APPROVAL

NAME: Corene Texada Lindsay

DEGREE: M.A.

TITLE OF THESIS: Investigations into the Ethnographic and Prehistoric Importance of Freshwater Shellfish on the Interior Plateau of British Columbia

EXAMINING COMMITTEE:

Chair: Dr. D.S. Lepofsky
Associate Professor

Dr. G.P. Nicholas, Associate Professor
Senior Supervisor

Dr. J.C. Driver, Professor

Dr. C.C. Carlson, Associate Professor
Anthropology, University of the Cariboo

M.K. Rousseau, President
Antiquus Archaeological Consultants Ltd
Examiner

Date Approved: 

ii
I HEREBY GRANT TO SIMON FRASER UNIVERSITY THE RIGHT TO LEND MY
THESIS, PROJECT OR EXTENDED ESSAY (THE TITLE OF WHICH IS SHOWN
BELOW) TO USERS OF THE SIMON FRASER UNIVERSITY LIBRARY, AND TO
MAKE PARTIAL OR SINGLE COPIES ONLY FOR SUCH USERS OR IN RESPONSE
TO A REQUEST FROM THE LIBRARY OF ANY OTHER UNIVERSITY, OR OTHER
EDUCATIONAL INSTITUTION, ON ITS OWN BEHALF OR FOR ONE OF ITS
USERS. I FURTHER AGREE THAT PERMISSION FOR MULTIPLE COPYING OF
THIS WORK FOR SCHOLARLY PURPOSES MAY BE GRANTED BY ME OR THE
DEAN OF GRADUATE STUDIES. IT IS UNDERSTOOD THAT COPYING OR
PUBLICATION OF THIS WORK FOR FINANCIAL GAIN SHALL NOT BE
ALLOWED WITHOUT MY WRITTEN PERMISSION.

TITLE OF THESIS/PROJECT/EXTENDED ESSAY

Investigations into the Ethnographic and Prehistoric Importance of Freshwater
Shellfish on the Interior Plateau of British Columbia

AUTHOR

__________________________________________
(signature)

__________________________________________
(name)

__________________________________________
(date)
ABSTRACT

The remains of freshwater shellfish are frequently found during archaeological investigations of prehistoric sites on the Interior Plateau of British Columbia. This thesis investigates the ethnographic accounts and the archaeological evidence that identify past Aboriginal utilization of shellfish in the Thompson River drainage of south-central British Columbia. In this study, I examine several key questions regarding past subsistence practices in the region and the role of freshwater shellfish as a food resource. For example, were molluscs only of importance as famine food, or did they play a larger or more important role in Aboriginal Plateau cultures? If so, what was this role and how is it evident in the archaeological record? Finally, to what degree have ethnographic accounts been projected into the more distant past? Teit (1909: 513, 517), for one, has noted that among the Shuswap Indians, dogs and shellfish were eaten only in times of starvation, and that such times occurred towards the end of winter when stored supplies were sometimes depleted, and has further noted that among the Thompson Indians insects and shellfish were not eaten. Statements such as these have provided the impetus for this investigation.

The results of the research on shellfish remains at archaeological sites in the Region indicate that prehistoric usage of shellfish was widespread in all areas of the Plateau. The 124 shell sites (149 site components) are identified based on their association with diagnostic artifacts and/or radiocarbon dates. Aboriginal peoples harvested shellfish from the Middle Period to the present, sometimes in substantial amounts. Shell remains are found at Middle Period (27) sites, Shuswap Horizon (35 sites,
Plateau Horizon (41) sites, Kamloops Horizon (13) sites, and Historic Period (3) sites. However, it is difficult to assess the relative importance of the resource in Aboriginal diet and subsistence from the limited available data. The resource was obviously of some importance in the overall subsistence pattern.

