiquitous throughout the life of the pithouse. However, the observable trend does suggest that at the end of BR2 (IIg-IIh) and again toward the end of BR3 (IIc-IIa) fragmentation of mammal bones was undertaken to an exceptional degree, with the practice reducing the vast majority of specimens to less than one centimeter in greatest length-width dimension. So, while the extensive processing of mammal bone down into very small parts was a common practice from the earliest occupations of the pithouse, it does appear to have increased during times of assumed food stress.

These multiple tests of Malthusian population dynamics at Housepit 54 provide valuable insights into subsistence and demographic change over time within the wider context of prehistoric winter pithouse village life. Clearly, the proxies analyzed here suggest periods of village growth and decline. The overall trend over time is one of punctuated population growth during the late BR2 – early BR3 periods followed by declines toward the end of BR3. These results are in line with other assessments of growth and decline at the Bridge River village (Harris 2012; Prentiss et al. 2014). Throughout the BR2 and BR3 periods, subsistence practices changed in response to varying conditions, including localized resource declines and increasing pithouse (and assumedly village) demographics. Over multiple generations the household at Housepit 54 underwent demographic changes that closely mirror those that appear to have been occurring at the village scale, making observations from Housepit 54 ideal platforms for inferring village-wide variability.

The Malthusian population dynamics model (Lee 1986; Malthus 1798) suggests that increased access to resources leads to increased population growth. Periods of growth occur (the “copial” phase) during an interval in which human populations and available resources remain either in relative equilibrium or so long as human populations simply remain low enough that they are nowhere near the carrying capacity of the environment. However, growth continues inevitably under conditions where it can occur. As human population increases, it approaches carrying capacity under conditions of assumedly finite available resources. Following the copial phase, the human population enters a transitional phase where food shortfalls (of whatever nature) cause generally less-optimal living conditions. Following this, a population eventually reaches a Malthusian phase (of Malthusian Ceiling) during which accessible resources simply

cannot support the population. Upon reaching the Malthusian Ceiling, population declines (often rapidly and drastically) to once again below carrying capacity. This research has endeavored to find out if such demographic trends can be inferred from archaeological faunal data and proxy data used to determine variation over time in housepit population.

It is my assessment that the above Malthusian population dynamics model describes the changes evident in the archaeological assemblage from Housepit 54 remarkably well. There is an initial period of growth during early- to mid-BR2 followed by an overshoot of the local carrying capacity somewhere around the BR2-BR3 transition (a miniature or quasi-Malthusian Ceiling event) from which the village emerged into a period of stochastic equilibrium. This was followed by a short-lived but massive increase in population during which the local carrying capacity was once again overshot, but from which the inhabitants of the pithouse and the village did not emerge intact and both pithouse and village were subsequently abandoned following a demographic crash.

Various test expectations designed to evaluate the validity of the Malthusian hypothesis alternately falsified and supported the hypothesis. Two test expectations were falsified and three of the five tests failed to falsify the hypothesis. These results may be summarized as follows: 1) evidence supports that expectation that population growth occurred, and can be observed in two basic stages, one during BR2 and another during BR3; 2) significant growth – especially during the final phases of BR3 - was followed by an abrupt decline; 3) the assumption that as conditions became sub-optimal villagers would quickly alter the subsistence strategy and widen diet-breadth is falsified – the diet-breadth remained relatively stable throughout much of the duration of the

pithouse, concentrating on anadromous salmon and medium- to large-sized terrestrial mammals regardless of the availability of other potential protein sources in the surrounding environment; 4) the assumption that salmon and deer should have been intensely processed only during times of resource stress is also falsified, but evidence for the intensification of fish heads (particularly during the final phased of BR3) supports an alternative, unforeseen implication – that high-value, fat-rich resources (such as salmon heads) were cached as A) an emergency response to resource shortfalls under growing population pressure and more mouths to feed, or B) as a feasting commodity during peak/growth periods; and 5) the assumption that resource declines occurred and should be observable in proxy data such as the differential representation and long distance transport of high-value skeletal parts of artiodactyls, as well as the intensive processing of bone for marrow and bone grease in response to increased nutritional needs of a growing human population is supported with the acknowledgment that bone fragmentation was ubiquitous and may not indicate a representative change over time.

CONCLUSION

This dissertation has assessed change over time in subsistence practices and population demographics during an interval of prehistoric occupations of the Bridge River winter pithouse village by observing change over time from the scale of a single pithouse – Housepit 54. Archaeological materials were used as proxy data to track changes between occupation floors spanning the Bridge River 2 and Bridge River 3 periods, predicated on the observation that the village was abandoned at the end of Bridge River 3, circa 1100 B.P.

This study has specifically tested the proposition that changes over time in village growth might follow a pattern suggested by concepts of Malthusian population dynamics, particularly relating to the interdependent relationship between resource stress and population growth.

At Housepit 54, subsistence practices undertaken within the pithouse were dynamic, complex, and changed with, and were changed by, variation in conditions of household and village population. According to all the available data utilized here, the general trend of household development is consistently one in which growth began relatively slowly during the Bridge River 2 period but within perhaps only a few generations population at the village scale appears to have reached a Malthusian equilibrium with available resources. This was followed by an event(s) that triggered notable changes in village and household life (the BR2-BR3 transition). These included a general trend of village growth from under twenty concurrently occupied pithouses to possibly as many as thirty (although both numbers were likely somewhat lower). The village became seemingly organized around two core neighborhoods (one roughly circular in the north and one U-shaped in the south), perhaps partially surrounding plazas used for common activities and communal food storage (Prentiss et al. 2008; Prentiss et al. 2012). Neighborhoods may have sprung up as a result of the development of a clan-based kinship system, and/or as a means of organizing labor for food gathering and storing – developments that may have come about in direct response to lived resource shortfalls by earlier generations. As the BR3 period developed, evidence for wealth-based inequality emerges, particularly in the form of prestige items recovered from newly-founded houses. Outdoor cooking ovens also seem to develop after the BR2-BR3 transition, possibly marking the onset of communal feasting events (Prentiss et al. 2012). It has also been suggested that during BR3 more prestigious

households may have sought to control access to particularly productive fishing rocks along the western shores of the Six-Mile Rapids. Smith (2014) suggests that during the Fur Trade period, access to Chinook salmon (among other “prestige foods”) may be an indicator of access to special fishing rocks, as Chinook tend to swim in deeper channels that should be more difficult to access with dip-nets from less-productive shore features. If this were the case during BR3, presence or absence of Chinook bones may provide insights into socioeconomic disparities emerging within the village at that time. Thus far, among the BR2 and BR3 faunas from Housepit 54, Chinook remains are uncommon. This may indicate that the inhabitants of Housepit 54 did not have great access to productive fishing rocks, or equally as likely, due to their size and fat content, that Chinook salmon were butchered differently and were generally brought into the pithouse off the bone. Nevertheless, control of fishing rocks may have been another condition that emerged as the village grew during BR3 in response to previous resources stresses felt during the Malthusian equilibrium phase experienced at the end of BR2 and into BR3. Prentiss et al. (2012; 2014) suggest that emerging inequality during BR3 was a major development of this final phase of the village and that access to high-ranked (high-utility) food resources was a contributing factor to prestige-based wealth. The increased presence of fish heads during the last occupation floor of the house may be indicator of such wealth emerging within the pithouse. Clearly, changes occurred at the pithouse-scale during the BR2-BR3 transition and continued thru the BR3 occupations.

A major result of this research is the observation that the BR2-BR3 transition appears to have been accompanied (and perhaps caused by) a relatively sudden decline in pithouse population that suggests an overshoot scenario (Kirch 1984) in which population grew too

quickly for local resources to keep up. Previously more autonomous households may have coalesced, developing the neighborhood organization that quickly emerged following BR2. Survivors of the BR2 Malthusian event(s) likely developed means of coping with such situations – rather than diversify their diet hunters responded to declines in local medium and large mammals by transporting high-utility parts from greater distances and continued to utilize salmon by increasing their overall annual yields as human populations continued to increase. Over time, growth continued unabated until a similar Malthusian event – this time village population reaching a fully-realized Malthusian Ceiling and the organized village system simply crashed, leading to wide-scale abandonment after the IIa occupation.

FUTURE RESEARCH

This analysis has relied (admittedly) on partial excavation data. Further excavations at Housepit 54 and detailed analysis of materials and features will be necessary to falsify or corroborate any findings discussed here, particularly as complete samples become available. However, correlations between the various proxies data used in this research indicate that the trends observed (especially those from fully or nearly-fully excavated strata of the late BR3 period) are likely to persist. With more complete data on all occupation strata at Housepit 54, spatial analysis of faunal remains may elucidate activity areas and more definitive interior storage patterns. Evaluating specific changes in subsistence strategies from faunal materials in particular at Housepit 54 is problematic given the extensive degree of bone fragmentation that makes positive identification even to genera often impossible. Juxtaposed against the generally excellent preservation of salmon bones that can often be identified to species or a species-

indicative size category that precludes many of the other potential salmonid subspecies, I feel that future analysts must be careful to not overinflate evidence of salmon use and underestimate the use of terrestrial mammals (even if they can't be positively identified).

The application of Malthusian population dynamics to model changes among semi-sedentary hunter-gatherer-fishers of the Middle Fraser Canyon region may be especially pertinent to understanding the rise and fall of the region's complex late-Holocene village developments and abandonments (Prentiss et al. 2014). The annual availability of anadromous salmon in the area likely shaped a unique pattern of subsistence resource abundances, shortfalls, declines, and their dynamic effects on human populations over time. Further whole-housepit excavations like that undertaken at Housepit 54 should ultimately provide means of contrasting the patterns seen between longer- and shorter-lived pithouses, smaller- and larger-sized pithouses, and more- or less-affluent pithouse households across time. Modelling subsistence change under various changing conditions provides valuable insights into the decision-making patterns among prehistoric pithouse households. Further analyses of activity areas within pithouses and the various used of interior and exterior storage will be vital to developing understandings of complex strategies used to cope with food stress and population packing. Ultimately, this research has just scratched the surface of the potential for studies of subsistence change to elucidate wider patterns in demographic change and the modeling of decision-making in response to, and responsible for, such changes.

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APPENDIX A
DESCRIPTIONS OF FLOOR DEPOSITS

STRATUM IIj

Stratum IIj probably represents the initial occupation of the pithouse as it would be structured for generations. The people living their lives on this floor were likely egalitarian hunter-gather-fishers with access to a variety of marine and terrestrial animals and plants.

Faunal materials from Stratum IIj consisted of 179 specimens from two levels and three features (A-19/2, A-22/1, and A-23/2).

Level One

Level one contained the majority of animal remains. Of these, five were fragments of indeterminable mammal origin. Other Level one mammalian faunal materials were: one transverse process section of a lumbar vertebra from a bighorn sheep (*O. canadensis*), eight specimens were from mule deer (*O. hemionus*) including: two fragments of metatarsal, one fragment from the acetabulum of the left pubis, two thoracic vertebrae fragments, both from the anterior section of the vertebral body, three lumbar vertebral fragments, one a section of the anterior articular process, one a posterior body fragment, and the other a section of the dorsal spinous process. Other large animal bones included a diaphyseal fragment of a tibia, consistent with deer/sheep-sized artiodactyl, and one similarly-sized but indistinguishable diaphyseal fragment from a long bone. One diaphyseal fragment of a dog (*Canidae* spp.) rib was identifiable. Four other medium-sized mammal bone fragments could not be further identified. 33 specimens of heavily fragmentary (1-9mm) bone of unidentifiable medium- to large-bodied mammal were recovered. Of these, two fragments were consistent with being cranial in origin,

but otherwise indistinguishable to taxon. A single element from a small mammal was present. This was one whole 2nd phalange from a squirrel, likely a North American Red Squirrel (*Tamiasciurus hudsonicus*).

Fish bone from Level one consisted of 59 specimens. Of these, one specimen was an indeterminate vertebral fragment of unknown origin; 34 were from Sockeye (*O. nerka*), and three were trout-sized, consistent with rainbow trout (*O. mykiss*). Of the Sockeye remains, there were two atlas vertebrae, seven thoracic vertebrae, six pre-caudal vertebrae, five caudal vertebra, and 16 indistinguishable vertebral fragments. Other Sockeye elements included: 16 rays/spines/ribs, and four cranial bone fragments, one from the sub-orbital section of the circumorbital series of lateral skull bones (Cannon 1987: 32). Trout bones consisted of one fragmentary and one whole thoracic vertebra, and one fragmentary pre-caudal vertebra.

Level Two

Mammal remains from Level two consisted of one fragment from the posterior articular process of a mule deer lumbar vertebra and two indeterminate bone fragments of indeterminate medium-sized mammal. Fish remains were all from Sockeye salmon and consist of: one indeterminate bone fragment – likely cranial, four cranial bone fragments, one fragmental and three complete thoracic vertebrae, two fragmentary caudal vertebrae, two undeterminable vertebra fragments, and two rays/spines/ribs.

Feature A-19/2

Feature A-19 was a relatively sparse basin-shaped hearth. Remains from Feature A-19/2 consisted of five bone fragments from the proximal portion of a right ulna, including a portion of the semi-lunar notch. This compared favorably to mule deer.

Feature A-22/1

Feature A-22 was another basin-shaped hearth. Mammal remains from Feature A-22/1 consisted of one diaphyseal long bone fragment from an indeterminate large mammal and 22 fragments of indistinguishable element from medium- to large-sized mammal. Fish remains consisted of 11 Sockeye specimens, including: five indeterminate cranial fragments, four thoracic vertebrae, one pre-caudal vertebra, and one ray/spine/rib. Four indeterminate trout-sized vertebrae were also present.

Feature A-23/2

Feature A-23 was a deep, cylindrical pit that, despite its depth, contained relatively few faunal materials. Remains from Feature A-23/2 consisted of only three specimens. These included: one proximal fragment from a left 1st phalanx of a medium-sized *Canid*, one diaphyseal fragment of a long bone from an indeterminate medium- to large-sized mammal, and one ray/spine/rib from a medium-sized salmonid, most likely Sockeye.

STRATUM Iii

Faunal materials from Stratum Iii consisted of 190 specimens from two levels and a single feature (A-11).

Level One

Level one contained the vast majority of remains, accounting for all but three specimens of fragmentary large mammal bone. Level one faunal materials consist of: one specimen of a long bone fragment of from an unidentifiable medium-sized Avian; 70 specimens from mammals: 12 fragments of which are of indeterminable origin, twelve are from large-bodied animals, five from medium, four from small, 12 from medium/large, and 25 from small/medium animals. Of the remains designated to large-sized mammals, one is a fragment of a left calcaneus of an adult artiodactyl that exhibits multiple parallel cut-marks, one is a whole left astragalus of a mule deer (*Odocoileus hemionus*), one is a fragment of the left pubic synthesis of a sub-adult artiodactyls, three are proximal rib fragments and one is a diaphyseal rib fragment all of which compare favorably to mule deer, one is a proximal rib fragment that compares favorably to both mountain sheep (*Ovis canadensis*) and mule deer. Other remains include one fragmentary vertebral spine from a thoracic vertebra of a mule deer, one fragmentary vertebral body from a thoracic vertebra of a mule deer, and one is a fragment from an indistinguishable vertebra, also likely from a mule deer. Medium-sized mammal remains consist of two fragmentary cranial elements of unknown origin, one unidentifiable fragment, and one fragmentary incisor that compares favorably to that of a beaver (*Castor canadensis*). Of remains designated as those of medium- to large-sized mammal, 11 are of indeterminable origin; one is a fragmentary section of the acetabulum from

the pelvis of an indeterminate animal. Small mammal remains consist of one indeterminable fragment, one diaphyseal long bone fragment of indeterminate designation, and two proximal fragments of a femur and humerus, respectively, each from a small rodent (possibly *Mus*, *Peromyscus*, or *Microtus* spp.) too deteriorated to positively identify to species. Of specimens designated from small- to medium-sized mammal, 24 are unidentifiable fragments, and one is a cranial fragment of indeterminate animal origin.

122 specimens are the complete and fragmentary bones from bony fishes (*Osteichthyes* spp.), most of which are morphologically most similar to the remains of Sockeye salmon (*Oncorhynchus nerka*). However, five specimens are unidentifiable. Sockeye remains consist of four positively unidentifiable fragments, two unidentifiable vertebral fragments, three caudal vertebrae, 13 fragmentary and one complete pre-caudal vertebra, 12 fragmentary and seven complete thoracic vertebrae, eight fragmentary ribs/spines/rays, 12 fragments of cranial elements including one hyoid mandibular and one mandibular arch quadrate.

Level Two

Faunal materials from Level two consist of three specimens from mule deer: one fragmentary transverse process from a lumbar vertebra, and two pelvic acetabulum fragments.

Feature A-11

Feature A-11 was a shallow hearth from Level one that contained 18 fragments of a scapula from a single sub-adult mule deer.

STRATUM IIh

Faunal materials from Stratum IIh consisted of 421 specimens from two levels and two features (A-5 and A-13). Feature A-5 consisted of five intra-feature arbitrary 10cm levels, and was split between a “North” section and a “Central” section.

Level One

Level one contained 34 specimens, 24 from mammals and 10 from fish. Mammal bone consisted of 13 unidentifiable fragments from indeterminate taxa and two enamel fragments from teeth that compared favorably to *Cervidae* spp. of indeterminate size. One fragment of crania and one vertebra fragment from an indeterminate large mammal and one indeterminate fragment of medium- to large-sized mammal bone were also recovered. Other mammal bone included one anterior articular process section of a lumbar vertebra from a bighorn sheep (*O. canadensis*), one fragmentary section of the epiphyseal plate of a vertebral body from a mule deer (*O. hemionus*), along with two thoracic vertebra fragments from mule deer - one a vertebral epiphysis and the other an anterior portion of the vertebral body. Medium mammal bone consisted of one whole caudal vertebra and one whole lumbar vertebra, both from beaver (*C. canadensis*).

Fish bone consisted of 10 specimens. These included: three thoracic vertebrae, one caudal vertebra, three undistinguishable vertebra, and three rays/spines/ribs, all fragmentary.

Level Two

Level two contained 387 specimens, including those from features. Not counting specimens from features this number drops to 65. Of those 65, 39 are from mammals and 26 are from fish.

Mammal bone specimens included: one vertebral fragment from an indeterminate large taxa; one cervical vertebra fragment, two lumbar vertebrae fragments, one thoracic vertebra fragment, and one vertebral body fragment from an indeterminable vertebral element, all from mule deer. Additional mule deer specimens included one cranial fragment, two mandible fragments, and a portion of a pubis. Two proximal dog (*Canidae* spp.) rib fragments were identified, as was a single fragment of a beaver incisor. Other mammal specimens were comprised of 23 taxonomically indeterminate medium- to large-sized mammal bone fragments and two small- to medium-sized mammal bone fragments, one of which was a portion of diaphyseal long bone of indistinguishable element.

Fish specimens numbered 24 from Sockeye (*O. nerka*) and one from trout (*O. mykiss*). Of Sockeye elements, there were: one indeterminable fragment (likely cranial), one cranial bone fragment, 12 thoracic vertebrae, one pre-caudal vertebra, three caudal vertebrae (including one ultimate vertebra), one ray/spine/rib, and six indeterminate vertebrae, the majority of all of which were in fragmentary condition. Trout-sized specimens included one whole thoracic vertebra and one unidentifiable vertebral fragment.

Feature A-5 Central

Feature A-5 was a deep, bell-shaped pit that contained a large amount of fire-cracked rock (n=742). The Level two faunal contents of the central portion of Feature A-5 consisted of: 18

mammal bones of indistinguishable size or species, one anterior articular process portion of a lumbar vertebra from a mule deer, as well as a proximal rib (head) fragment from a mule deer, and a labial fragment of tooth enamel from a *Cervidae* spp. consistent with a deer-sized animal. A single thoracic vertebra from a bighorn sheep was also identified. Other mammal specimens included: a fragment of thoracic vertebra from a beaver, a cervical vertebra fragment from a medium- to large-sized *Canid* that compared favorably to grey wolf (*Canis lupus*), and a proximal rib portion (head) from a smaller dog, consistent with coyote (*Canis latrans*) in size.

Fish remains in Level two of the central portion of Feature A-5 were relatively abundant, but the majority fall within the less-informative rays/spines/ribs category (n=152). Other specimens include: 26 heavily decayed/weathered cranial bone fragments, five fragmentary and four complete thoracic vertebrae, 18 caudal vertebrae including 13 ultimate vertebrae, three Hypurals (also from the caudal section), and eight indeterminate fragmentary vertebrae. All specimens are consistent with Sockeye salmon. The relatively high frequency of cranial bones and ultimate caudal vertebrae and Hypurals to thoracic elements in Feature A-5 Level two suggests that multiple (n=13) fish tails and possibly a fish head(s) were deposited in Feature A-5.