Although the research for this thesis has identified shell-bearing archaeological sites, and cultural periods during which they are found, the evidence is not sufficient to conclude that molluscs were an important food resource for Aboriginal peoples, nor does it suggest that they represented only starvation food. Seasonal availability and ethnographic accounts that link shellfishing with food scarcity may be responsible for James Teit’s description of freshwater shellfish as “famine food” consumed only in the absence of all other resources.
ACKNOWLEDGEMENTS

I would like to thank the members of my committee—Dr. George Nicholas, Dr. Catherine Carlson, and Dr. Jon Driver—for the many helpful comments and suggestions they made during the preparation of this thesis. My sincere thanks are extended to Dr. Nicholas for his guidance and encouragement throughout my graduate studies, for suggesting this topic, for encouraging my interests in the archaeology of the Plateau culture area of North America, and for editing this thesis and otherwise translating the thesis manuscript into English. My appreciation is also extended to Mike Rousseau for his assistance with the shell line drawings and for the shell photography in Figures 2 and 3 of this thesis. The development of this thesis would not have been possible without information from many individuals. I am indebted to Dr. William Belcher, Dr. Cheryl Claasen, Dr. Jon Erlandson, Dr. Paul Parmalee, Dr. James Theler, and Dr. Robert Warren, all of whom have generously provided me with copies of their research of freshwater shellfish in North America. Any success I have had at understanding these animals is due to their investigations.

This research has benefited greatly from my discussions with many people. I would particularly like to acknowledge the contributions of Mike Rousseau, Rick Harbo, and Dr. Kevin Cummings. A special note of appreciation goes to Romi Casper, Doris Lundy, John McMurdho and Dee Milton, all of the Archaeology and Registry Services Branch of the B. C. Ministry of Sustainable Resource Management. They have all provided me with archaeological reports and publications on freshwater shellfish, and other research material. A special note of appreciation goes to Patricia Brearley for her
help with the thesis formatting and otherwise assisting in putting this document together. Finally I thank my son, John Lindsay for the support and encouragement he has given me throughout every stage of this research.
# TABLE OF CONTENTS

Approval ........................................................................................................................................ ii
Abstract ......................................................................................................................................... iii
Acknowledgements ...................................................................................................................... v
Table of Contents ........................................................................................................................ v
List of Tables .................................................................................................................................. x
List of Figures ................................................................................................................................ xi

**CHAPTER ONE** *"NO INSECTS OR SHELLFISH WERE EATEN": PROBLEM ORIENTATION, AND RESEARCH GOALS* ..................................................................................... 1

- Research Orientation .................................................................................................................. 2
- Description of Project Area .......................................................................................................... 3
- Shell Midden Research and its Contribution to Archaeology ....................................................... 8
  - A Brief Overview of Global Shell Midden Research .................................................................. 8
  - Freshwater Shell Midden Research in North America ............................................................... 9
  - Freshwater Shellfish Research in the Plateau Culture Area ..................................................... 10
- Research Goals ........................................................................................................................... 12
- Famine Food Defined .................................................................................................................. 13
- Organization of the Thesis ........................................................................................................... 14
- Chapter Summary ...................................................................................................................... 16

**CHAPTER TWO** *THEORY AND METHOD IN HUNTER-GATHERER SUBSISTENCE RESEARCH* ............................................................................................................................ 17

- Theoretical Perspectives on Hunter-Gatherer Foraging Strategies ........................................... 17
  - Cultural Ecology ....................................................................................................................... 18
  - Middle-Range Theory ............................................................................................................... 19
  - Optimal Foraging and Related Models ...................................................................................... 20
- Hunter-Gatherer Foraging Diversity .......................................................................................... 25
- Research Methods ..................................................................................................................... 27
  - Literature Survey ..................................................................................................................... 27
  - Survey Methods ....................................................................................................................... 28
- Methodological Concerns ........................................................................................................... 29
- Chapter Summary ...................................................................................................................... 33
CHAPTER THREE  THE NATURAL HISTORY, BIOLOGY, AND ECOLOGY  OF FRESHWATER MOLLUSCS .............................................................................. 35