Level three of Feature A-5 Central contained five indeterminate mammal bone fragments, and one fragment of a thoracic vertebra of a medium mammal. Fish remains consisted of two fragmentary thoracic vertebrae and two unidentifiable fragmentary vertebra fragments, both from Sockeye.

Level five of Feature A-5 Central contained five fragmentary mammal bone specimens of indeterminate origin or size category, one unidentifiable diaphyseal fragment from a medium- to large-sized mammal long bone, as well as one posterior epiphyseal vertebral plate and one anterior epiphyseal plate, both fragmentary, and both from a medium-sized *Canid* spp. Fish remains consisted of one fragmentary and two complete thoracic vertebrae, three indistinguishable fragmentary vertebrae, and two rays/spines/ribs, all from Sockeye.

Feature A-5 North

Level two of the north portion of Feature A-5 contained one unidentifiable cranial bone fragment consistent in size with those of Sockeye, and one whole thoracic vertebra and two whole pre-caudal vertebrae also of Sockeye. One complete pre-caudal vertebra from a Chinook salmon (*O. tshawytscha*) and one complete thoracic vertebra from a trout-sized salmonid were also present.

Level four of the north portion of Feature A-5 contained two indeterminate mammal bone fragments, two unidentifiable fragments from medium- to large-sized mammals, one unidentifiable diaphyseal long bone fragment from a medium- to large-sized mammal, and one diaphyseal long bone fragment from an indeterminate large mammal, as well as one distal fragment from the right radius of a mule deer, one distal phalange fragment, also from mule deer, and one right tarsal fragment from a bighorn sheep. Fish bone included a fragmentary Supracleithrum (part of the pectoral girdle directly behind and adjacent to cranial bones), five pre-caudal vertebrae, five caudal vertebrae, five indistinguishable fragmentary vertebrae, and three rays/spines/ribs, all fragmentary.

Level four of Feature A-5 contained three mammal bone fragments of indeterminable size-category or taxon, five unidentifiable fragments from medium- to large-sized mammal, one left rib body fragment from a beaver, and one atlas vertebra fragment from a medium-sized dog. Fish remains comprised one cranial bone fragment, one thoracic vertebra fragment, two pre-caudal vertebrae fragments, one indeterminate vertebra fragment, and five rays/spines/ribs, all from Sockeye.

Feature A-13

Feature A-13 was a deep, cylindrical pit that contained a single diaphyseal fragment from the right humerus of a mule deer.

STRATUM IIg

Faunal materials from Stratum IIg consisted of 576 specimens from two levels and seven features (A-1, C-7, C-12, C-27, C-28, C-31, and C-33). Feature A-1 consisted of seven intra-feature levels.

Level One

Level one contained 374 specimens, 223 from mammals, 147 from fish, and four from birds. Unidentifiable mammal bone consisted of 64 fragments from animals of indeterminate size and taxa. Of mammal bone from large-sized animals, 30 could not be assigned to a particular taxon, but one fragment was identified as that from a cranium, while another was a long bone fragment; three were enamel fragments from indistinguishable *Cervidae*. One horn core from a mountain goat (*Oreamnos americana*) was identified. 21 specimens were identified as mule deer (*O. hemionus*) or compared favorably. All deer bones identified were highly fragmentary and all less than 60mm in greatest dimension. Identifiable deer elements consisted of: one anterior articular process from a cervical vertebra, one dewclaw, one diaphyseal femur fragment, one distal humerus, one fragment from the ischium section of a (c.f.) right pelvis, three fragments from the pubis section of a right pelvis, one anterior body of a lumbar vertebra, one anterior section of a left mandible, one distal 1st phalange, one proximal rib (with articular head facet), one lateral portion of a scaphoid, two diaphyseal tibia fragments, one posterior epiphyseal plate from an indeterminate vertebra, and a body fragment from an indeterminate vertebra. 83 specimens were unidentifiable beyond belonging to indeterminate medium- to large-sized mammals. One of those specimens was identified as a cranial fragment and another was diaphyseal long bone. Six

specimens were from medium-bodied mammals. These included one complete right femur from a beaver (*C. canadensis*), one distal fragment of a right femur of another beaver, two fragmentary beaver incisors, and one rib fragment that compared favorably to medium-sized dog (*C. latrans*), as well as one unidentifiable bone fragment. 14 unidentifiable bone fragments came from small- to medium-sized mammals. One of these specimens was a cranial fragment and another was from the diaphyseal portion of an indistinguishable long bone.

Fish bone consisted of 147 specimens. One of these was a fragment of a Chinook (*O. tshawytscha*) vertebra. Eight specimens were cranial bone fragments from indeterminate species but were consistent in size and structure to Sockeye (*O. nerka*) cranial elements. All other specimens were from Sockeye. These included: 30 rays/spines/ribs, 30 cranial bones including one fragmentary ceratobranchial (a segment of the Branchial Arch), one quadrate (part of the Mandibular Arch), and one fragmentary basiptyrgium (part of the Pelvic Girdle), ten thoracic vertebrae, three pre-caudal vertebrae, eight caudal vertebrae, and 57 highly fragmentary vertebrae of unknown designation.

Bird bone specimens from Level one consisted of one fragmented coracoid, one diaphyseal portion of a tibiotarsus, and two indeterminate diaphyseal fragments from long bones, all consistent with grouse-sized members of the *Phaseanidae* family, particularly the Sooty Grouse (*Dendragapus fuliginosus*) common to the mountainous terrain of British Columbia's Coast Range.

Level Two

Faunal remains from Level two consisted of only three specimens: one anterior articular process fragment from a cervical vertebra of a mule deer, one indeterminate fragment from a medium- to large-sized mammal, and one pre-caudal vertebra from a Sockeye salmon.

Feature A-1 Level 1

Feature A-1 was a deep, bell-shaped pit containing homogenous soils and no obvious layering or stratification of sediments. As such, it was excavated in arbitrary 10-centimeter levels. Level one of Feature A-1 contained five faunal specimens. These included one mammal bone fragment from an indeterminate mammal of indeterminate size, one fragment from a large but otherwise indeterminate mammal, and two bone fragments from a medium- to large-sized mammal. One pre-caudal vertebra from a Sockeye salmon was also present.

Feature A-1 Level 2

Level two of Feature A-1 contained 14 mammal bones and five fish bones. Mammal bone included eight unidentifiable fragments from animal(s) of indeterminate size or taxon, three unidentifiable fragments from indeterminate large-sized mammal, and one fragment from a medium- to large-sized individual. Fish bone consisted of three thoracic vertebrae, one pre-caudal vertebrae, and one right scapula (from the Collar section of the fish head) – all from Sockeye salmon.

Feature A-1 Level 3

Level three of Feature A-1 contained no faunal remains.

Feature A-1 Level 4

Level four of Feature A-1 contained 33 specimens: 22 from mammal and 11 from fish. Mammal bone consisted of: 17 fragmentary specimens of indeterminate element from unidentifiable size or taxon, one unidentifiable fragment from a medium- to large-sized animal, and one similarly unidentifiable specimen from a small- to medium-sized mammal. Identifiable mammal bones consisted of: one fragmentary diaphyseal section of a deer femur, one proximal fragment of a left deer ulna, and one incomplete carpal from a deer/sheep-sized artiodactyl. Fish remains consisted of: four incomplete thoracic vertebrae and seven rays/spines/ribs, all from Sockeye salmon.

Feature A-1 Level 5

Level five of Feature A-1 contained one incomplete thoracic vertebra from a Sockeye salmon.

Feature A-1 Level 6

Level six of Feature A-1 contained 11 specimens. Eight of these were from mammal – two fragments from indeterminate element, size, or taxon, and six fragments from unidentifiable element from medium- to large-sized mammal(s). Fish bone consisted of two incomplete thoracic vertebrae and one unidentifiable vertebra, all from Sockeye salmon.

Feature A-1 Level 7

Level seven of Feature A-1 contained five specimens. These included one proximal fragment of a deer 1st phalange, and one thoracic vertebra, one caudal vertebra, and two rays/spines/ribs from Sockeye salmon.

Feature C-7

Feature C-7 was a basin-shaped hearth. It contained a large collared post-hole indentation that likely housed one of the major roof support beams. It also contained 27 mammal bone fragments and eight fragmentary Sockeye vertebrae. Mammal bones consisted of six unidentifiable pieces of bone from indeterminate mammal, one fragment from a large-bodied mammal of unknown distinction (18 pcs), and two fragments from a medium- to large-sized undeterminable mammal. One diaphyseal rib fragment from a deer was also present. Fish bones were limited to three caudal vertebrae and five highly fragmentary vertebrae of unknown position.

Feature C-12

Feature C-12 was a relatively shallow but spatially-expansive hearth that covered much of the central portion of Block C. It contained 25 faunal specimens. These included 23 fragments of bone that compared favorably to diaphyseal long bone material from an indeterminable medium- to large-sized mammal(s), and a single thoracic vertebra from a Sockeye salmon. The fourth specimen was a thick (9mm), irregularly-shaped and fractured segment of crania. The dense nature of the specimen and the shape and patterning of a suture present suggest that it was likely part of the posterior of a human (*Homo sapiens*) skull. Not enough of the suture was present to accurately determine if it marked the Lambdoidal or Sagittal suture, but certainly placed the segment to the posterior of the skull. The fragment could not be positively identified as human when compared to a series of human skulls housed at the University of Montana's Physical and Forensic Anthropology Lab. Fusing of the sutures, thickness of the cranial surface, and surface structure of the specimen suggest it came from a mature individual. Fracturing of the specimen was irregular with no signs of perimortem trauma.

Feature C-27

Feature C-27 was a basin-shaped hearth that contained 34 mammal bone specimens and four fish bones. These included: 14 indeterminate fragmentary specimens from undeterminable mammal bone, one fragment from a large-sized mammal, three similarly indistinguishable specimens from medium- to large-sized mammal, and 11 specimens from small- to medium-sized mammal. Identifiable mammal specimens included five fragments that compared favorably to deer: one proximal portion of a right metacarpal, one fragmentary tarsal, one fragment of a pubis, and two fragments from the distal end of a radius. Fish bones recovered were: one caudal vertebra, and three rays/spines/ribs, all incomplete and consistent with Sockeye salmon.

Feature C-28

Feature C-28 was a collared post-hole that contained ten specimens: nine of mammal bone and one of fish. The mammal bone assemblage consisted of one fragment that was unidentifiable to taxon or size, three indeterminate fragments from medium- to large-sized mammal, and four fragments of diaphyseal long bone from small- to medium-sized mammal. One fragment of tooth enamel from a *Cervid* was also present, consistent with a deer/sheep-sized animal. The single fish bone was an indeterminate cranial bone fragment consistent in size and structure to Sockeye salmon.

Feature C-31

Feature C-31 was a basin-shaped hearth that contained five specimens, two from mammal and three from fish. Mammal bone consisted of one fragmentary specimen from an indeterminate

large-bodied animal, and one diaphyseal segment of a deer rib. Fish bone consisted of one incomplete thoracic vertebra, one fragmentary vertebra of indistinguishable position, and one ray/spine/rib.

Feature C-33

Feature C-33 was a post-hole that contained nine specimens, three from mammal and six from fish. Mammal bones were limited to three indeterminate fragments of bone from medium- to large-sized mammal. Fish bones consisted of five incomplete Sockeye vertebrae of undeterminable position and a single ray/spine/rib.

STRATUM II_f

Stratum II_f represents the floor of the house as it was utilized during the final phase of the Bridge River 2 Period. At this time the village probably consisted of only 15 or so occupied pithouses, most of which were concentrated in a roughly U-shaped configuration at the northern end of the village. The people living on this floor may have participated in a social institution that their ancestors had not – the initial stages of hierarchical social inequality. Certainly, later incarnation of the Housepit 54 household were immersed in a world where social standing played a part in everyday decision-making. It also appears that many pithouses were not continuously occupied throughout the life of the village, so new houses weren't simply being added to the tally of existing houses, but instead there was what appears to be a conscious decision to physically manufacture new homes and not just reoccupy previously abandoned ones.

Faunal materials from Stratum II_f consisted of 1522 specimens from one level and five features (A-17, C-1, C-7, C-23, and C-26).

Level One

Level one contained 542 mammal bone specimens, 978 fish bone specimens, and two bird bone specimens.

Mammal bone consisted of eight fragments from unidentifiable elements from indeterminate taxon or size category, 118 specimens were from unidentifiable large-sized mammals, 39 of which were diaphyseal fragments from unidentifiable long bone elements. 270 specimens were

fragments from unidentifiable elements of indeterminate medium- to large-sized mammals, at least 18 of which were from diaphyseal long bone. 43 specimens were from similarly undistinguishable medium-sized animals, 11 of which were diaphyseal long bone sections. One specimen was a vertebra fragment from an unidentifiable small mammal. Identifiable element fragments that could not be determined to genera or species included: one diaphyseal portion of a metatarsal from a large ungulate, one rib fragment from a large mammal, one vertebra fragment from a large mammal; four cranial fragments, one sesamoid, and four tooth enamel fragments, all from medium- to large-sized mammals; one proximal femur fragment, two rib fragments, and one proximal tibia fragment, all from medium-sized mammal(s).

Identifiable specimens from large-sized mammals consisted of 24 *Cervidae* tooth fragments including two incisors and one molar that compared favorably to those of mule deer, but may be from any similarly-sized animal with selenodont dentition. Four fragments of indeterminate deer/sheep-sized artiodactyl vertebrae were identified, along with one diaphyseal metatarsal fragment and a single selenodont tooth fragment. Deer (*O. hemionus*) remains consisted of: two calcaneus fragments, one carpal fragment, one diaphyseal humerus fragment, one diaphyseal fragment from an indeterminate long bone that compared favorably to deer, one posterior articular process fragment from a lumbar vertebra, one body fragment from a lumbar vertebra, two diaphyseal fragments from a metapodial, one distal fragment of a metacarpal; eight metatarsal fragments including four diaphyseal portions, one proximal fragment and one distal fragment, two fragments of pelvis both including sections of the acetabulum, four distal phalange fragments, three rib fragments, and one left tibia fragment.

Eight identifiable specimens were from medium-sized mammals, including: one complete caudal vertebra, one fragment from a cervical vertebra, one fragment from a lumbar vertebra, one fragment of articular facet (Glenoid fossa) from a scapula, and one diaphyseal tibia fragment, all from beaver (*C. canadensis*). One ulna compared favorably to medium-sized rodent, but could not be identified to particular species, and as such could be from beaver, muskrat (*Ondatra zibethicus*), Hoary or Yellow-bellied marmot (*Marmota* spp.), or similar-sized *Rodentia* endemic to south-central British Columbia. Two dog (c.f. *C. latrans*) bone specimens consisted of one rib fragment, and one fragment of a thoracic vertebra.

The fish bone assemblage from IIf Level one contained 12 specimens from indeterminate taxa, including two thoracic vertebrae fragments, and eight rays/spines/ribs consistent in size and structure to medium-sized bony fish – probably salmon. Other specimens from medium-sized *Osteichthyes* included: two coracoids, one caudal vertebra, ten cranial elements, three unidentifiable elements (likely cranial), two thoracic vertebrae, 46 incomplete vertebrae of undeterminable position, and 56 rays/spines/ribs – all fragmentary. 687 specimens were identified as Sockeye salmon (*O. nerka*). These included 127 cranial elements or element fragments including 91 indeterminate specimens, two angulars, three Basipterygiums, two coracoids, two hyomandibulars, four mesocoracoids, two opercles, six pre-opercles, two scapula, two supracleithrums, and three urohyals. Sockeye vertebrae consisted of eight atlas vertebrae (MNI=8), 131 thoracic vertebrae, 47 pre-caudal vertebrae, 18 caudal vertebrae, and 60 incomplete vertebrae of undeterminable position. 305 rays/spines/ribs compared consistently with Sockeye or medium-sized salmon.

Nine specimens were from Chinook salmon (*O. tshawytscha*), including one cranial bone fragment, two pre-caudal vertebrae, three incomplete vertebrae, and three rays/spines/ribs.

Fish specimens from trout-sized fish consisted of three pre-caudal vertebrae, ten thoracic vertebrae, and two incomplete vertebrae – all compared favorably to rainbow trout (*O. mykiss*). Two fragmentary caudal vertebrae were consistent in structure and morphology to small-sized salmonid, but could not be positively differentiated to sub-species.

One branchial element compared favorably to that of Pacific cod (*Gadidae* spp.) – the only positively identifiable non-salmonid specimen in the assemblage.

Two avian bone specimens were recovered. These were a proximal and a diaphyseal fragment, both from the ulna of a medium-sized bird that compared favorably to a member of the *Phasianidae* family, most likely from one of three possible species, either Spruce grouse (*Falcipennis canadensis*), Dusky grouse (*Dendragapus obscurus*), or Sooty grouse (*Dendragapus fuliginosus*).

Feature A-17

In Stratum II_f, Feature A-17 was a deep, bell-shaped pit that contained a high amount of fire-cracked rock (n=266). Feature A-17 also contained two mammal bone specimens and three fish bone specimens. Mammal bone consisted of one mandible fragment from a mule deer, and one distal fragment of a medium-sized dog radius (c.f. *C. latrans*).

Fish bone consisted of three Sockeye vertebrae – one a thoracic and two incomplete and of undeterminable position.

Feature C-1

Feature C-1 was a post-hole that contained six mammal bone fragments. These consisted of two fragments of tibia that compared favorably to medium- to large-sized dog (c.f. *C. lupus*), and four indeterminate fragments from undistinguishable elements from medium- to large-sized mammal(s), at least one of which was from the diaphyseal portion of a long bone.

Feature C-7

Feature C-7 was a basin-shaped hearth that contained eight unidentifiable fragments from indeterminate medium- to large-sized mammal, including one bone flake from a long bone diaphysis.

Of the fish bone from Feature C-7, 127 specimens were from salmon. These included two cranial bone fragments, one complete pre-caudal vertebra and one complete thoracic vertebra, and 123 rays/spine/ribs, all from medium-sized fish comparable to Sockeye. One complete thoracic vertebra from a trout-sized salmonid (*O. mykiss*) was also recovered.

Feature C-23

Feature C-23 was another basin-shaped hearth. This one contained 15 specimens, all of mammal bone. Three specimens were from undeterminable elements from unknown large mammal(s), one from diaphyseal long bone. Eight specimens were fragments from diaphyseal long bone of

indeterminate medium- to large-sized mammal. Identifiable specimens consisted of two distal fragments from an artiodactyl metapodial, one fragmentary femoral head portion of the femur of a mule deer, and one complete sesamoid, also from mule deer.

Feature C-26

Feature C-26 was a deep cylindrical pit that contained five mammal bone specimens: one diaphyseal long bone fragment from a medium-sized dog, two proximal fragments of metapodial from a medium-sized dog that compared favorably to domestic dog (*C. familiaris*), and two unidentifiable bone fragments from medium- to large-sized mammal(s).

STRATUM IIe

Stratum IIe represents the initial occupation of the Bridge River 3 Period. The transition from Bridge River 2 to Bridge River 3 was not likely a memorable (or even that noticeable) event as it unfolded, but it marked the beginning of a period of growth in the village and surrounding areas that would have a profound impact on the local environment, economy, and social interaction (Prentiss and Kuijt 2013). Later incarnations of the household living in Housepit 54 would experience times during which the village nearly doubled in size (and assumedly population) and in which increasing status differentiation between families (perhaps even within households) is thought to have led to increasing competition for local resources and access to resources that ultimately played a role in the abandonment of the village, as for some, access to basic needs became uncertain (Prentiss *et al.* 2008; Prentiss *et al.* 2014).

Faunal materials from Stratum IIe consisted of 775 specimens from four levels and ten features (A-12, B-1, B-3, B-5, B-6, B-14, B-15, B-16, C-1, and C-3).

Level One

Level one contained 203 mammal bone specimens, 219 fish bone specimens, and four avian specimens.

Mammal bone consisted of 5 fragments of unidentifiable elements from indeterminate taxon or size category, 18 unidentifiable specimens were from unknown large-sized mammals. 109 specimens were fragments of indeterminate elements from unidentifiable medium-to large-sized

mammals. 27 specimens were fragments of unknown elements from medium-sized mammals, two were similarly unidentifiable element fragments from indeterminate small- to medium-sized mammals, and two were remains of small members of the *Rodentia* Family – a cranial fragment and an incisor – neither identifiable to taxon.