Biology, Feeding, and Reproduction .......................................................... 37
Reproduction and Life Stages .................................................................. 37
The Shell ................................................................................................. 39
Ecology ................................................................................................... 41
Four Genera of Freshwater Molluscs in the Interior Plateau of British Columbia ......................................................... 43
Margaria falcata, Western-River Pearl Mussel (Figure 2) figure on next page 43
Anodonta kentleri, Western Floater (Figure 3) figure on next page ...... 45
Gonidea angulata, Rocky Mountain Ridged Mussel (Figure 4.) figure on next page 48
Environmental Conditions and Mollusc Colonization .......................... 53
Chapter Summary .................................................................................. 56

CHAPTER FOUR  ETHNOGRAPHIC, DIETARY AND CULTURAL ISSUES  SURROUNDING FRESHWATER SHELLFISH ........................................................................ 57

Ethnographic Accounts of Aboriginal Shellfish Harvesting .................. 57
Freshwater Shellfishing Practices in The Plateau Culture Area .......... 59
Ethnographic and Contemporary Mollusc Collectors of Interior British Columbia .......................................................... 62
Dietary Issues ......................................................................................... 64
Nutritional Values of Shellfish ................................................................. 65
Cultural Aspects of Shellfish ................................................................. 70
Shellfish and Gender Issues ................................................................. 72
Chapter Summary ................................................................................. 73

CHAPTER FIVE  ARCHAEOLOGICAL EVIDENCE FOR ABORIGINAL USE  OF FRESHWATER SHELLFISH ........................................................................ 75

Cultural Overview of the Interior Plateau .............................................. 75
The Early Period .................................................................................... 76
The Late Period ...................................................................................... 79
Investigations into Shellfish Use in the Region ..................................... 80
Shell-Bearing Sites by Cultural Affiliation and Age .......................... 85
Shell Remains at Three Sites in the British Columbia Interior .......... 94
EeRh 61--The Rattlesnake Hill Site, Ashcroft ..................................... 94
DiQv 39--Tsinstikeptum Indian Reserve, Okanagan Lake .................. 98
EeRb 77--Kamloops Indian Reserve, Kamloops ................................ 101
Chapter Summary ................................................................................. 104

CHAPTER SIX  FRESHWATER SHELLFISH IN THE MODERN RIVER  SYSTEM .......................................................................................... 106

Survey Results ......................................................................................... 106
Kamloops Lake Area ............................................................................. 106
North Thompson River ........................................................................ 107
South Thompson River ........................................................................ 108
Discussion .............................................................................................. 109
Changes in Species Representation ..................................................... 110
Possible Effects of Historic Dredging Upon Shellfish Populations ........ 111
Chapter Summary .................................................................................. 112
CHAPTER SEVEN  SUMMARY AND CONCLUSION.................................................................113
Results of the Research ........................................................................................................114
Discussion ...............................................................................................................................117
The Theoretical Models ..........................................................................................................117
Review of the Research Goals and Research Questions ......................................................120
Research Goal 1: Determining Mollusc Distribution and Usage ........................................121
Research Goal 2: The Role of Shellfish in Past Subsistence Patterns .................................122
Research Goal 3: Comparing Prehistoric and Modern River Conditions .............................123
Research Goal 4: Evaluating the Ethnographic Accounts ....................................................123
Conclusion .............................................................................................................................124
Appendix A: Middle Period Sites with freshwater mussel shell ...........................................128
Appendix B: Shuswap Horizon Sites with freshwater mussel shell .......................................130
Appendix C: Plateau Horizon Sites with freshwater mussel shell .........................................132
Appendix D: Kamloops Horizon Sites with freshwater mussel shell ....................................134
Appendix E: Historic Period sites with freshwater mussel shell ...........................................135
Appendix F: Unidentified Shellfish Species at Archaeological Sites, and Identified Shell Species Found in Unidentified Cultural Sequences .................................................................136
References Cited.....................................................................................................................139
LIST OF TABLES