Identifiable large mammal specimens consisted of one complete selenodont molar and one enamel fragment from a deer/sheep-sized *Cervidae* sp., one carpal fragment, one fragment from the head portion of a humerus, two vertebra fragments and one fragmentary vertebral plate, and five diaphyseal long bone fragments – all that compared favorably to artiodactyl but could not be determined to genera or species. Other identifiable remains consisted of one proximal portion of a bighorn sheep (*O. canadensis*) tibia; two fragments from the anterior articular process of cervical vertebrae, one relatively intact proximal-diaphyseal portion of a femur, one distal portion of a femur including a section of the distal condyle, one humerus fragment, one diaphyseal portion of humerus in 13 refitted fragments, one metapodial fragment, one diaphyseal tibia fragment, and four diaphyseal fragments from unidentifiable long bone(s) – all from mule deer (*O. hemionus*).

Three specimens from medium-sized mammal(s) were identified. These consisted of one diaphyseal fragment from a beaver (*C. canadensis*) humerus, one articular facet (Glenoid fossa) section of a right beaver scapula, and one distal epiphyseal portion of a dog (c.f. *Canis familiaris*) tibia.

Fish bone from Level one of Stratum IIe consisted of 61 specimens from indeterminate taxa, but consistent in size and bone structure with medium-sized *Salmonidae* spp, likely Sockeye salmon (*O. nerka*); of these, 12 were incomplete vertebrae of undistinguishable type, four were fragmentary cranial elements of unidentifiable designation, and 42 were rays/spines/ribs. 155 specimens were identified as coming from Sockeye salmon, including: 26 unidentifiable cranial bone fragments, 23 thoracic vertebrae, 14 pre-caudal vertebrae, five caudal vertebrae, 16 fragmented or incomplete vertebrae, one penultimate vertebra, and 70 rays/spines/ribs. Two specimens were from trout-sized salmonids (*O. mykiss*). These consisted of one thoracic vertebra and one incomplete, indeterminate vertebra. One incomplete vertebra was consistent in size and centrum-body structure with that of Chinook salmon (*O. tshawytscha*).

Bird bone consisted of one complete carpometacarpus and one proximal fragment of a carpometacarpus, one digit element, and one phalanx – all compared favorably to medium-sized avian from the *Phasianidae* Family, probably Sooty Grouse (*Dendragapus fuliginosus*) or given the relative size of the specimens, but possibly from a similarly-sized Willow ptarmigan (*L. lagopus*) as well.

Level Two

Level two contained a single faunal specimen – a fragment of undistinguishable bone from a medium- to large-sized mammal of undeterminable taxon.

Level Three

Level three did not contain any faunal remains.

Level Four

Level for contained four caudal vertebrae from a single Sockeye salmon.

Feature A-12

Feature A-12 was a shallow bowl-shaped indentation that contained six mammal bones and 45 Sockeye salmon bones and one trout bone. The three mammal bone specimens were all fragments from unidentifiable element(s) from medium -sized mammal.

Fish bones consisted of one unidentifiable cranial bone fragment, one atlas vertebra, five thoracic vertebrae, two pre-caudal vertebrae, two caudal vertebrae, 32 incomplete vertebrae of undeterminable position, and two rays/spines/ribs – all from Sockeye salmon. Four incomplete vertebrae from trout-sized salmonid were also identified but could not be determined to vertebral type.

Feature B-1

Feature B-1 was an ephemeral surface hearth that contained six fragmentary mammal bone specimens from undeterminable element(s) from unknown medium- to large-sized mammal(s).

Feature B-3

Feature B-3 was a bell-shaped pit composed of gravelly/rocky sediments throughout. It contained 23 fragmentary mammal bone specimens and 12 salmon bone specimens. Mammal bone consisted of: one metacarpal fragment from an indistinguishable artiodactyl, six fragments

of bone from large-sized mammal(s), 15 specimens from medium- to large-sized mammal bones, and one vertebra fragment from a undeterminable medium-sized mammal.

Fish bone consisted of one cranial element – a ceratobranchial, two thoracic vertebrae, one pre-caudal vertebra, three incomplete and undeterminable vertebrae, and five rays/spines/ribs – all from Sockeye salmon.

Feature B-3, Level Two

Level two of Feature B-3 contained nine mammal bone specimens, all fragmentary pieces from undistinguishable elements from medium- to large-sized mammal(s).

Fish remains from Feature B-3, Level two consisted of: one cranial element – a mandible fragment, one thoracic vertebra, two caudal vertebrae, and two incomplete vertebrae – all from Sockeye salmon.

Feature B-3, Level 3

Level two of Feature B-3 contained ten mammal bone specimens. These included: one undistinguishable fragment from a large-sized mammal, seven long bone fragments from undeterminable medium- to large-sized mammal(s), one unidentifiable fragment from a small- to large-sized mammal, and one diaphyseal humerus fragment from a beaver.

Fish remains from Level two of Feature B-3 consisted of two undistinguishable cranial bone fragments, three thoracic vertebrae, one caudal vertebra, and six rays/spines/ribs – all attributed to Sockeye salmon.

Feature B-5

Feature B-5 was a shallow hearth that produced only a single faunal specimen – one thoracic vertebra from a Sockeye salmon.

Feature B-6

Feature B-6 was a post-hole that contained two faunal specimens. These consisted of one bone fragment from an undistinguishable element from an indeterminate medium- to large-sized mammal, and one unidentifiable fragment from a Sockeye salmon cranial bone.

Feature B-14

Feature B-14 was a large, micro-bedded cache pit that contained 49 mammal bone specimens and 139 fish bone specimens. The mammal bone assemblage contained two completely unidentifiable fragments; eight fragments from unknown elements from indeterminate large-sized mammal(s); 21 fragmentary specimens of bone from indeterminate medium- to large-sized mammal, including one section of cranial bone; and three fragmentary specimens from indeterminate small- to medium-sized mammal. Identifiable specimens included: one diaphyseal fragment of a mule deer metatarsal, one diaphyseal fragment of a beaver humerus, one nearly complete tibia that compared favorably to that of a canyon mouse (*Peromyscus crinitus*), one complete femur that compared favorably to that of *Neotominae* sp. (most likely

wood rat - *Neotoma cinerea*), one complete humerus from an undistinguishable *Peromyscus* sp. (likely the common deer mouse - *P. maniculatus*), one complete mandible from a western jumping mouse (*Zapus princeps kootenayensis*), and one partially-intact crania and eight cervical vertebrae from one individual *Neotominae* sp., possibly from the same individual as the femur listed above.

Fish bone from Feature B-14 was all attributed to Sockeye salmon and contained 25 cranial elements, including one Basipterygium, three ceratobranchials, one coracoid, one symplectic, and 19 unidentifiable cranial bone fragments. Other specimens included 26 thoracic vertebrae, seven pre-caudal vertebrae, nine caudal vertebrae, 14 incomplete vertebra of undeterminable position, and 58 rays/spines/ribs.

The faunal assemblage from this feature suggests that it may have been filled with refuse, as it included dog coprolites and micro-bedded sediments that could have resulted from the sweeping up of floor debris. The rodent species richness (identifiable species n=4) suggests the presence of owl pellets (Andrews 1990), further supporting the possibility that this feature was used to “clean up” the pithouse space, possibly upon the return of inhabitants to the pithouse after summer hunting-foraging activities, or after a more extended abandonment.

Feature B-15

Feature B-15 was another micro-bedded bell-shaped pit. Unlike Feature B-14, it produced only two specimens – one tooth enamel fragment likely from a molar or pre-molar of a deer/sheep-sized *Cervidae* sp. and one unidentifiable fragment of bone from a medium-sized mammal.

Feature C-1

Feature C-1 was a shallow hearth with a relatively high density of fire-cracked rock for such a feature. The animal bone assemblage from Feature C-1 consisted of: one unidentifiable fragment of bone from a large-sized mammal, one similarly unidentifiable diaphyseal long bone fragment from a medium- to large-sized mammal, and one spiral-fractured distal portion of radius from a mule deer.

Fish bone from C-1 consisted of five pre-caudal vertebrae, four incomplete vertebrae of unknowable position, and four rays/spines/ribs – all identified as being from Sockeye salmon.

Feature C-3

Feature C-3 was another shallow hearth that contained only three specimens – one fragment from the dorsal spinous process of a bighorn sheep, one spiral-fractured proximal portion of a mule deer humerus, and one caudal vertebra from a Sockeye salmon.

STRATUM IIId

Faunal materials from Stratum IIId consisted of 636 specimens from two levels and three features (A-17, C-2, and D-11).

Level One

Level one contained 275 mammal specimens, 296 fish bone specimens, and 19 fragmentary pieces of shellfish.

Mammal bone consisted of 15 fragments of unidentifiable elements from indeterminate taxon or size category, 69 specimens were from large-sized mammals, of which 57 were unidentifiable fragments, 24 of which were diaphyseal segments from unidentifiable long bone elements. 70 specimens were fragments of indeterminate elements from unidentifiable medium-to large-sized mammals. 97 specimens were fragments of unknown elements from medium-sized mammals, four were similarly unidentifiable element fragments from indeterminate small- to medium-sized mammals, and eight were unidentifiable remains of small members of the *Rodentia* family.

Identifiable large mammal specimens consisted of one diaphyseal fragment of an artiodactyl metatarsal consistent in size with that of deer/sheep, two lumbar vertebra fragments from a mule deer (*O. hemionus*), one diaphyseal femur fragment, three radius fragments (one diaphyseal), and three diaphyseal tibia fragments – all from mule deer. One atlas vertebra fragment from a brown bear (*U. arctos*) was also recovered.

Nine medium-sized mammal bones were identified. These include: three rib fragments and an ulna fragment from beaver (*C. Canadensis*), four *Canid* specimens including one vertebral body fragment, one fragmentary section of the posterior articular facet of a cervical vertebra, one diaphyseal tibia fragment, and one carnassial tooth – all consistent with medium-sized dog (c.f. *C. latrans*). One fragment from a muskrat (*Ondatra zibethicus*) cranium was also identified.

Small mammal remains include one relatively tiny incisor (c.f. *Peromyscus* spp.) and one phalanx, one deer mouse (*Peromyscus maniculatus*) mandible, and one indeterminate cranial fragment.

Fish bone from Level 1 consisted of 38 specimens from indeterminate taxa, but consistent in size and bone structure with medium-sized *Salmonidae* spp, likely Sockeye salmon (*O. nerka*). 245 specimens were identified as coming from Sockeye salmon, including: one atlas vertebra, 35 thoracic vertebrae, four pre-caudal vertebrae, 33 caudal vertebrae, 72 heavily fragmented, incomplete or otherwise indeterminate vertebrae, two Hypural, one Ultimate caudal vertebra, and one Penultimate vertebra (all from the tail section), eight fragmentary cranial bones including one basiptyrgium, one branchiostegal ray, one coracoid, and one scapula, and 78 rays/spines/ribs. Four specimens were from trout-sized salmonids (*O. mykiss*). These consisted of three incomplete thoracic vertebrae and one indeterminate vertebra. One ray/spine/rib was significantly large as to be consistent with Chinook salmon (*O. tshawytscha*).

Shellfish from Level one consisted of 19 heavily weathered shell fragments of Mollusk consistent in shape, composition, and color with True Oysters of the family *Ostreidae* spp.

Four small (<19mm), severely fragmented weathered specimens were too deteriorated to be identified to any particular taxonomic designation.

Level Two

Level two contained relatively few faunal remains. These included six fragments from indeterminate vertebral elements from large-sized mammal(s): one small section of a vertebral fin, and five fragments around the anterior transverse process portions of lumbar vertebra from deer/sheep-sized artiodactyl.

Fish bone consisted of ten specimens. Three of these were unidentifiable cranial bone fragments that compared favorably to Sockeye-sized *Salmonidae* but could not be positively identified. Additional specimens were six caudal vertebrae and one unidentifiable incomplete vertebra, both from Sockeye salmon.

Feature A-17

Feature A-17 was a deep, bell-shaped pit that ultimately expanded out into a bell-shape at its deepest extents. In Stratum II it contained eight mammal bones and three Sockeye salmon bones. Three specimens were fragments from unidentifiable element(s) of medium- to large-sized mammal, and one fragment was of indeterminate medium mammal bone. Identifiable mammal bone included three diaphyseal long bone fragments from deer/sheep-sized artiodactyl and one fragment of a deer lumbar vertebra.

Fish bones consisted of two Sockeye caudal vertebrae and one thoracic vertebra, also from Sockeye. All three were fragmentary.

Feature C-2

Feature C-2 was a post-hole that contained six mammal bone specimens and eight fish bone specimens. Mammal bone consisted of one indeterminate fragment from a large-sized mammal and five similarly indeterminate fragments from a medium- to large-sized mammal, two of which compared favorably to cranial bone but could not be positively compared to any of the comparative samples available.

Fish bone consisted of one unidentifiable cranial bone fragment, one incomplete vertebra fragment of undeterminable position, and one ray/spine/ray – all from Sockeye salmon.

Feature D-11

Feature D-11 was another post-hole that contained a single faunal specimen – one diaphyseal fragment from an indeterminate large mammal long bone.

STRATUM IIc

Faunal materials from Stratum IIc consisted of 1458 specimens from one level and four features (B-14, D-6, D-10, and D-13).

Level One

Level one contained 548 mammal specimens, 708 fish bone specimens, three bird specimens, and one piece of shellfish.

Mammal bone consisted of 27 fragments of unidentifiable elements from indeterminate taxon or size category. 282 specimens were from unidentifiable elements from indeterminate large-sized mammals, of which 154 were diaphyseal long bone fragments. 116 specimens were fragments of indeterminate elements from unidentifiable medium-to large-sized mammals, 22 of which were diaphyseal long bone fragments. 53 specimens were fragments of unknown elements from medium-sized mammals, and seven specimens were unidentifiable element fragments from indeterminate small- to medium-sized mammals.

Identifiable large mammal specimens consisted of one pubis fragment, seven rib fragments, and three vertebra fragments, one a portion of the anterior transverse process of a lumbar vertebra, and all from artiodactyl(s) consistent in size with deer/sheep but not positively identifiable. One lumbar vertebra fragment, two rib fragments, one rib fragment, and three tibia fragments including a portion of the Tibial tuberosity, compared favorably to mule deer (*O. hemionus*). Positively identifiable deer remains included: one tarsal, one carpal, one cranial section with a

portion of the tympanic bulla, one diaphyseal fibula, one distal right humerus with a portion of the posterior section of the olecranon fossa, one section of a left mandible including the 2nd premolar alveolar process, one proximal section of a left metatarsal, one diaphyseal portion of a metatarsal, one radial carpal, one diaphyseal radius, one body section of a thoracic vertebra, one diaphyseal tibia, one anterior vertebral body, one vertebral spinous process, and one indeterminate vertebral section – all fragments. Whole deer elements included one left trapezoid magnum and one uniciform. Two tooth fragments closely matched mule deer in the comparative collection and were designated as being from a *Cervid*, but due to the close similarity in dentition between medium-sized artiodactyls, the specimens could also be from a sheep/goat (*Ovis/Aries*) member of the *Caprinae* subfamily of *Bovids*.

Five medium-sized mammal bones were identifiable. These included one vertebra fragment, a section of the superior crest of an ilium, and a rib fragment – all consistent with medium-sized dog (c.f. *C. latrans*). One incisor and one fragment of a vertebral body were also identified – both from beaver (*C. canadensis*).

Small mammal remains included a single fragment of a proximal tibia designated as coming from an indeterminate mammal, but of comparable size to that of small muskrat (*Ondatra zibethicus*), squirrel (*Sciuridae* spp.), or fisher (*Martes pennanti*).

Fish bone from Level 1 consisted of 84 specimens from indeterminate taxa, all of which was consistent in size and bone structure with medium-sized *Salmonidae* spp, likely Sockeye salmon (*O. nerka*). 616 specimens were identified as coming from Sockeye salmon. These included:

one Atlas vertebra, two basipterygium, one caudal Epural bone, one coracoid, one hypobranchial, two mesocoracoids, one scapula, 42 unidentifiable cranial element fragments, 55 thoracic vertebrae, 22 pre-caudal vertebrae, 32 caudal vertebrae, and 45 incomplete or indistinguishable vertebrae. Seven specimens were from trout-sized salmonids (*O. mykiss*). These consisted of six thoracic vertebrae and one caudal vertebra. One basipterygium was from Chinook salmon (*O. tshawytscha*).

Shellfish from Level one consisted of a single heavily weathered shell fragment consistent in shape, composition, and color with True Oysters of the family *Ostreidae* spp.

Feature B-14

In Stratum IIc, Feature B-14 contained only four Sockeye bones: two pre-caudal vertebrae and two incomplete vertebrae of unidentifiable position. As detailed in proceeding strata, this feature turned out to be one of the largest cache pits excavated at Housepit 54 and turned out to contain a unique assemblage of animal remains, including a variety of bones from diverse species, but also coprolites, probably from domesticated dogs.

Feature D-6

Feature D-6 had only three specimens: one complete and two fragmentary thoracic vertebrae from Sockeye salmon.

Feature D-10

Feature D-10 was a deep, bell-shaped pit that contained 190 faunal specimens. As with similar pits elsewhere in the housepit, it appears to have been a cache pit that was ultimately filled with refuse. 19 specimens from this feature were from unidentifiable elements from mammals of indistinguishable size or taxon, ten were similarly unidentifiable fragments from large-sized mammal(s), 16 were from medium- to large-sized mammals, and 13 from medium-sized mammals.

Identifiable specimens from large-sized mammals included: one lumbar vertebra fragment with a section of the posterior arch from a bighorn sheep (*Ovis canadensis*), and one posterior diaphyseal section of a mule deer radius with the ulna articular oblique line present. Medium mammal specimens consisted of one proximal fragment of a dog rib with articular head surface, one proximal fragment of a left ulna with semi-lunar notch present, and one proximal radius fragment with articular rim of head present – both also from medium dog. Two cranial fragments from a medium mammal were also recovered, as was a body fragment from a thoracic vertebra of unknown designation.

Fish bone from Feature D-10 consisted of 130 specimens. Of these, one specimen was deteriorated to such a degree as to be unidentifiable beyond *Osteichthyes* (bony fishes) species. Ten cranial bone fragments from Sockeye were present, including one scapula. Additional Sockeye bones included: 18 thoracic vertebrae, two pre-caudal vertebrae, eight caudal vertebrae, 22 incomplete vertebrae of indeterminable position, and 64 rays/spines/ribs.

One bird bone specimen was recovered in Feature D-10. This was a fragment of synsacrum that compared favorably to that of a bird in the *Phaseanidae* family, most likely Sooty Grouse (*Dendragapus fuliginosus*).

Feature D-13

Feature D-13 was a small post-hole that had only two specimens in it: one unidentifiable bone fragment from a small- to medium-sized mammal and one incomplete thoracic vertebra from a Sockeye salmon.

STRATUM IIb

Faunal materials from Stratum IIb consisted of 4390 specimens from one level and three features (A-5, D-4, and D-8). The assemblage contained 725 mammal specimens, 3651 fish specimens, nine bird specimens, and five taxonomically unidentifiable specimens. Although the fish specimen count is relatively high comparatively, 2400 of the fish specimens fall into the somewhat anomalous category of “rays/spines/ribs” and offer little to no diagnostic or interpretive data regarding numbers of fish present or human predation strategies (Colley 1990: 212).

Level One

Mammal bone specimens from Level one included 34 fragmentary specimens from indeterminate elements from unidentifiable mammal(s), 99 similarly unidentifiable element fragments were from large-sized mammal (78 of which were fragments from diaphyseal long bone), 256 from medium- to large-sized mammal, 51 from medium-sized mammal, 13 from small- to medium-sized mammal, and two from small mammal.

Identifiable large mammal remains included one posterior fragment of a lumbar vertebra including a section of the superior articular process, one mandible fragment, and one proximal fragment of a femoral head, all from unidentifiable large-sized animal(s). 144 specimens were identified as deer (*O. hemionus*) or compared most favorably to deer. These included: one complete carpal bone, one fragmentary carpal, one fragment of a cervical vertebra, one radius fragment, one diaphyseal fragment of a tibia, ten cranial fragments, one fragmentary dew claw,

one diaphyseal fragment and four distal-epiphyseal fragments of femur, one lumbar vertebra fragment, one proximal fragment of a left metacarpal, one diaphyseal fragment of a left metatarsal, one proximal and diaphyseal fragment of a metatarsal, one proximal phalanx fragment, one distal fragment of a 2nd phalanx, one distal fragment of a left radius, five diaphyseal fragments of a right radius, one diaphyseal radius fragment, 20 rib fragments, one superior section of a sacrum, one fragment of a thoracic vertebra, one fragmentary anterior crest section of a tibia, six fragments of unidentifiable vertebral body, and one nearly-complete left scapula. Five *Cervid* teeth were identified, one fragment and four complete or nearly complete specimens: one right 1st incisor, one pre-molar, and two incomplete premolars – all from deer/sheep-sized animal(s). Three other enamel fragments were also likely those of *Cervidae* given surface structure and color, but were too fragmentary to be positively identified.

Identifiable medium-sized mammal bone consisted of: one proximal rib fragment, one proximal-epiphyseal humerus fragment, one posterior fragment of a lumbar vertebra including a section of the transverse process, one left metacarpal, and one fragment of the dorsal spine of a thoracic vertebra – all from medium-sized dog (c.f. *C. latrans*). One diaphyseal long bone fragment from a beaver (*C. canadensis*) was identified, as were one left mandible fragment, one fragment of mandible including the base of the ascending ramus, one fragment of the anterior articular process from a thoracic vertebra, and one fragmentary incisor – all from beaver.

Identifiable small mammal remains consisted of one phalanx, one vertebral body fragment, and one diaphyseal long bone fragment, all from undeterminable species, and all from individual(s)

of roughly muskrat-size. One tiny rodent (c.f. deer mouse – *Peromyscus* sp.) proximal left ulna with a section of the semi-lunar notch was also identified.

Avian faunas from Level one consisted of six specimens, including one diaphyseal long bone fragment of unknown element from a medium (grouse-sized) bird, one right carpometacarpus and one right phalanx from a member of the *Phasianidae* family, likely Sooty Grouse (*Dendragapus fuliginosus*), two bone fragments from indeterminate elements from a small-sized bird, as well as one complete coracoid, also from a small bird (c.f. White-tailed Ptarmigan - *Lagopus leucura*).

Fish remains from Level one included four entirely unidentifiable specimens from *Osteichthyes* spp., and 101 specimens from medium-sized bony fish of undeterminable species, including 81 incomplete vertebra fragments, one coracoid and 12 unidentifiable cranial bone fragments, and seven rays/spines/ribs. Sockeye (*O. nerka*) remains consisted of 2177 specimens, including 17 positively-identifiable elements: two basiptyrgiums, one branchial arch, two branchiostegal rays, two cleithrums, three coracoids, one ectopterygoid, one hypobranchial, one frontal, one maxilla, one mesocoracoid, one opercle, one parasphenoid, six scapulas, one subopercle, one supracleithrum, one symplectic, and one urohyal. Other Sockeye specimens included 98 thoracic vertebrae, 31 pre-caudal vertebrae, 74 caudal vertebrae, 184 incomplete vertebrae, two expanded Haemal spines, and 1602 rays/spines/ribs.

Salmon bones that could not be positively identified to Sockeye but were consistent in size, morphology, and structure to medium-sized *Salmonidae* spp. included 782 specimens: 34 cranial

bone fragments including 11 identifiable elements: three branchial arches, two branchiostegal rays, three mandibular arches, one mesocoracoid, one Otic region element, and one parasphenoid. Other identifiable elements consisted of 67 thoracic vertebrae, 22 pre-caudal vertebrae, and four caudal vertebrae, 142 incomplete vertebrae of undeterminable position, one Ultimate vertebra, three penultimate vertebrae, three extended Haemal spines, two neural arch fragments, and 503 rays/spines/ribs.

Small Salmonid bones included: one thoracic vertebra and one incomplete vertebra from unidentifiable small *Salmonidae* sp. Identifiable trout-sized (*O. mykiss*) specimens consisted of five identifiable cranial bones: one basiptyrgium, three hypobranchials, and one scapula, as well as five thoracic vertebrae, two pre-caudal vertebrae, two caudal vertebrae, 22 incomplete vertebrae of unknown position, as well as one tooth.

Feature A-5

Feature A-5 was a deep, bell-shaped pit that may have initially been used as a cache pit, but was ultimately used to store or discard fire-cracked rocks. The pit contained four mammal bones from medium- to large-sized animals. Three of these were fragments from unidentifiable elements and one was a fragment of a lumbar vertebra. Fish bone consisted of seven specimens from Sockeye salmon. These included one cranial bone – a mandibular arch, two thoracic vertebrae, two pre-caudal vertebrae, one incomplete vertebra of undeterminable position, and one ray/spine/rib.

Feature D-4

Feature D-4 was a basin-shaped hearth that contained 82 faunal specimens. Mammal bone consisted of six fragments from indistinguishable elements from large-sized mammal(s) and three similarly indeterminate fragments from medium- to large-sized mammal. Fish bone consisted of 70 specimens, all consistent with Sockeye salmon. These included one sphenotic – a cranial element from the Otic region of the lateral skull, two thoracic vertebrae, one pre-caudal vertebra, and 69 rays/spines/ribs.

Feature D-8

Feature D-8 was a deep, bell-shaped pit likely used to discard fire-cracked rock, given an extremely high relative frequency of those materials. The feature also contained a relatively high number of faunal remains: 591 specimens in all. Of this, 120 specimens were of mammal bone, 462 were fish, three were from bird, and three were weathered to such a degree as to be unassignable to any taxonomic category.

Mammal bone specimens in Feature D-8 consisted of 18 fragmentary specimens from indeterminate elements from indeterminate size or taxon, 22 specimens from indeterminate large mammal, 43 from indeterminate medium- to large-sized mammal, 5 from indeterminate medium mammal, and two from unidentifiable small- to medium-sized mammal. Identifiable specimens from large mammal(s) included: one fragment of cranium from an unspecifiable deer/sheep-sized artiodactyl, one proximal fragment of an artiodactyl femur, eight diaphyseal long bone fragments of indeterminate artiodactyl, three artiodactyl rib fragments, and one diaphyseal tibia fragment, also from artiodactyl. Other large-sized animal bone specimens consisted of one diaphyseal fragment of a deer (*O. hemionus*) metatarsal, one rib fragment, one diaphyseal fragment from a

right tibia, one distal epiphyseal fragment of a tibia, one diaphyseal humerus fragment, and one vertebra fragment - all from deer. Identifiable medium-sized mammal remains consisted of one wing fragment from a lumbar vertebra from a dog (c.f. *C. latrans*), and one *Canid* tooth, along with one proximal fragment of a beaver (*C. canadensis*) metacarpal and one fragmentary incisor. One complete rodent radius was also recovered but could not be positively identified to species.

Fish bone specimens consisted of 19 unidentifiable fragments from indeterminate species, but consistent in size and bone structure with medium salmonid, likely from cranial bones. Identifiable specimens included 66 cranial bone specimens, including: three basiptyrgiums, one branchial arch, one cleithrum, one postcleithrum, one collar, two coracoids, one mesocoracoid, one preopercle, one prootic, and one urohyal as well as 53 cranial bone fragments that could not be identified to element, all consistent with Sockeye salmon. Other Sockeye remains included 41 thoracic vertebrae, 14 pre-caudal vertebrae, 31 caudal vertebrae, 42 incomplete or fragmentary vertebrae, one expanded Haemel spine (tail element), and 206 rays/spines/ribs. Three vertebrae were trout-sized (c.f. *O. mykiss*), including two thoracic vertebrae and one incomplete vertebra of undeterminable position. Two Chinook salmon (*O. tshawytscha*) elements were identified – both right cleithrum specimens.

Bird bone specimens consisted of one diaphyseal fragment from a long bone from a medium-sized bird and one proximal fragment of a tibiotarsus from a medium-sized bird, both consistent in size with grouse-sized avian. One complete left carpometacarpus from a Sooty Grouse (*Dendragapus fuliginosus*) was also recovered.

STRATUM IIa

Stratum IIa is the final floor of the Bridge River Period 3 occupation. Theoretically, it represents the last activities undertaken at the house prior to the abandonment of the village and the subsequent hiatus of occupations that lasted hundreds of years leading up to the reoccupation of the village during Bridge River 4.

Faunal materials from Stratum IIa consisted of 3461 specimens from five levels. The assemblage contained 805 mammal specimens, 2650 fish specimens, six bird specimens, and just one taxonomically unidentifiable specimen (from level four). Although the fish specimen count is relatively high comparatively, 1806 of the fish specimens fall into the somewhat anomalous category of “rays/spines/ribs” and offer little to no diagnostic or interpretive data regarding numbers of fish present or human predation strategies (Colley 1990: 212).

Level One

Mammal bone from Level one consisted of 560 mostly fragmentary specimens. Of these, 98 were from indeterminate elements from unidentifiable mammal(s), one was a cranial bone fragment from an indeterminate mammal and one was a vertebral body fragment of unidentifiable position, size category or taxon. 36 were similarly unidentifiable element fragments from large-sized mammal(s), 280 were from medium- to large-sized mammal, nine were from indeterminate medium-sized mammal, ten were from small-to medium-sized mammal, and 6 were fragmentary unidentifiable specimens of indistinguishable small mammal bone.

Identifiable large mammal remains included two cervical vertebrae fragments, two indeterminate diaphyseal long bone fragments, one scapula fragment, one vertebral body fragment of unknown position, and one vertebral epiphysis, all from deer/sheep-sized artiodactyl. Three cranial fragments, one diaphyseal rib fragment, two vertebrae fragments and two tooth fragments from large-sized mammals were also identified. The tooth fragments are consistent with *Cervidae* of deer/sheep-size, but were too fragmentary to be accurately identified beyond that distinction. 56 specimens of mule deer (*O. hemionus*) were positively identified, including: one cervical vertebra, two diaphyseal femur fragments, one posterior diaphyseal fragment of a right humerus, three diaphyseal fragments of unidentifiable long bone, one fragment from a lumbar vertebra, two mandible fragments – one from the right side, the other indeterminable, one diaphyseal fragment of a metacarpal, one lateral-anterior fragment of the proximal end of a metacarpal, one diaphyseal fragment of a left metatarsal, one diaphyseal fragment of an un-sided metatarsal, two diaphyseal fragments of right metatarsal, one 2nd phalanx, one fragment of the right pubis, eight phalanges (including three complete elements), one distal fragment of a left radius, one diaphyseal fragment of a radius, one distal fragment of an un-sided radius, fourteen rib fragments, one thoracic vertebra fragment, four diaphyseal tibia fragments – one a proximal portion of a left element, three tooth fragments (compared exceptionally well to selenodont dentition of multiple comparative collection mule deer, but may be from another deer/sheep-sized *Cervid*), two vertebra fragments of unknown position, and one complete dew claw (vestigial metapodial). One distal condyle from a metacarpal and one proximal fragment of a metatarsal, both from bighorn sheep (*O. canadensis*) were also identified.

Identifiable medium- to large-sized mammal bone consisted of a fragment from the posterior epiphyseal surface of a cervical vertebra, one fragment from the anterior body of an indeterminate vertebra, seven other indeterminate vertebra fragments, one diaphyseal fragment from a tibia, one rib fragment, for *Cervidae* tooth fragments consistent with deer/sheep-sized individuals, and at least 29 fragments of diaphyseal long bone.

Faunal specimens identified from medium-sized mammals consisted of one proximal fragment from the epiphyseal surface of a tibia, one fragment from a lumbar vertebra, two thoracic vertebrae fragments, and one diaphyseal fragment from a right ulna, all from medium-sized dog (c.f. *C. latrans*). Identifiable beaver (*C. Canadensis*) remains consisted of one cranial fragment, three fragmentary incisors, one mandible fragment, one rib fragment and two complete ribs, one tibia fragment and one fragment of a vertebral articular surface – possibly from a lumbar vertebra. Other specimens included: one rib fragment of unknown origin and one undiagnostic tooth enamel fragment that could not be apportioned to any taxonomic class beyond likely coming from a medium mammal.

Identifiable bones attributed to small- to medium-sized mammals included nine fragmentary specimens, four of which exhibit features consistent with vertebral morphology, such as pedicle-articular process sections, but could not be positively identified to particular vertebral elements or to taxon.

Avian faunas from Level one consisted of six specimens, including two specimens from a medium (grouse-sized) bird, one right carpometacarpus and one incomplete tibiotarsus fragment,

both compared favorably to a member of the *Phasianidae* family, likely Sooty Grouse (*Dendragapus fuliginosus*). Two specimens compared favorably to White-tailed Ptarmigan (*Lagopus leucura*) and articulated with one another. These were one complete left carpometacarpus and one complete left 1st phalanx. Another unidentifiable specimen was consistent with diaphyseal long bone of small-sized bird, but could not be positively compared. One incomplete fragment of a carpometacarpus from a small- to medium-sized bird was also recovered but could not be positively identified.

Fish remains from Level one of stratum IIa included one specimen that could not be identified beyond that of the Class *Osteichthyes* (bony fish), and one, similarly anomalous vertebra fragment. Other specimens included one indeterminate cranial bone from a medium-sized bony fish and 23 rays/spines/ribs also consistent in size with medium-sized fish. Remains identified to Salmonidae of indeterminate size included 52 specimens, comprised of one branchial arch and eight unidentifiable cranial bone fragments, seven thoracic vertebrae, ten pre-caudal vertebrae, six caudal vertebrae, ten incomplete vertebrae of indeterminate position, one expanded Haemal spine, two neural spines, and seven rays/spines/ribs.

Sockeye salmon (*O. nerka*) made up the bulk of the fish assemblage of IIa. Identifiable specimens included: one angular, one cerato-branchial, four branchial arches, one circumorbital bone, four collars, three coracoids, one frontal, nine hyoid arches, one mandibular arch, four opercles, one orbital, four pectoral girdles, five pelvic girdles, one postcleithrum, one quadrate, three scapulas, one suborbital, 361 unidentifiable fragmentary cranial bones, and nine indeterminate element fragments consistent with cranial bone structure. Identifiable vertebral

specimens consisted of 50 thoracic vertebrae, 20 pre-caudal vertebrae, 35 caudal vertebrae, and 163 incomplete vertebrae of indistinguishable position. Other Sockeye elements included one expanded Haemal spine, and 1672 rays/spines/ribs.

Small “trout-sized” fish remains consisted of one caudal vertebra from an indeterminate small-bodied *Osteichthyes*, three cranial bone fragments from small *Salmonidae* (c.f. *O. mykiss*), and ten thoracic vertebrae, one pre-caudal vertebra, four incomplete vertebra of unknown position, and one ray/spine/rib – all consistent with rainbow trout (*O. mykiss*).

Chinook salmon (*O. tshawytscha*) specimens in Level one consisted of ten pre-caudal vertebrae and three fragmentary vertebrae of indistinguishable position.

Level Two

Level two contained 192 mammal and 91 fish specimens.

Mammal bone specimens consisted of 12 entirely indeterminate specimens, ten indeterminate specimens from large-sized mammal(s), including nine diaphyseal long bone fragments. Two enamel fragments from *Cervidae* teeth were identified, and were consistent in general thickness and shape with deer/sheep-sized individuals, but could not be positively designated beyond the *Cervid* classification. Deer (*O. hemionus*) specimens included: one femur fragment, one lateral fragment of a distal condyle from a metatarsal, one undesignated vertebra body fragment, and one diaphyseal long bone fragment.

Medium- to large-sized mammal bone consisted of 163 specimens. These included: one fragment that compared favorably to a posterior section of a scapula, and 110 fragments of diaphyseal long bone.

One fragmentary specimen was from a diaphyseal portion of long bone from an indeterminate small-sized mammal.

Fish remains from Level two consisted of: two thoracic vertebrae and two incomplete vertebrae from unidentifiable *Salmonidae* spp., one thoracic vertebra from a Chinook salmon, seven cranial bone specimens from Sockeye, including one branchial arch, one mandible, and five unidentifiable cranial bone fragments, one thoracic vertebra, one pre-caudal vertebra, two incomplete vertebra of unknown position, and 53 rays/spines/ribs. Trout-sized specimens consisted of three thoracic vertebrae consistent with rainbow trout.

Level Three

Level three contained only 22 faunal specimens. These included: four unidentifiable mammal bone fragments from indeterminate size or taxon, one diaphyseal long bone fragment from an unknown large mammal, seven diaphyseal long bone fragments from indeterminate medium- to large-sized mammal(s), and seven indeterminate element fragments from medium- to large-sized mammal.

Fish bone consisted of two incomplete vertebrae specimens from *Salmonidae* spp. of unknown size, and one incomplete vertebra from a small *Salmonid*.

Level Four

Level four contained one specimen that could not be identified to any taxonomic category due to deterioration/weathering. Nine specimens were unidentifiable fragments from indeterminate mammal(s). Two specimens were from deer, both diaphyseal fragments from metapodials. 20 fragments were from medium- to large-sized mammals, at least one of which was that of diaphyseal long bone. One specimen was from a fragment of bone from an indeterminate small mammal.

Fish specimens from Level four consisted of one fragmentary cranial element (epural bone) from an indeterminate medium-sized bony fish and six unidentifiable fragments of similar designation. Specimens identified to medium *Salmonidae* spp. included one mandibular arch, three thoracic vertebrae, one caudal vertebra, two ultimate vertebrae, six incomplete vertebrae of undeterminable position, 41 rays/spines/ribs, and five unidentifiable fragments consistent in structure with cranial bone fragments.

12 Chinook pre-caudal vertebrae were also identified from Level four.

Level Five

Level Five contained two mammal bone specimens from indeterminate element or taxon, one of which was from a small-sized animal. Two incomplete vertebrae were from *Salmonidae* spp. of indeterminable size, and one incomplete vertebra was consistent with that of rainbow trout.

ROOF DEPOSITS

Roof deposits generally consist of a matrix of mixed sediments and other organic and inorganic materials. In all cases at Housepit 54, these deposits have been altered by fire, presumably as the roofs themselves were razed as a precursor to pithouse reconstruction about every 20-25 years. Most roof deposits contain relatively large amounts of artifacts and animal remains that were discarded from the interior of the house onto the roof during the life of the pithouse. Because these remains are associated with both initial roof construction, consisting of the layering and building up of wood beams, various sediments, sod, and other organic materials, as well as countless subsequent depositional events such as refuse disposal, materials recovered from roof contexts cannot be positively associated to exact interior occupation floor levels, features, or activity areas so are therefore considered only generally concomitant with whatever stratum they directly overlay. For these reasons, roof deposits are described separately from the occupational strata that they once housed. Their description is included here because (as will be discussed later) their contents may contribute valuable information regarding assemblage structure between strata.

STRATUM Vc

Stratum Vc represents the remains of a roof deposit from between occupations midway through BR2, between Strata IIh and IIg.

Faunal materials from roof Stratum Vc consisted of 201 specimens from a single level. The assemblage contained 106 mammal bone specimens and 95 fish specimens.

Level One

The mammal bone assemblage from Stratum Vc contained 41 unidentifiable fragmentary specimens from large-sized animal(s). Identifiable specimens from large-sized mammals included 16 fragments of diaphyseal long bone consistent with those of artiodactyls, including three fragments of metatarsal. Other identifiable remains were those of mule deer (*O. hemionus*) and consisted of: one complete cuniform, two complete pisiforms, one sesamoid, one complete 1st phalanx, two proximal phalange fragments that could not be identified to position, one diaphyseal fragment of a right radius, one rib fragment, one diaphyseal fragment of a tibia, and one selenodont molar consistent with mule deer samples, but potentially from any similarly-sized *Cervidae* spp. with selenodont dentition.

Specimens from medium- to large-sized mammals consisted of 27 unidentifiable fragments from indistinguishable elements, although 11 of which were fragments from diaphyseal portions of long bones.

Fish specimens consisted of one cranial element fragment from an undistinguishable medium-sized bony fish, three specimens from Chinook salmon (*O. tshawytscha*) – one cranial bone fragment, one pre-caudal vertebra, and one Haemel spine (a caudal portion), 90 Sockeye (*O. nerka*) specimens, and one incomplete thoracic vertebra from a rainbow trout (*O. mykiss*). Sockeye specimens consisted of one cranial bone – a Branchial arch, 43 thoracic vertebrae, 34 pre-caudal vertebrae, one caudal vertebra, one ultimate vertebra, one incomplete vertebra of unknowable position, and nine rays/spines/ribs.

STRATUM Vb

Stratum Vb actually represents deposits from two roofing events, one from Blocks A and C, and one, seemingly a sub-roof overlaying a portion of Block B, both constructed midway through BR3, between Strata IId and IIc. Because these roofs overlay the same occupation floor (Stratum IId) they have been combined for the purposes of this analysis.

Faunal materials from roof Stratum Vb consisted of 178 specimens from one level and two features (B-3 and D-8). The assemblage contained 135 mammal bone specimens and 43 fish specimens.

Level One

The mammal bone assemblage from Stratum Vb contained six specimens from undistinguishable elements from individuals of unknown size or taxon. Specimens from large-sized mammals included 60 fragments from undeterminable elements, 46 of which were diaphyseal portions of long bones. Other specimens from large-sized mammals included one fragment of a metapodial from an undistinguishable artiodactyl, one proximal fragment of a radius and two diaphyseal fragments from a tibia – both from bighorn sheep (*O. canadensis*); one diaphyseal fragment compared favorably to the right metapodial of a mule deer (*O. hemionus*), and other identifiable deer remains consisted of one dew claw, three metatarsal fragments, two radius fragments – one a distal portion of a right radius, one diaphyseal tibia fragment, one selenodont deer premolar (which could possibly be from a similarly-dentitioned *Cervidae* genera of deer/sheep-size, but compared favorably to mule deer in the comparative collection), one rib fragment, and one

diaphyseal fragment from a long bone not positively identifiable to specific element but consistent in size, bone structure, and diameter to those of mule deer.

Specimens from medium- to large-sized mammals consisted of 40 fragmentary pieces of bone, all unidentifiable to specific element, but 25 of which were diaphyseal portions of long bone.

Medium-sized mammal bone consisted of only five specimens, two of which were undeterminable to element or taxon. Two specimens were from beaver (*C. canadensis*) – one rib fragment and one incisor. The right portion of a porcupine (*Erethizon dorsatum*) mandible was also identified.

One specimen was from an undistinguishable element from an undeterminable small- to medium-sized mammal, and one specimen of small-sized mammal remains compared favorably to the lower incisor of a muskrat (*Ondatra zibethicus*), but could possibly be from a large squirrel (*Sciuridae* spp.) or Yellow-bellied marmot (*Marmota flaviventris*).

Fish bone specimens from the Vb roof deposit consisted of nine incomplete vertebra fragments from *Salmonidae* spp. of undeterminable size range, but likely consistent with medium-sized fish (i.e. Sockeye). These included one thoracic vertebra, one pre-caudal vertebra, and seven vertebrae too fragmented to identify to position. Five Sockeye (*O. nerka*) vertebrae were identified, including one thoracic vertebra and four pre-caudal vertebrae.

Feature B-3

Feature B-3 contained four bone specimens: two fragments of undeterminable elements from large-sized mammal(s), one a diaphyseal portion of a long bone; and two entirely unidentifiable fragments from medium- to large-sized mammal(s).

Feature D-8

Feature D-8 contained two mammal bone specimens and 29 fish bone specimens. The mammal bone specimens were both diaphyseal long bone fragments from undeterminable elements from large-sized animals. The fish bone specimens were all from Sockeye salmon, and consisted of: 17 cranial bone fragments, one a pectoral girdle, but the others too fragmentary to identify to element, and 12 rays/spines/ribs.

STRATUM Va

Stratum Va represents the final roof at Bridge River during the BR3 period – marking the last roof burned down over the last floor (IIa) seemingly immediately prior to village abandonment.

Faunal materials from roof Stratum Va consisted of 985 specimens from four levels. The assemblage contained 723 mammal bone specimens, 273 fish specimens, 11 bird specimens, and 15 taxonomically unidentifiable specimens.

Level One

Mammal bone from Level one consisted of 570 fragmentary specimens (no complete mammal bone was recovered). Of these, 35 were from indeterminate elements from unidentifiable mammal(s). 154 specimens were similarly unidentifiable element fragments from large-sized mammal (although, three specimens were identified that compared favorably to specific elements of mule deer (*O. hemionus*): one metatarsal, one rib, and one diaphyseal tibia – all fragments). 285 were from medium- to large-sized mammal; 40 were from indeterminate medium-sized mammal, one was from small-to medium-sized mammal, and one specimen was from an indistinguishable small mammal bone.

Identifiable bone specimens from large mammals included one calcaneus, one lumbar vertebra, and one rib, all fragments and all from indeterminate deer/sheep-sized artiodactyl. Two specimens came from bighorn sheep (*O. canadensis*). These consisted of one radius fragment and one ulna fragment with cut marks. 42 fragmentary specimens were identified as mule deer.

These included: one 1st phalanx, one 2nd phalanx, and one 3rd phalanx (all from different spatial contexts, although the 1st and 2nd phalanx do come from adjacent Units in Block A and thus could be from the same individual). Other deer specimens consisted of: one epiphyseal articular process from an undeterminable long bone, three rib fragments, one diaphyseal femur fragment, two humerus fragments (both with spiral fractures and one with flake scars and some evidence of polishing), one metacarpal fragment, six metatarsal fragments, one fragment from an indeterminable metapodial, one phalanx fragment, one radius fragment, four fragments of tibia, one diaphyseal ulna fragment, two indeterminable vertebra fragments, and 14 diaphyseal long bone fragments from unknown elements. One fragment of a selenodont tooth from a deer/sheep-sized *Cervidae* was also recovered.

Identifiable bone attributed to medium- to large-sized mammal(s) consisted of one rib fragment and one vertebra fragment, both from undeterminable taxon.

Identifiable specimens from medium-sized mammals consisted of one tibia fragment, one rib fragment, and one incisor from beaver (*C. canadensis*). One fragment compared favorably to a dog (c.f. *C. latrans*) ulna, and one carnassial tooth was also from dog. Other identifiable fragments consisted of one 1st phalanx, and one section of vertebral epiphysis, neither of which could be identified to taxon.

Specimens from small- to medium-sized mammal and small-sized mammal consisted of a single fragment from indeterminable origin from each.

Avian faunas from Level one consisted of 12 specimens, including five crania fragments, one fragmentary mandible, and three pelvis fragments, all from a medium (grouse-sized) bird that compared favorably to a member of the *Phasianidae* family, likely Sooty Grouse (*Dendragapus fuliginosus*) or Dusky Grouse (*Dendragapus obscurus*). One incomplete occipital bone was from a smaller bird – possibly a Ptarmigan (*Lagopus* spp.), Band-tailed Pigeon (*Patagionas fasciata*) or similar slightly smaller-sized avian. Two specimens could not be positively identified, but one was determined to be a diaphyseal fragment from a long bone, probably an ulna or lower section of a tibiotarsus, and possessed four un-decorative perpendicular cut marks and had also been polished.

Fish remains from Level one of stratum Va included 36 specimens from indeterminate medium-sized *Osteichthyes* (bony fishes) including 34 fragmentary vertebra of undeterminable position, one ray/spine/rib, and one unidentifiable element fragment (likely cranial); five specimens from *Salmonidae* spp. of indeterminate size included one fragmentary Branchial arch, one caudal vertebra, one ray/spine/rib, and two unidentifiable fragments. 31 specimens were from medium-sized *Salmonidae* spp. (likely Sockeye or Pink, but also potentially in the size range of steelhead, Coho, or Chum salmon). These consisted of: four thoracic vertebra, six pre-caudal vertebrae, 19 incomplete vertebrae of undeterminable position, and one ray/spine/rib. One fragment could not be positively identified beyond that of bony fish.

Sockeye (*O. nerka*) remains consisted of 81 specimens. These included: 14 thoracic vertebrae, three pre-caudal vertebrae, 11 caudal vertebrae, and 51 incomplete vertebrae of undeterminable position.

Four specimens were from Chinook salmon (*O. tshawytscha*). These consisted of three fragmentary vertebrae and one caudal vertebra.

Remains from small-sized fish included two thoracic vertebrae that could not be positively identified to specific taxon beyond coming from bony fishes. 19 specimens were from rainbow trout (*O. mykiss*), including: nine thoracic vertebrae, three caudal vertebrae, and seven incomplete vertebrae of indistinguishable position. Other small fish remains included 13 thoracic vertebrae, five caudal vertebrae, five incomplete vertebrae of undeterminable position, and one ray/spine/rib.

Levels One and Two

The transition between Level one and Level two in Unit 14 of Block C was difficult to distinguish, resulting in four bone specimens having been collected as from Level 1/2. For purposes of this analysis, these specimens have been included in the Level one count outside this description (Tables and subsequent Figures). These specimens consisted of: one spiral-fractured fragment that compared favorably to the humerus of a black bear (*Ursus americanus*), one vertebra fragment from an undistinguishable medium-sized mammal, one diaphyseal long bone fragment from an indeterminable large-sized mammal, and one caudal vertebra from a small salmonid.

Level Two

Level two contained 157 specimens: 128 from mammals and 29 from bony fishes.

The Level two mammal bone assemblage contained three fragmentary specimens that could not be distinguished to size or taxon. Bone fragments attributed to large-sized mammals consisted of 30 specimens from indeterminable element or taxon (including one metacarpal/metatarsal fragment). Other specimens from large-sized mammals consisted of: two diaphyseal tibia fragments, one right humerus fragment with multiple perpendicular cut marks, one radius fragment, one rib fragment, and one undeterminable vertebra fragment. One fragment of a cervical vertebra from an indistinguishable artiodactyl was also identified.

Medium- to large-sized mammal bone specimens consisted of 72 fragments from undeterminable element or taxon. Medium-sized mammal bone consisted of one fragment of a dog humerus, and eight unidentifiable bone fragments, two of which appeared to be cranial.

Mammal bone from small-sized animals consisted of two unidentifiable fragments and two fragmentary rodent humeri, both from mouse-sized individual(s).

The fish bone assemblage from Level two contained: six incomplete specimens from *Salmonidae* spp. of undeterminable size, including two thoracic vertebrae, two caudal vertebrae, one ray/spine/rib, and one undistinguishable fragment (likely from a cranial element). Five incomplete vertebrae were from medium-sized bony fish of undistinguishable taxon. Eight specimens were from Sockeye salmon, including: one thoracic vertebra, four caudal vertebrae, and three incomplete vertebrae of unknowable position.

Level 2 fish bone specimens from small-sized fish included: one entirely unidentifiable fragment (possibly cranial), eight specimens consistent with small-bodied *Salmonidae* spp. (likely rainbow trout but potentially Mountain whitefish [*Prosopium williamsoni*], or char [*Salvelinus* spp.]) or other similarly-sized salmonids, including three thoracic vertebrae, two caudal vertebrae, one undeterminable vertebra, one unidentifiable fragment, and one ray/spine/rib. One rainbow trout thoracic vertebra was also identified.

Level Three

The Level three faunal assemblage from stratum Va contained 26 specimens. These consisted of: three unidentifiable fragments from large-sized mammal(s); four deer bone specimens including one incomplete phalanx fragment and one incomplete 3rd phalanx fragment and two unidentifiable diaphyseal long bone fragments; ten unidentifiable fragments of bone from medium- to large-sized mammal(s); four fragmentary specimens from medium-sized mammals, including two from beaver – the 1st and 2nd phalanges (these articulate and are likely from the same individual); one humerus fragment from a indeterminate mouse-sized mammal; and four specimens from a small-sized *Salmonidae* spp., including one thoracic vertebra and three unidentifiable fragments (likely from cranial elements).

Level Four

A single unidentifiable fragment from a trout-sized *Salmonidae* spp. was recovered from Level four.

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APPENDIX B

FAUNAL ASSEMBLAGES BY STRATUM & EXCAVATION MAPS OF FAUNAL DISTRIBUTIONS BY UNIT

Stratum IIj Faunal Assemblage and Distribution

Taxon	Stratum IIj Taxon by Block		Stratum IIj Assemblage	Feat A-19/2	Feat A-22/1	Feat A-23/2	IIj Total
	A Level 1	A Level 2					
Osteichthyes	44	13	57	0	14	0	71
<i>Salmonidae</i>	0	0	0	0	0	0	0
c.f. <i>Oncorhynchus nerka</i>	40	13	53	0	10	0	63
c.f. <i>Oncorhynchus tshawytscha</i>	0	0	0	0	0	0	0
c.f. <i>Salmonid</i> (trout-sized)	3	0	3	0	4	0	7
Indeterminate	1	0	1	0	0	0	1
Mammalia	55	3	58	1	23	2	84
Small	1	0	1	0	0	0	1
Medium	5	2	7	0	0	1	8
Small-Medium	0	0	0	0	0	0	0
Large	11	1	12	1	1	0	14
Medium-Large	33	0	33	0	22	1	56
Undeterminate	5	0	5	0	0	0	5
Artiodactyla	9	1	10	1	0	0	11
Indeterminate <i>Cervidae</i> / <i>Artiodactyl</i>	0	0	0	0	0	0	0
<i>Odocoileus hemionus</i>	8	1	9	1	0	0	10
<i>Ovis canadensis</i>	1	0	1	0	0	0	1
Carnivora	1	0	1	0	0	1	2
<i>Ursus americanus</i>	0	0	0	0	0	0	0
<i>U. arctos</i>	0	0	0	0	0	0	0
Canis sp.	1	0	1	0	0	1	2
<i>Canis</i> sp. (c.f. <i>Canis latrans</i>)	1	0	1	0	0	1	2
Rodentia	1	0	1	0	0	0	1
<i>Castor canadensis</i>	0	0	0	0	0	0	0
<i>Ondatra zibethicus</i>	0	0	0	0	0	0	0
Erethizon dorsatum	0	0	0	0	0	0	0
Scuriidae sp.	1	0	1	0	0	0	1
<i>Sciuridae</i> (c.f. <i>Tamiasciurus hudsonicus</i>)	1	0	1	0	0	0	1
Aves	0	0	0	0	0	0	0
<i>Falconiformes</i> (c.f. <i>Buteo</i> sp.)	0	0	0	0	0	0	0
c.f. <i>Phasianidae</i> sp.	0	0	0	0	0	0	0
<i>Phasianidae</i> sp. (c.f. <i>Dendragapus fuliginosus</i>)	0	0	0	0	0	0	0
<i>Phasianidae</i> sp. (c.f. <i>Lagopus leucura</i>)	0	0	0	0	0	0	0
Bivalvia	0	0	0	0	0	0	0
<i>Ostreidae</i> spp.	0	0	0	0	0	0	0
Unidentifiable	0	0	0	0	0	0	0

Table A.1. Stratum IIj Faunal Assemblage.

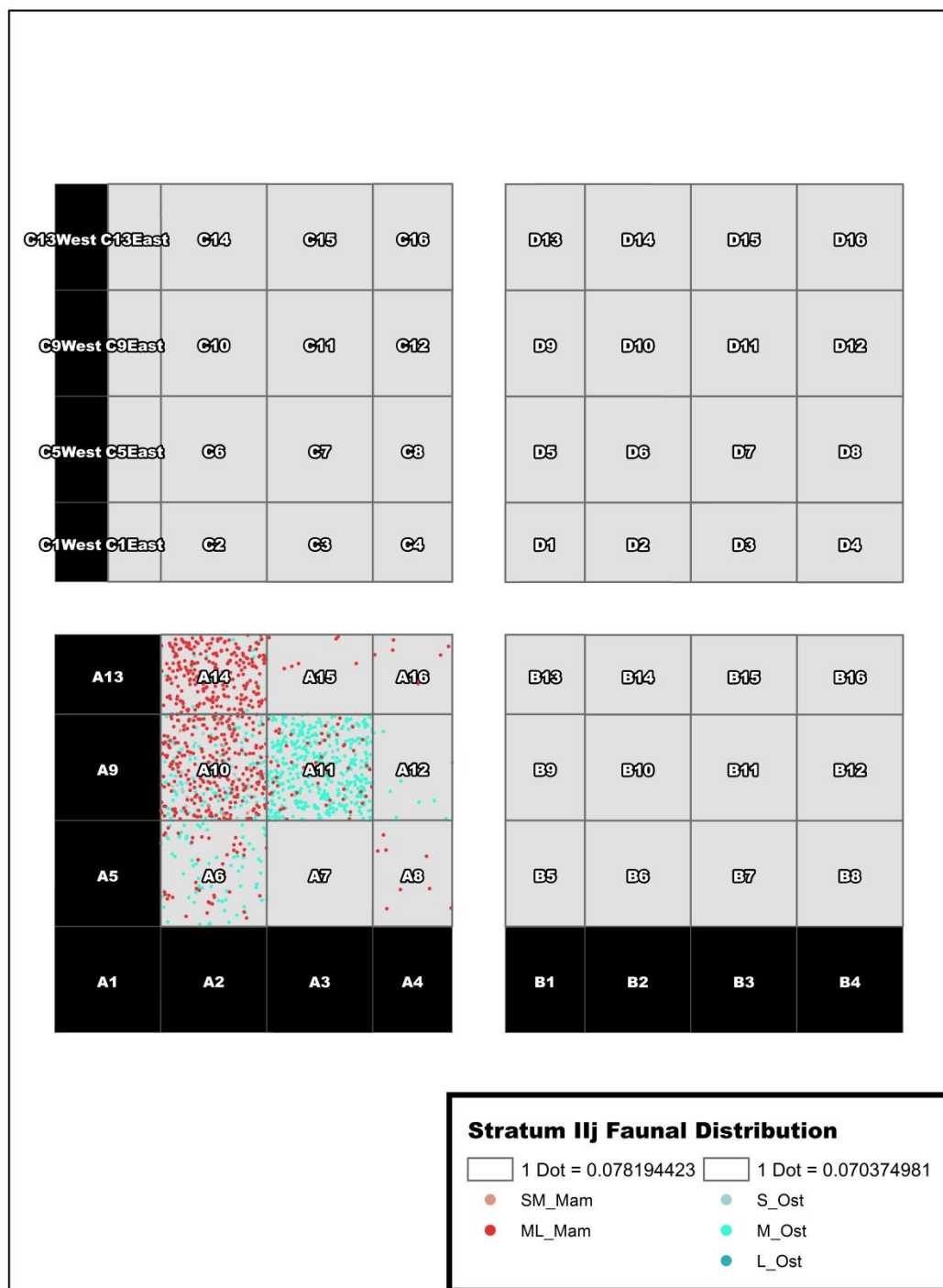


Figure A.1. Stratum IIj Faunal Assemblage Distribution by Unit.

Stratum Ili Faunal Assemblage and Distribution

Taxon	Stratum Ili Taxon by Block		Stratum Ili Assemblage	Feat A-11	Ili Total
	A Level 1	A Level 2			
Osteichthyes	114	0	114	0	114
<i>Salmonidae</i>	0	0	0	0	0
c.f. <i>Oncorhynchus nerka</i>	110	0	110	0	110
c.f. <i>Oncorhynchus tshawytscha</i>	0	0	0	0	0
c.f. <i>Salmonid</i> (trout-sized)	0	0	0	0	0
Indeterminate	4	0	4	0	4
Mammalia	70	3	73	2	75
Small	4	0	4	0	4
Medium	5	0	5	0	5
Small-Medium	25	0	25	0	25
Large	12	3	15	2	17
Medium-Large	12	0	12	0	12
Undeterminate	12	0	12	0	12
Artiodactyla	11	3	14	2	16
Indeterminate <i>Cervidae</i> / <i>Artiodactyl</i>	1	0	1	0	1
<i>Odocoileus hemionus</i>	9	3	12	2	14
<i>Ovis canadensis</i>	1	0	1	0	1
Carnivora	0	0	0	0	0
<i>Ursus americanus</i>	0	0	0	0	0
<i>U. arctos</i>	0	0	0	0	0
Canis sp.	0	0	0	0	0
<i>Canis</i> sp. (c.f. <i>Canis lupus</i>)	0	0	0	0	0
Rodentia	4	0	4	0	4
<i>Castor canadensis</i>	1	0	1	0	1
<i>Ondatra zibethicus</i>	0	0	0	0	0
c.f. <i>Peromyscus maniculatus</i>	3	0	3	0	3
Erethizon dorsatum	0	0	0	0	0
Scuriidae sp.	0	0	0	0	0
Aves	1	0	1	0	1
<i>Falconiformes</i> (c.f. <i>Buteo</i> sp.)	0	0	0	0	0
c.f. <i>Phasianidae</i> sp.	0	0	0	0	0
<i>Phasianidae</i> sp. (c.f. <i>Dendragapus fuliginosus</i>)	0	0	0	0	0
<i>Phasianidae</i> sp. (c.f. <i>Lagopus leucura</i>)	0	0	0	0	0
Bivalvia	0	0	0	0	0
<i>Ostreidae</i> spp.	0	0	0	0	0
Unidentifiable	0	0	0	0	0

Table A.2. Stratum Ili Faunal Assemblage.

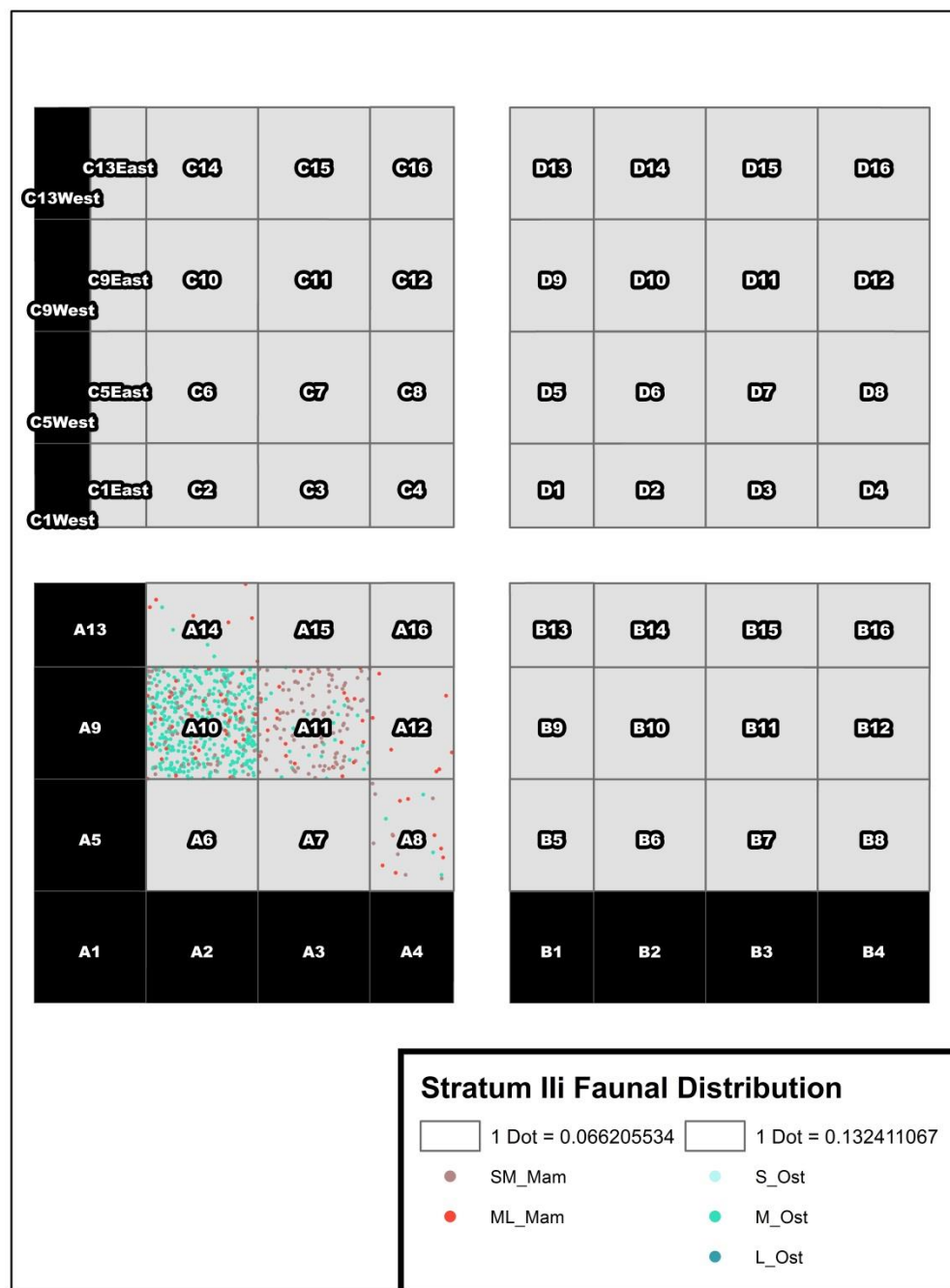


Figure A.2. Stratum Ili Faunal Assemblage Distribution by Unit.

Stratum IIh Faunal Assemblage and Distribution

Taxon	Stratum IIh Taxon by Block		C Levels 1&2	Stratum IIh Assemblage	Feat A-5 Level					Feat A-13	IIh Total
	A Level 1	A Level 2			2	3	4	5	6		
Osteichthyes	5	25	2	32	70	4	22	6	0	0	134
<i>Salmonidae</i>	0	0	0	0	0	0	0	0	0	0	0
c.f. <i>Oncorhynchus nerka</i>	5	23	2	30	69	4	22	6	0	0	131
c.f. <i>Oncorhynchus tshawytscha</i>	0	0	0	0	1	0	0	0	0	0	1
c.f. <i>Salmonid</i> (trout-sized)	0	2	0	2	1	0	0	0	0	0	3
Indeterminate				0	0	0	0	0	0	0	0
Mammalia	24	38	0	62	24	6	19	8	1	1	120
Small	0	0	0	0	0	0	0	0	0	0	0
Medium	2	3	0	5	3	1	3	2	0	0	14
Small-Medium	0	1	0	1	0	0	0	0	0	0	1
Large	6	11	0	17	4	0	3	3	0	1	25
Medium-Large	1	23	0	24	0	0	8	1	0	0	33
Undeterminate	15	0	0	15	18	5	5	5	0	0	48
Artiodactyla	4	10	0	14	4	0	2	0	0	1	21
Indeterminate Cervidae/Artiodactyl	0	0	0	0	1	0	0	0	0	0	1
<i>Odocoileus hemionus</i>	3	10	0	13	2	0	2	0	1	1	18
<i>Ovis canadensis</i>	1	0	0	1	1	0	0	0	0	0	2
Carnivora	0	2	0	2	2	0	1	2	0	0	7
<i>Ursus americanus</i>	0	0	0	0	0	0	0	0	0	0	0
<i>U. arctos</i>	0	0	0	0	0	0	0	0	0	0	0
Canis sp.	0	2	0	2	2	0	1	2	0	0	7
<i>Canis sp.</i> (c.f. <i>Canis lupus</i>)	0	0	0	0	1	0	0	0	0	0	1
Rodentia	2	1	0	3	1	0	2	0	0	0	6
<i>Castor canadensis</i>	2	1	0	3	1	0	2	0	0	0	6
<i>Ondatra zibethicus</i>	0	0	0	0	0	0	0	0	0	0	0
<i>Peromyscus maniculatus</i>	0	0	0	0	0	0	0	0	0	0	0
Erethizon dorsatum	0	0	0	0	0	0	0	0	0	0	0
Scuriidae sp.	0	0	0	0	0	0	0	0	0	0	0
Aves	0	0	0	0	0	0	0	0	0	0	0
<i>Falconiformes</i> (c.f. <i>Buteo sp.</i>)	0	0	0	0	0	0	0	0	0	0	0
c.f. <i>Phasianidae sp.</i>	0	0	0	0	0	0	0	0	0	0	0
<i>Phasianidae sp.</i> (c.f. <i>Dendragapus fuliginosus</i>)	0	0	0	0	0	0	0	0	0	0	0
<i>Phasianidae sp.</i> (c.f. <i>Lagopus leucura</i>)	0	0	0	0	0	0	0	0	0	0	0
Bivalvia	0	0	0	0	0	0	0	0	0	0	0
<i>Ostreidae spp.</i>	0	0	0	0	0	0	0	0	0	0	0
Unidentifiable	0	0	0	0	0	0	0	0	0	0	0

Table A.3. Stratum IIh Faunal Assemblage.

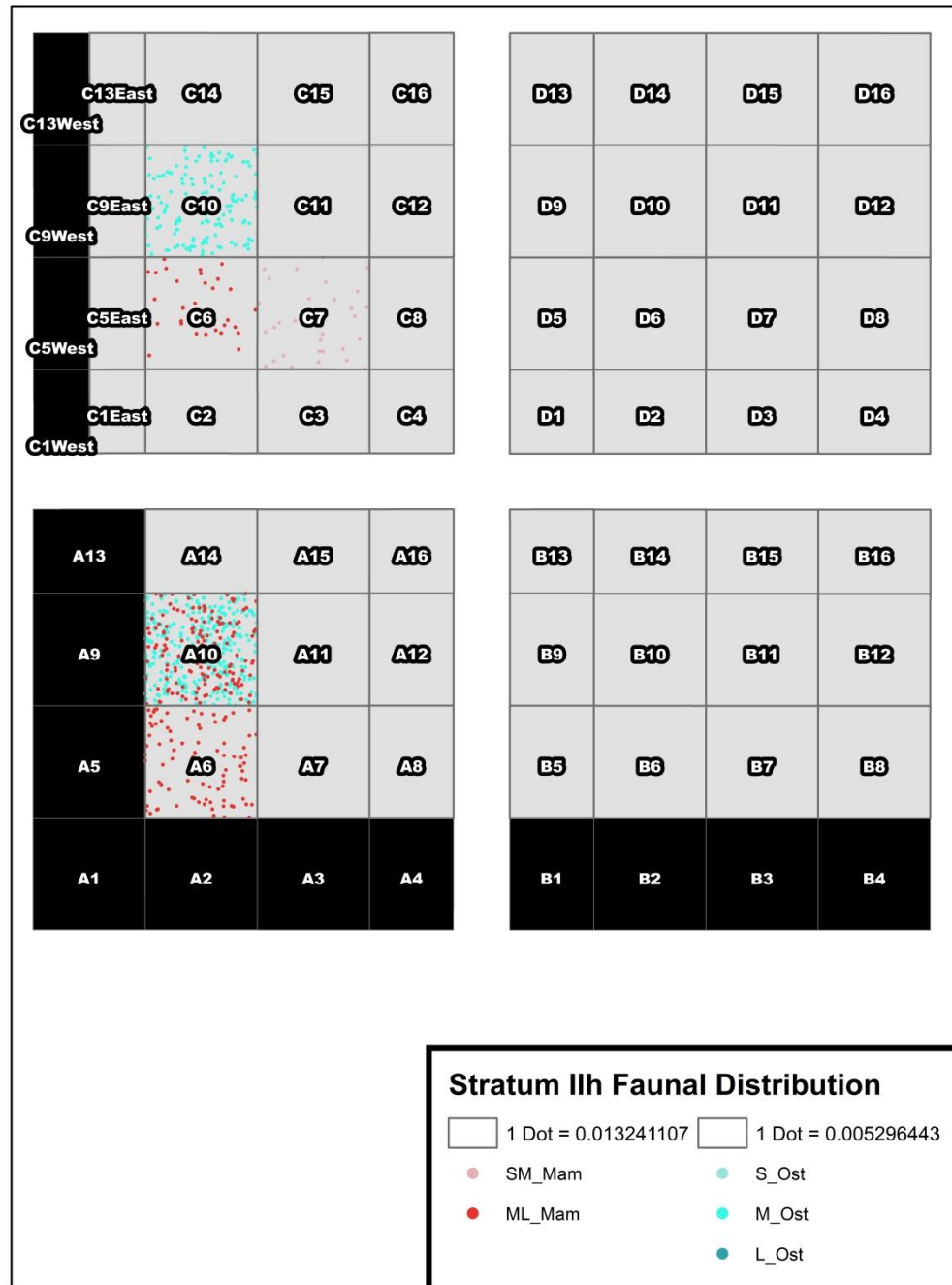


Figure A.3. Stratum IIh Faunal Assemblage Distribution by Unit.

Stratum IIg Faunal Assemblage and Distribution

Taxon	Stratum IIg Taxon by Block										Stratum IIg Levels 1&2	Feat A-1 Level 1										Feat A-1 Level 2	Feat A-1 Level 3										Feat A-1 Level 4	Feat A-1 Level 5	Feat A-1 Level 6	Feat A-1 Level 7	Feat C-7	Feat C-12	Feat C-27	Feat C-28	Feat C-31	Feat C-33	IIg Total
	A	B	C	D	Level 2 (Block A only)	Stratum IIg Levels 1&2	Feat A-1 Level 1	Feat A-1 Level 2	Feat A-1 Level 3	Feat A-1 Level 4		Feat A-1 Level 5	Feat A-1 Level 6	Feat A-1 Level 7	Feat C-7	Feat C-12	Feat C-27	Feat C-28	Feat C-31	Feat C-33	IIg Total																						
<i>Osteichthyes</i>	6	0	111	0	1	118	1	5	0	1	1	3	2	8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	149									
<i>Salmonidae</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
<i>C.f. Oncorhynchus nerka</i>	6	0	102	0	1	109	1	5	0	1	1	3	2	8	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	138									
<i>C.f. Oncorhynchus tshawytscha</i>	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1										
<i>C.f. Salmon (trout-sized)</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0										
Indeterminate	0	0	8	0	0	8	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10										
Mammalia	52	0	171	0	2	225	4	12	0	21	4	8	1	27	25	34	9	2	3	375																							
Small	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																							
Medium	2	0	4	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0																							
Small-Medium	0	0	14	0	0	14	0	0	0	1	0	0	0	0	0	0	0	0	0	0																							
Large	18	0	37	0	1	55	2	3	0	2	3	0	1	19	1	6	1	1	2	0																							
Medium-Large	27	0	56	0	1	84	2	1	0	1	1	6	0	2	24	3	3	0	3	100																							
Undeterminate	5	0	60	0	0	65	1	8	0	17	0	2	0	6	0	14	1	0	0	114																							
Artiodactyla	6	0	19	0	1	26	1	0	0	2	2	0	1	0	0	5	0	1	0	38																							
Indeterminate Cervidae (Artiodactyl)	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2																							
<i>Odocoileus hemionus</i>	6	0	17	0	1	24	0	0	0	2	1	0	1	0	0	5	0	1	0	34																							
<i>Ovis canadensis</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																							
<i>Oreamnos americanus</i>	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1																							
Carnivora	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1																							
<i>Ursus americanus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																							
<i>U. arctos</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																							
<i>Canis</i> sp.	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0																							
Rodentia	2	0	2	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	4																							
<i>Castor canadensis</i>	2	0	2	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0																							
<i>Onychomys leucogaster</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																							
<i>Peromyscus maniculatus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																							
Erethizontidae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																							
<i>Erethizon dorsatum</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																							
Scuriidae sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																							
Aves	0	0	4	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0																							
<i>C.f. Phasianidae</i> sp.	0	0	4	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0																							
Bivalvia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																							
<i>Ostreidae</i> spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																							
Unidentifiable	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0																							

Table A.4. Stratum IIg Faunal Assemblage.

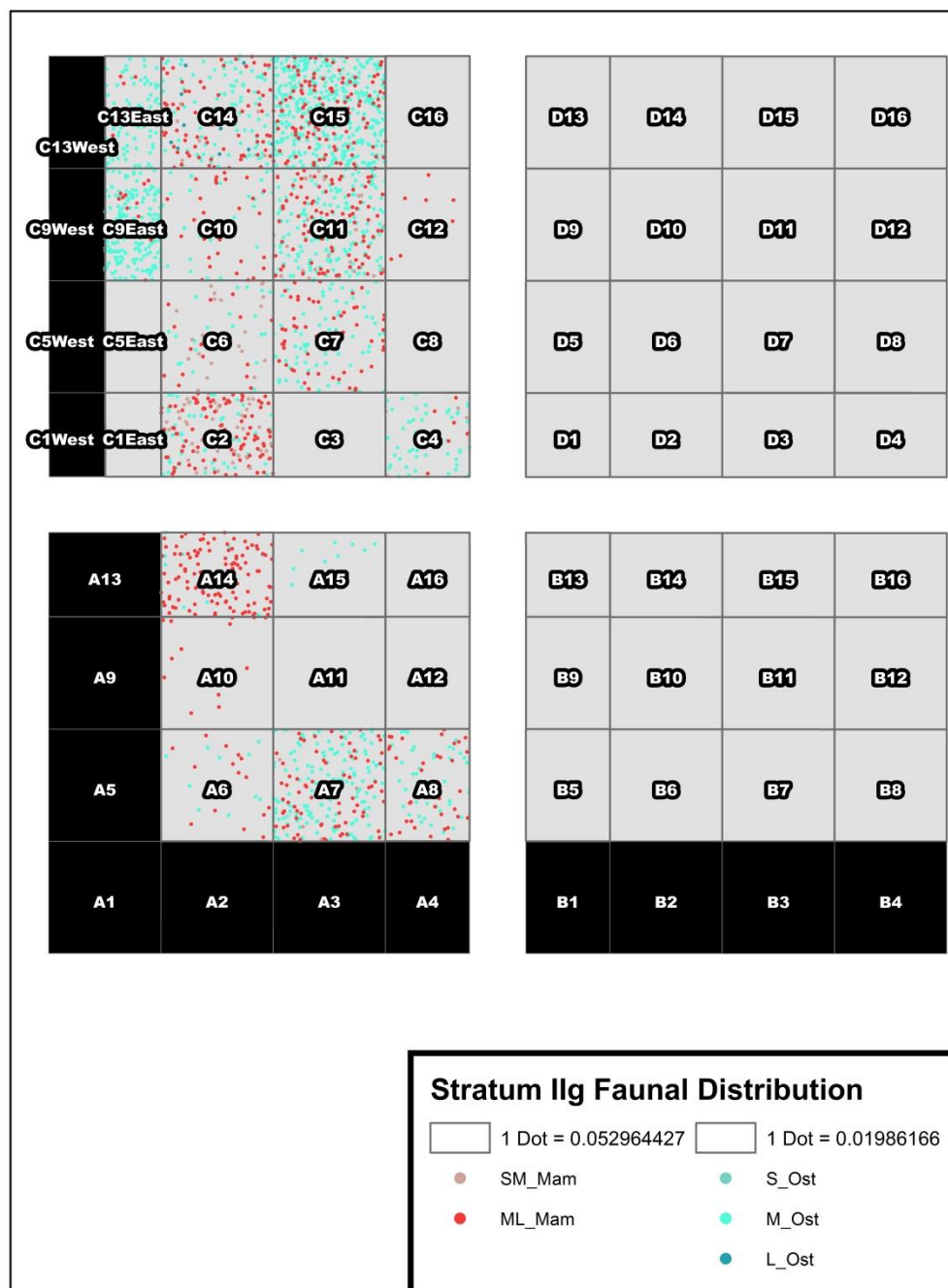


Figure A.4. Stratum IIg Faunal Assemblage Distribution by Unit.

Stratum IIg Faunal Assemblage and Distribution

Taxon	Stratum IIg Taxon by Block									Stratum IIg Assemblage
	A	Feat A-17	B	C	Feat C-1	Feat C-7	Feat C-23	Feat C-26	D	
Osteichthyes	71	3	0	409	0	5	0	0	0	488
<i>Salmonidae</i>	0	0	0	0	0	0	0	0	0	0
c.f. <i>Oncorhynchus nerka</i>	32	3	0	348	0	4	0	0	0	387
c.f. <i>Oncorhynchus tshawytscha</i>	0	0	0	6	0	0	0	0	0	6
c.f. <i>Salmonid</i> (trout-sized)	3	0	0	15	0	1	0	0	0	19
Indeterminate	36	0	0	39	0	0	0	0	0	75
<i>Gadidae</i> spp.	0	0	0	1	0	0	0	0	0	1
Mammalia	91	2	0	413	6	8	15	5	2	542
Small	0	0	0	1	0	0	0	0	0	1
Medium	2	1	0	51	2	0	0	3	0	59
Small-Medium	0	0	0	0	0	0	0	0	0	0
Large	88	1	0	82	0	0	6	0	2	179
Medium-Large	1	0	0	271	4	8	8	2	0	294
Undeterminate	0	0	0	8	0	0	3	0	0	11
Artiodactyla	28	1	0	26	0	0	3	4	2	64
Indeterminate <i>Cervidae</i> /Artiodactyl	20	0	0	4	0	0	1	0	1	26
<i>Odocoileus hemionus</i>	8	1	0	22	0	0	2	4	1	38
<i>Ovis canadensis</i>	0	0	0	0	0	0	0	0	0	0
Carnivora	0	1	0	2	1	0	0	3	0	7
<i>Ursus americanus</i>	0	0	0	0	0	0	0	0	0	0
<i>U. arctos</i>	0	0	0	0	0	0	0	0	0	0
<i>Canis</i> sp.	0	1	0	2	1	0	0	3	0	7
<i>Canis</i> sp. (c.f. <i>Canis latrans</i>)	0	1	0	2	0	0	0	1	0	4
<i>Canis</i> sp. (c.f. <i>Canis lupus</i>)	0	0	0	0	1	0	0	0	0	1
<i>Canis</i> sp. (c.f. <i>Canis lupus familiaris</i>)	0	0	0	0	0	0	0	2	0	2
Rodentia	0	0	0	9	0	0	0	0	0	9
<i>Castor canadensis</i>	0	0	0	8	0	0	0	0	0	8
<i>Ondatra zibethicus</i>	0	0	0	0	0	0	0	0	0	0
<i>Peromyscus maniculatus</i>	0	0	0	0	0	0	0	0	0	0
<i>Erethizon dorsatum</i>	0	0	0	0	0	0	0	0	0	0
<i>Scuriidae</i> sp.	0	0	0	0	0	0	0	0	0	0
Aves	0	0	0	2	0	0	0	0	0	2
c.f. <i>Phasianidae</i> sp.	0	0	0	2	0	0	0	0	0	2
Bivalvia	0	0	0	0	0	0	0	0	0	0
<i>Ostreidae</i> spp.	0	0	0	0	0	0	0	0	0	0
Unidentifiable	0	0	0	0	0	0	0	0	0	0

Table A.5. Stratum IIg Faunal Assemblage.

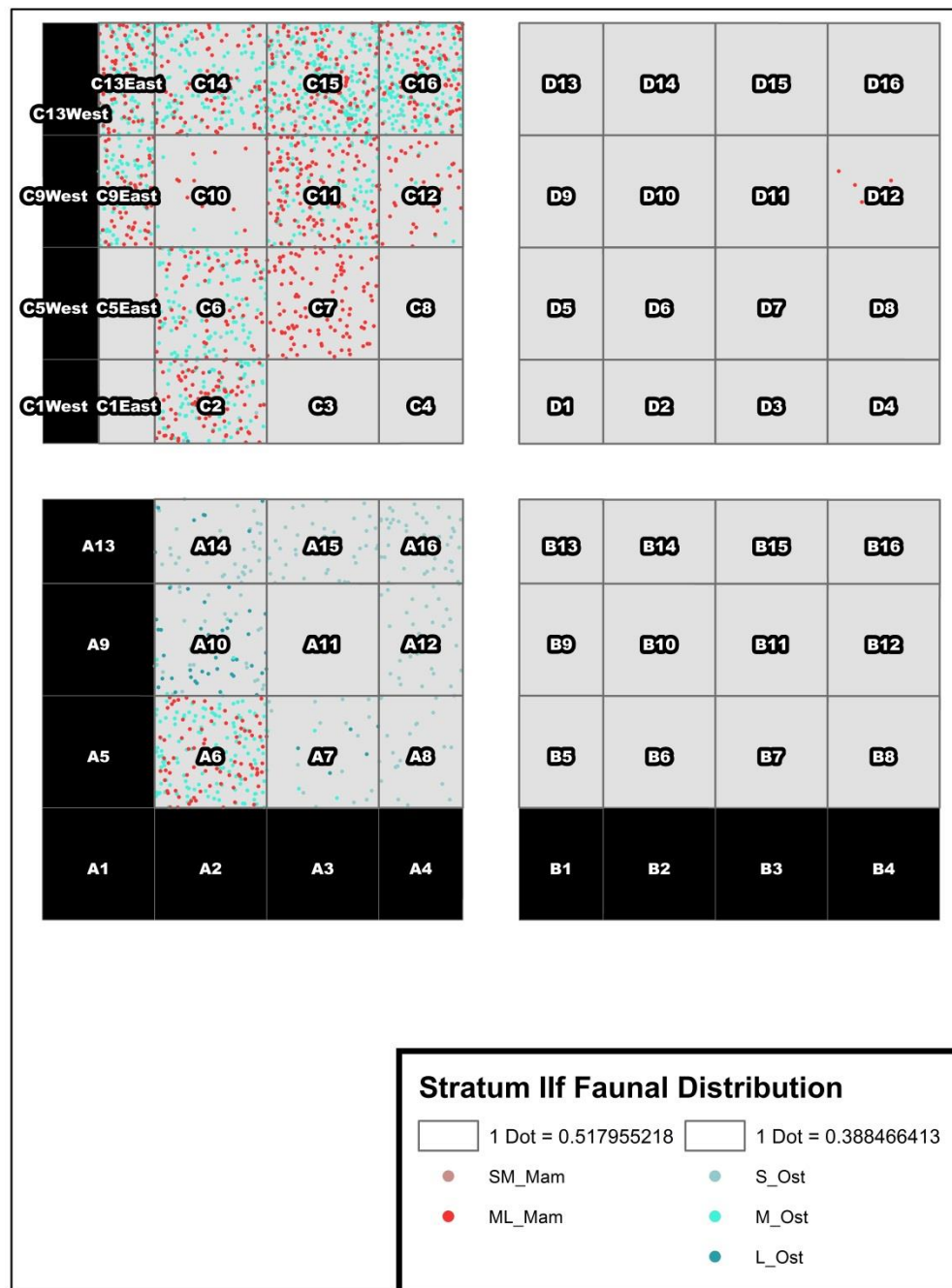


Figure A.5. Stratum IIf Faunal Assemblage Distribution by Unit.

Stratum IIe Faunal Assemblage and Distribution

Taxon	Stratum IIe Taxon by Block												Stratum IIe Assemblage
	A	Feat A-12	B	Feat B-1	Feat B-3	Feat B-5	Feat B-6	Feat B-14	Feat B-15	C	Feat C-1	D	
Osteichthyes	38	47	10	0	20	1	1	81	0	65	9	0	272
<i>Salmonidae</i>	0	0	0	0	0	0	0	0	0	0	0	0	0
c.f. <i>Oncorhynchus nerka</i>	18	47	10	0	19	1	1	81	0	62	9	0	248
c.f. <i>Oncorhynchus tshawytscha</i>	0	0	0	0	0	0	0	0	0	0	0	0	0
c.f. Salmonid (trout-sized)	2	0	0	0	1	0	0	0	0	0	0	0	3
Indeterminate	18	0	0	0	0	0	0	0	0	3	0	0	21
Mammalia	37	6	19	6	44	0	1	47	2	146	3	1	312
Small	1	0	0	0	0	0	0	13	0	1	0	0	15
Medium	24	6	0	0	2	0	0	1	1	6	0	0	40
Small-Medium	0	0	0	0	1	0	0	3	0	0	0	0	4
Large	5	0	4	0	10	0	0	9	0	46	2	0	76
Medium-Large	7	0	15	6	31	0	1	21	1	87	1	1	171
Indeterminate	0	0	0	0	0	0	0	2	0	5	0	0	7
Artiodactyla	0	0	4	0	3	0	0	1	1	31	1	0	41
Indeterminate <i>Cervidae/Artiodactyl</i>	0	0	2	0	1	0	0	0	1	9	0	0	13
<i>Odocoileus hemionus</i>	0	0	1	0	1	0	0	1	0	22	1	0	26
<i>Ovis canadensis</i>	0	0	1	0	1	0	0	0	0	0	0	0	2
Carnivora	0	0	0	0	0	0	0	0	0	1	0	0	1
<i>Ursus americanus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>U. arctos</i>	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Canis</i> sp.	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Canis</i> sp. (c.f. <i>Canis latrans</i>)	0	0	0	0	0	0	0	0	0	1	0	0	1
<i>Canis</i> sp. (c.f. <i>Canis lupus</i>)	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Canis</i> sp. (c.f. <i>Canis lupus familiaris</i>)	0	0	0	0	0	0	0	0	0	0	0	0	0
Rodentia	0	0	0	0	1	0	0	14	0	3	0	0	18
<i>Castor canadensis</i>	0	0	0	0	1	0	0	1	0	2	0	0	4
<i>Ondatra zibethicus</i>	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Peromyscus maniculatus</i>	0	0	0	0	0	0	0	1	0	1	0	0	2
<i>Peromyscus crinitus</i> (c.f.)	0	0	0	0	0	0	0	1	0	0	0	0	1
<i>Neotominae</i> spp.	0	0	0	0	0	0	0	1	0	0	0	0	1
<i>Zapus princeps</i>	0	0	0	0	0	0	0	1	0	0	0	0	1
Erethizon dorsatum	0	0	0	0	0	0	0	0	0	0	0	0	0
Scuriidae sp.	0	0	0	0	0	0	0	0	0	0	0	0	0
Aves	0	0	0	0	0	0	0	0	0	4	0	0	4
c.f. <i>Phasianidae</i> sp.	0	0	0	0	0	0	0	0	0	4	0	0	4
Bivalvia	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Ostreidae</i> spp.	0	0	0	0	0	0	0	0	0	0	0	0	0
Unidentifiable	0	0	2	0	0	0	0	0	0	0	0	0	2

Table A.6. Stratum IIe Faunal Assemblage.

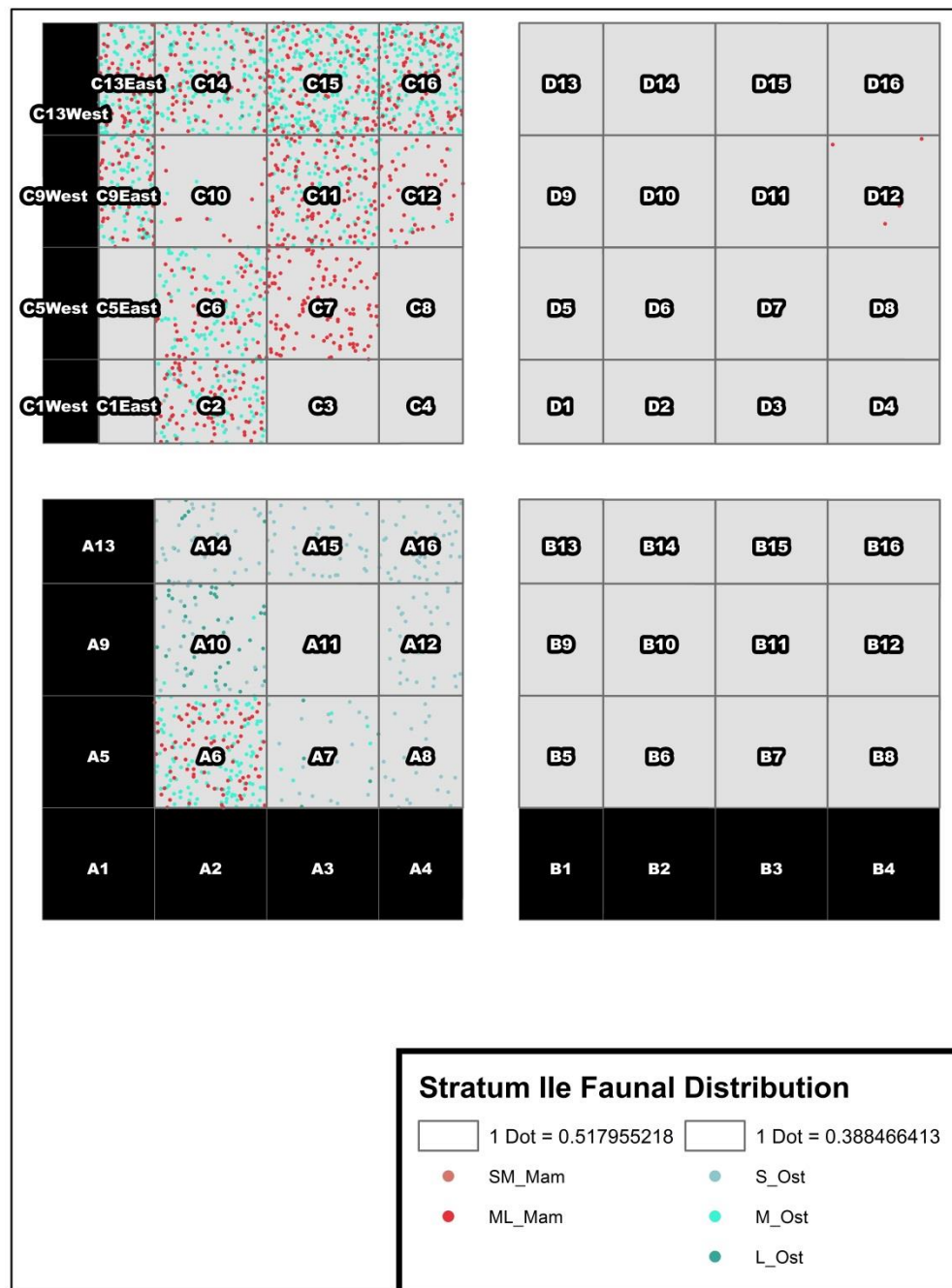


Figure A.6. Stratum Ile Faunal Assemblage Distribution by Unit.

Stratum IId Faunal Assemblage and Distribution

Taxon	Stratum IId Taxon by Block				Stratum IId Assemblage	Feat A-17	Feat C-2	Feat D-11	IId Total
	A	B	C	D					
Osteichthyes	18	27	169	10	224	3	8	0	235
<i>Salmonidae</i>	0	0	13	0	13	0	0	0	13
c.f. <i>Oncorhynchus nerka</i>	11	27	128	9	175	3	3	0	181
c.f. <i>Oncorhynchus tshawytscha</i>	0	0	1	0	1	0	0	0	1
c.f. <i>Salmonid</i> (trout-sized)	1	0	2	1	4	0	0	0	4
Indeterminate	6	0	25	0	31	0	5	0	36
Mammalia	50	19	186	8	263	8	6	1	278
Small	0	0	12	0	12	0	0	0	12
Medium	19	2	81	1	103	1	0	0	104
Small-Medium	4	0	0	0	4	0	0	0	4
Large	13	5	47	4	69	0	1	1	71
Medium-Large	12	12	14	3	41	1	5	0	47
Undeterminate	2	0	8	0	10	0	0	0	10
Artiodactyla	4	0	6	1	11	4	0	0	15
Indeterminate <i>Cervidae</i> / <i>Artiodactyl</i>	0	0	1	0	1	3	0	0	4
<i>Odocoileus hemionus</i>	4	0	5	1	10	1	0	0	11
<i>Ovis canadensis</i>	0	0	0	0	0	0	0	0	0
Carnivora	2	0	2	1	5	0	0	0	5
<i>Ursus americanus</i>	0	0	0	0	0	0	0	0	0
<i>U. arctos</i>	0	0	1	0	1	0	0	0	1
<i>Canis</i> sp.	2	0	1	1	4	0	0	0	4
Rodentia	2	0	7	0	9	0	0	0	9
<i>Castor canadensis</i>	0	0	2	0	2	0	0	0	2
<i>Ondatra zibethicus</i>	2	0	0	0	2	0	0	0	2
<i>Peromyscus maniculatus</i>	0	0	1	0	1	0	0	0	1
<i>Erethizon dorsatum</i>	0	0	0	0	0	0	0	0	0
<i>Scuriidae</i> sp.	0	0	0	0	0	0	0	0	0
Aves	0	0	0	0	0	0	0	0	0
<i>Falconiformes</i> c.f. <i>Buteo</i> sp.	0	0	0	0	0	0	0	0	0
c.f. <i>Phasianidae</i> sp.	0	0	0	0	0	0	0	0	0
<i>Phasianidae</i> sp. (c.f. <i>Dendragapus fuliginosus</i>)	0	0	0	0	0	0	0	0	0
<i>Phasianidae</i> sp. (c.f. <i>Lagopus leucura</i>)	0	0	0	0	0	0	0	0	0
Bivalvia	0	0	19	0	19	0	0	0	19
<i>Ostreidae</i> spp.	0	0	19	0	19	0	0	0	19
Unidentifiable	0	0	0	0	0	0	0	0	0

Table A.7. Stratum IId Faunal Assemblage.

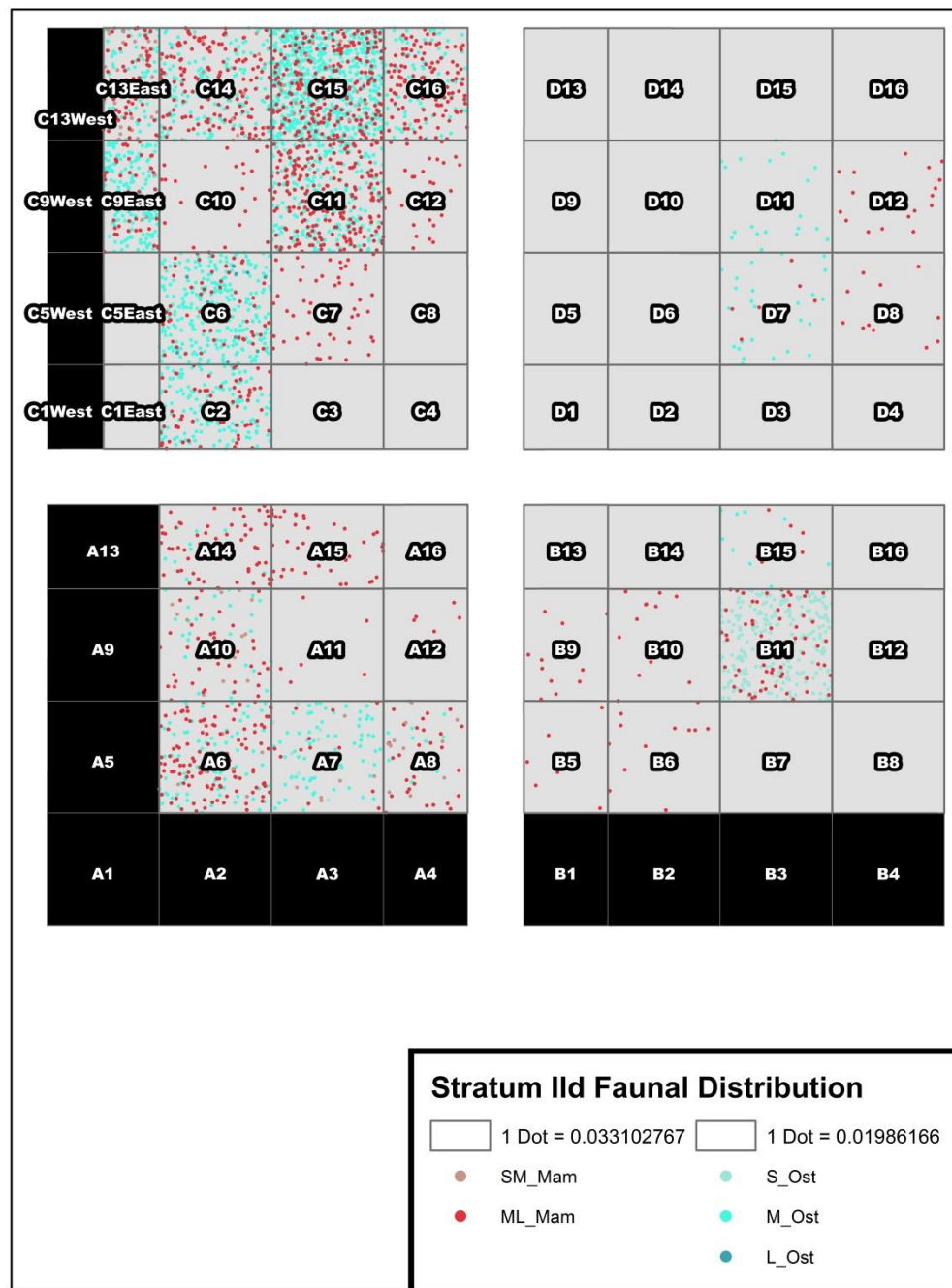


Figure A.7. Stratum IId Faunal Assemblage Distribution by Unit.

Stratum IIc Faunal Assemblage and Distribution

Taxon	Stratum IIc Level 1 Taxon by Block									
	A	B	C	D	Stratum IIc Level 1	Feat B-14	Feat D-6	Feat D-10	Feat D-13	IIc Total
Osteichthyes	12	2	243	147	404	4	3	66	1	478
<i>Salmonidae</i>	11	0	0	0	11	0	0	5	0	16
c.f. <i>Oncorhynchus nerka</i>	1	0	171	142	314	4	3	58	1	380
c.f. <i>Oncorhynchus tshawytscha</i>	0	0	0	0	0	0	0	0	0	0
c.f. <i>Salmonid</i> (trout-sized)	0	1	0	5	6	0	0	0	0	6
Indeterminate	0	1	72	0	73	0	0	3	0	76
Mammalia	51	48	290	150	539	0	0	64	1	604
Small	0	0	0	1	1	0	0	0	0	1
Medium	3	7	40	11	61	0	0	17	0	78
Small-Medium	0	0	1	6	7	0	0	0	1	8
Large	5	40	238	55	338	0	0	12	0	350
Medium-Large	28	1	11	77	117	0	0	16	0	133
Undeterminate	15	0	0	0	15	0	0	19	0	34
Artiodactyla	2	1	28	13	44	0	0	2	0	46
Indeterminate <i>Cervidae</i> / <i>Artiodactyl</i>	0	0	0	2	2	0	0	0	0	2
<i>Odocoileus hemionus</i>	2	1	26	10	39	0	0	1	0	40
<i>Ovis canadensis</i>	0	0	2	1	3	0	0	1	0	4
Carnivora	0	0	1	2	3	0	0	3	0	6
<i>Ursus americanus</i>	0	0	0	0	0	0	0	0	0	0
<i>U. arctos</i>	0	0	0	0	0	0	0	0	0	0
<i>Canis</i> sp.	0	0	1	2	3	0	0	3	0	6
Rodentia	1	0	1	0	2	0	0	0	0	2
<i>Castor canadensis</i>	1	0	1	0	2	0	0	0	0	2
<i>Ondatra zibethicus</i>	0	0	0	0	0	0	0	0	0	0
<i>Peromyscus maniculatus</i>	0	0	0	0	0	0	0	0	0	0
Erethizon dorsatum	0	0	0	0	0	0	0	0	0	0
Scuriidae sp.	0	0	0	0	0	0	0	0	0	0
Aves	1	0	0	1	2	0	0	0	0	3
<i>Falconiformes</i> c.f. <i>Buteo</i> sp.	1	0	0	0	1	0	0	0	0	1
c.f. <i>Phasianidae</i> sp.	0	0	0	1	1	0	0	1	0	2
<i>Phasianidae</i> sp. (c.f. <i>Dendragapus fuliginosus</i>)	0	0	0	0	0	0	0	0	0	0
<i>Phasianidae</i> sp. (c.f. <i>Lagopus leucura</i>)	0	0	0	0	0	0	0	0	0	0
Bivalvia	0	0	0	1	1	0	0	0	0	1
<i>Ostreidae</i> spp.	0	0	0	1	1	0	0	0	0	1
Unidentifiable	0	0	0	0	0	0	0	0	0	0

Table A.8. Stratum IIc Faunal Assemblage.

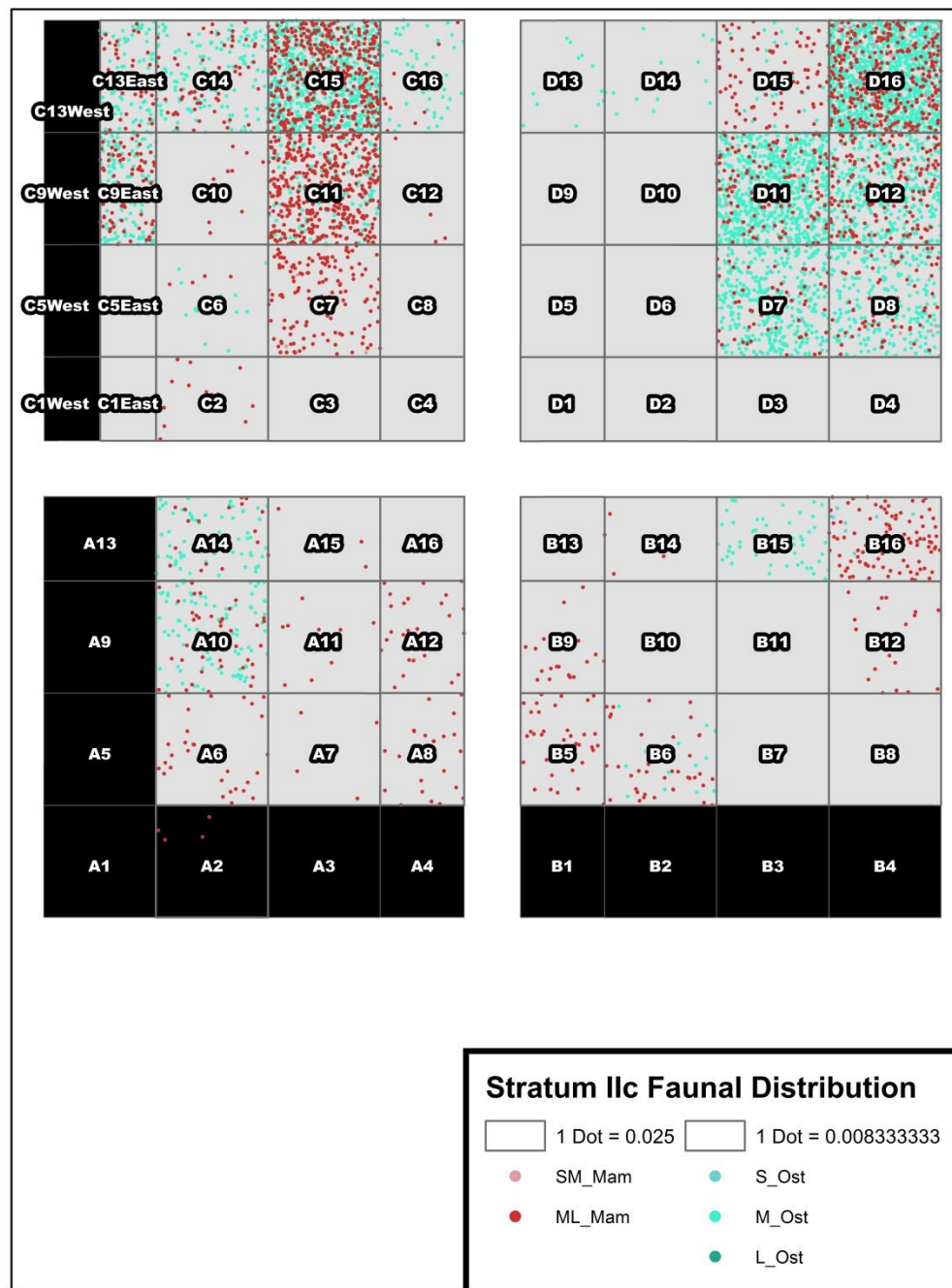


Figure A.8. Stratum IIc Faunal Assemblage Distribution by Unit.

Stratum IIb Faunal Assemblage and Distribution

Taxon		Stratum IIb Taxon by Block (Combined 2013-2014)									
	A	B	C	D	Stratum IIb Level 1	Feat. A-5	Feat D-4	Feat D-8	IIb Total		
Osteichthyes		71	1	1226	325	1623	6	4	247	1880	
<i>Salmonidae</i>		61	0	612	0	673	0	0	0	673	
c.f. <i>Oncorhynchus nerka</i>		0	0	507	295	802	6	4	223	1035	
c.f. <i>Oncorhynchus tshawytscha</i>		0	0	1	1	2	0	0	2	4	
c.f. <i>Salmonid</i> (trout-sized)		8	0	2	28	38	0	0	3	41	
Indeterminate		2	1	104	1	108	0	0	19	127	
Mammalia		99	53	204	232	588	4	9	120	721	
Small		4	0	0	3	12	0	0	1	13	
Medium		7	0	49	11	67	0	0	10	77	
Small-Medium		3	0	2	8	13	0	0	2	15	
Large		9	53	48	81	191	0	6	22	219	
Medium-Large		72	0	96	108	276	4	3	46	329	
Undeterminate		4	0	9	21	34	0	0	19	53	
Artiodactyla		7	9	20	53	89	0	0		89	
Indeterminate <i>Cervidae/Artiodactyl</i>		0	0	0	3	3	0	0	14	17	
<i>Odocoileus hemionus</i>		7	9	20	50	86	0	0	6	92	
<i>Ovis canadensis</i>		0	0	0	0	0	0	0	0	0	
Carnivora		1	0	1	4	6	0	0	2	8	
<i>Ursus americanus</i>		0	0	0	0	0	0	0	0	0	
<i>U. arctos</i>		0	0	0	0	0	0	0	0	0	
<i>Canis</i> sp.		1	0	1	4	6	0	0	2	8	
Rodentia		2	0	2	4	8	0	0	3	11	
<i>Castor canadensis</i>		2	0	1	2	5	0	0	2	7	
<i>Ondatra zibethicus</i>		0	0	0	0	0	0	0	0	0	
<i>Peromyscus maniculatus</i>		0	0	0	1	1	0	0	0	1	
Erethizon dorsatum		0	0	0	0	0	0	0	0	0	
										0	
Scuriidae sp.		0	0	0	0	0	0	0	0	0	
Aves		0	0	0	3	5	0	0	3	8	
c.f. <i>Phasianidae</i> sp.		0	0	0	2	2	0	0	2	4	
<i>Phasianidae</i> sp. (c.f. <i>Dendragapus fuliginosus</i>)		0	0	0	0	0	0	0	1	1	
<i>Phasianidae</i> sp. (c.f. <i>Lagopus leucura</i>)		3	0	0	0	3	0	0	0	3	
Bivalvia		0	0	0	0	0	0	0	0	0	
<i>Ostreidae</i> spp.		0	0	0	0	0	0	0	0	0	
Unidentifiable		0	0	1	1	2	0	0	3	5	

Table A.9. Stratum IIb Faunal Assemblage.

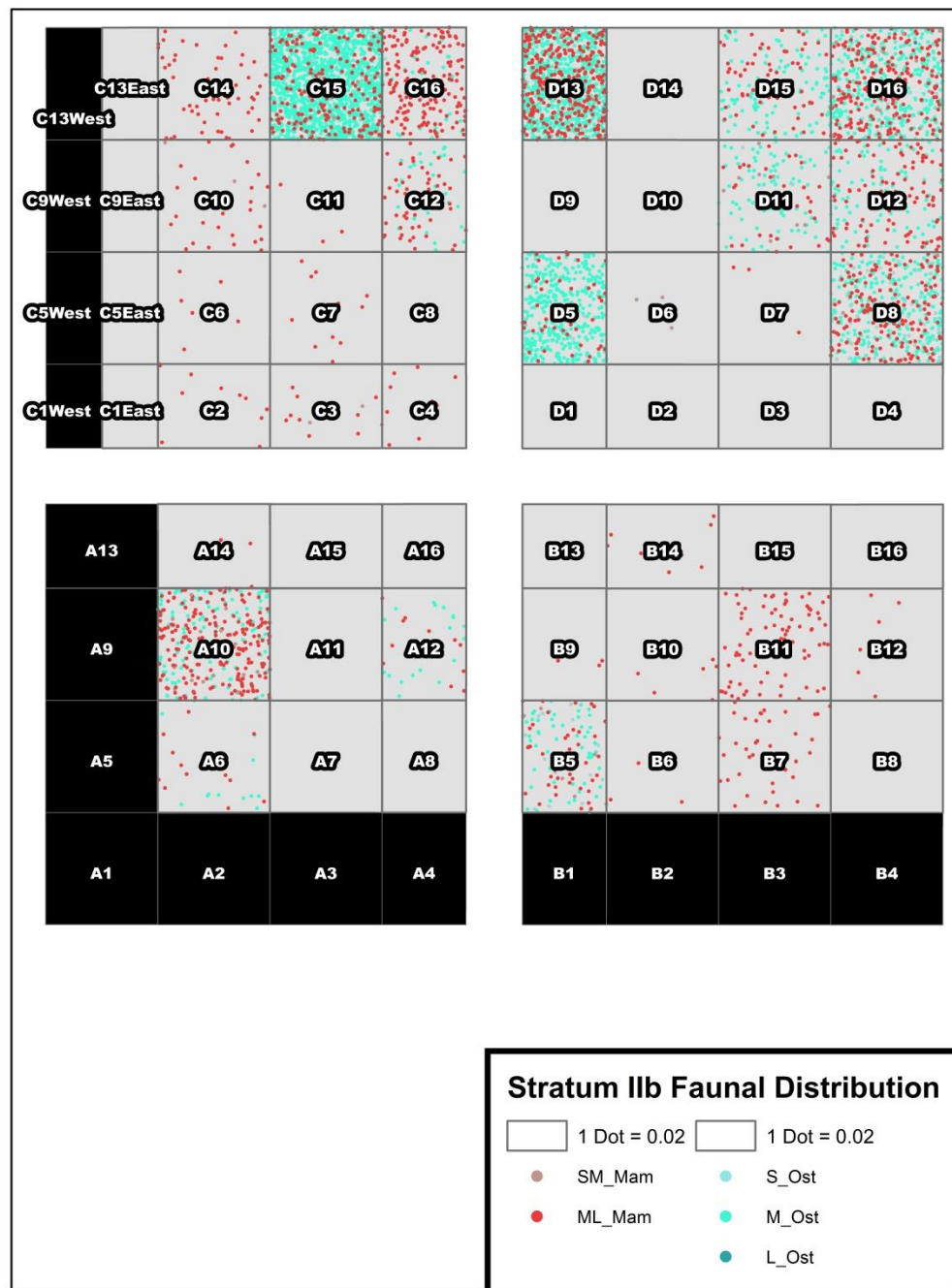


Figure A.9. Stratum IIb Faunal Assemblage Distribution by Unit.

Stratum IIa Faunal Assemblage and Distribution

Stratum IIa Level 1 Taxon by Block																			
2013 A	2014 A	2013 B	2014 B	2013 C	2014 C	2013 D	2014 D	Stratum IIa Level 1 Total				Level 2	Level 3	Level 4	Level 5	Total IIa			
Osteichthyes <i>Salmonidae</i> c.f. <i>Oncorhynchus nerka</i> c.f. <i>Oncorhynchus tshawytscha</i> c.f. <i>Salmonid</i> (trout-sized) Indeterminate	33	30	9	2	157	52	12	689	984	28	3	37	3	1055					
	33	18	7	0	100	26	0	0	184	4	2	18	2	210					
	0	0	0	0	25	13	1	682	721	20	0	1	0	742					
	0	0	0	0	23	10	0	3	36	1	0	12	0	49					
	0	12	1	1	1	2	1	4	22	3	1	0	1	27					
	0	0	1	1	8	1	10	0	21	0	0	6	0	27					
Mammalia <i>Small</i> <i>Medium</i> <i>Small-Medium</i> <i>Large</i> <i>Medium-Large</i> Undeterminate	64	57	236	49	140	113	17	340	1016	192	19	31	2	1260					
	0	0	1	0	3	1	0	5	10	1	0	1	1	13					
	1	2	0	0	4	5	0	20	32	0	0	0	0	32					
	2	2	0	0	0	0	0	8	12	0	0	0	0	12					
	15	12	17	17	18	23	9	57	168	16	1	2	0	187					
	44	39	80	25	93	73	8	164	526	163	14	20	0	723					
	2	2	138	7	22	11	0	83	265	12	4	8	1	290					
Artiodactyla Indeterminate Artiodactyl <i>Odocoileus hemionus</i> <i>Ovis canadensis</i>	13	12	4	6	10	20	0	35	100	6	0	2	0	108					
	0	1	0	1	0	0	0	13	15	2	0	0	0	17					
	0	1	0	1	0	0	0	13	15	4	0	2	0	21					
	0	1	0	1	0	0	0	13	15	0	0	0	0	15					
Carnivora <i>Ursus americanus</i> <i>U. arctos</i> <i>Canis</i> sp.	0	0	0	0	1	1	0	4	6	0	0	0	0	6					
	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
	0	0	0	0	1	1	0	4	6	0	0	0	0	6					
Rodentia <i>Castor canadensis</i> <i>Onдатra zibethicus</i> <i>Peromyscus maniculatus</i>	0	0	0	0	0	0	0	10	10	0	0	0	0	10					
	0	0	0	0	0	0	0	10	10	0	0	0	0	10					
	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
Erethizon dorsatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
Scuriudae sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
Aves <i>Phasianidae</i> sp. (c.f. <i>Dendragapus fuliginosus</i>) <i>Phasianidae</i> sp. (c.f. <i>Lagopus leucura</i>)	0	0	0	0	0	0	0	6	6	0	0	0	0	6					
	0	0	0	0	0	0	0	2	2	0	0	0	0	2					
	0	0	0	0	0	0	0	2	2	0	0	0	0	2					
Bivalvia <i>Ostreidae</i> spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
Indentifiable	0	0	0	0	1	0	0	0	1	0	0	1	0	2					

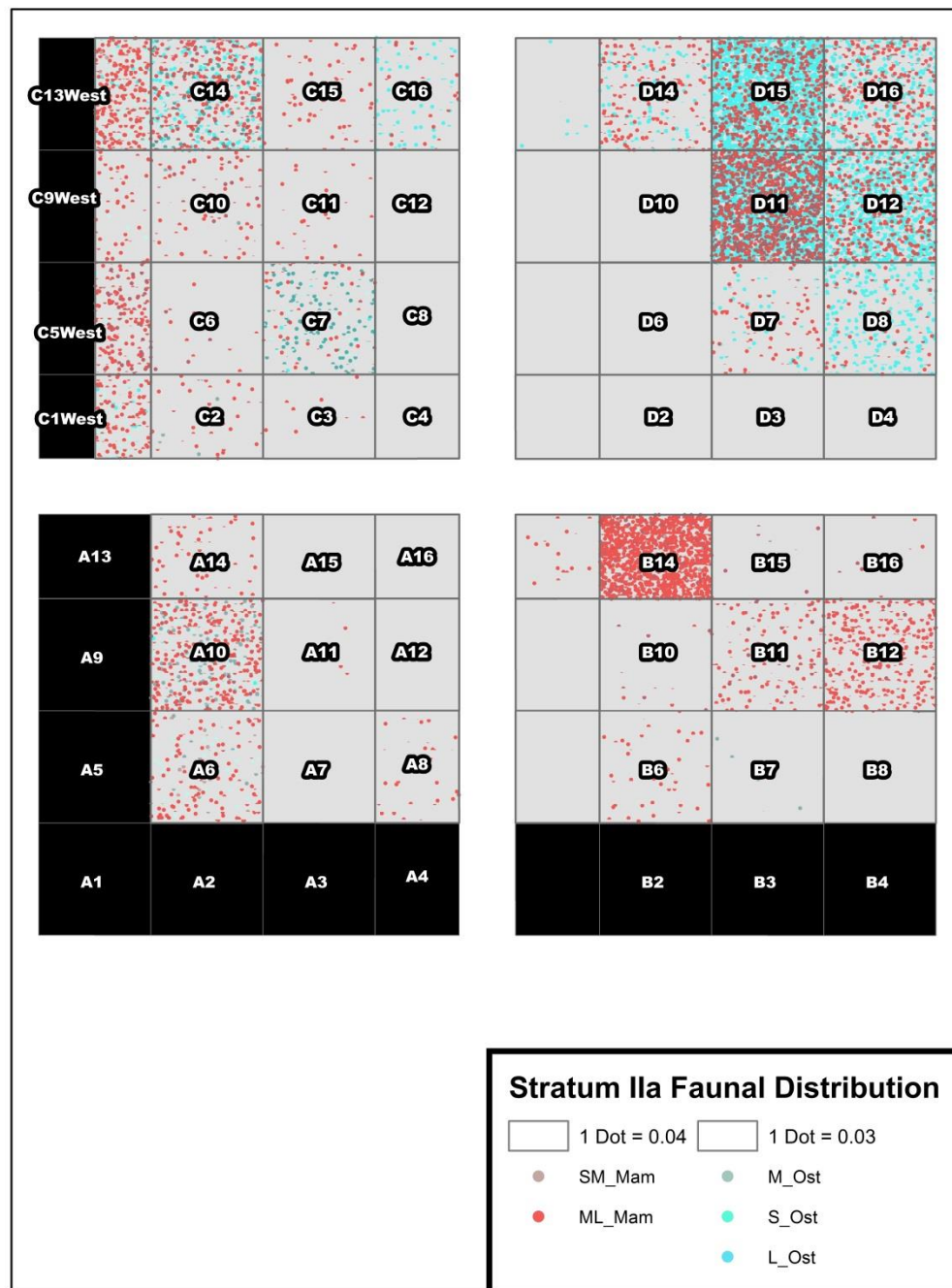


Figure A.10. Stratum Ila Faunal Assemblage Distribution by Unit.

APPENDIX C
RESULTS OF PEARSON'S CORRELATION COEFFICIENT TESTS OF DIVERSITY
INDICES

Stratum	TotalNISP*	Shannon Richness	Shannon Diversity	Shannon Evenness
IIj	155	4	0.31	0.17
IIi	189	5	0.23	0.13
IIh	254	8	0.30	0.15
IIg	524	8	0.38	0.18
IIf	1030	9	0.44	0.19
IIe	578	8	0.32	0.13
IIId	513	9	0.36	0.16
IIc	1082	9	0.35	0.16
IIb	2610	8	0.57	0.25
IIa	2315	8	0.57	0.26
Pearson's R-score		0.522400	0.941300	0.900100
P-value		0.121362	4.8E-0.5	0.000386
* NISP without fish rays/spines/ribs or entirely -taxonomically -unidentifiable specimens				

APPENDIX C. Summary Table of Correlation Coefficient values.