Table 1 Phases of Grassland Vegetation History and Climatic Interpretation for the Southern Interior of British Columbia and Adjacent Regions................. 6
Table 2. Biology of the Shell................................................................. 40
Table 3. Recommended Nutrient Intakes for Children and Adults.......................... 66
Table 4. Regional Distribution of Sites with Shell Included in this Study...................... 88
Table 5. Number of Shell-Bearing Sites Standardized by 500 Year Periods ................. 91
LIST OF FIGURES

Figure 1. The Interior Plateau Culture Sub-Area in British Columbia .................. 4
Figure 2. Margaritifera falcata ........................................................................... 44
Figure 3. Anodonta kennerlyi............................................................................... 46
Figure 4. Gonidea angulata ............................................................................... 49
Figure 5. Anodonta nuttalliana .......................................................................... 52
Figure 6. Archaeological Sequence for the Mid Fraser-Thompson River Valley .... 54
Figure 7. Shell Bearing Sites, Oregon Jack Creek, and Thompson River Valley .... 81
Figure 8. Shell Bearing Sites, North and South Thompson River Valleys ............ 82
Figure 9. Shell Bearing Sites, Nicola Valley/Nicola Lake .................................. 83
Figure 10. Shell Bearing Sites, Okanagan Lake, South Okanagan Valley ............. 84
Figure 11. Freshwater Shellfish by Cultural Affiliation and Radiocarbon Age ...... 86
Figure 12. Distribution of Radiocarbon Dated Shell Sites by Cultural Period ...... 87
Figure 13. Freshwater Mussels Identified by Species ........................................ 92
Figure 14. EeRh 61. The Rattlesnake Hill Archaeological Site ............................ 95
Figure 15. DiQv 39. Tsinstikeptum Archaeological Site, Okanagan Lake ............ 99
Figure 16. EeRb 77. Kamloops Indian Reserve .................................................. 102
CHAPTER ONE

“NO INSECTS OR SHELLFISH WERE EATEN”: PROBLEM ORIENTATION, AND RESEARCH GOALS

Archaeologists working in the Plateau culture area of North America have frequently encountered the remains of freshwater shellfish in their excavations. Their presence at archaeological sites indicates unequivocal evidence of harvesting and, in turn, their presumed consumption as a food source. However, various ethnographic sources for the region have indicated that molluscs were only of limited importance in the subsistence quest, at least in terms of volumes consumed (Spinden 1908). This supposition is supported by Post (1938), Ray (1933), and Teit (1900, 1909), all of whom have stated that ethnographically the relative importance of molluscs was primarily in terms of their use as survival or starvation food.

This thesis investigates the ethnographic accounts and the archaeological evidence that identify Aboriginal utilization of shellfish in the Thompson River drainage of south-central British Columbia. In this study, I examine several key questions regarding past subsistence practices in the region and the role of freshwater shellfish as a food resource. Were molluscs only of importance as famine food, or did they play a larger or more important role in Aboriginal Plateau cultures? If so, what was this role and how is it evident in the archaeological record? Finally, to what degree have ethnographic accounts influenced interpretations of the more distant past. For example, Teit (1909: 513, 517), for one, has noted that among the Shuswap Indians, dogs and shellfish were
eaten only in times of starvation, and that such times occurred towards the end of winter when stored supplies were sometimes depleted. This information has found its way into the archaeological literature and has possibly skewed our interpretation of past subsistence practices. It is thus important to address this topic in a systematic way.

**Research Orientation**

In this thesis, I am investigating questions regarding (a) past subsistence practices in the Interior Plateau of British Columbia, (b) the Aboriginal utilization of freshwater shellfish, (c) and the degree to which shellfish may have contributed to the diet of prehistoric Aboriginal peoples. To do this, I have investigated archaeological, ethnographic, and other evidence from elsewhere in the Plateau region of Western North America. My research goal is to determine whether molluscs were of importance only as famine food or had a more diversified extensive role in Aboriginal Plateau economy. If the latter, then what was this role and what is the archaeological signature (if any) associated with it?

To address these and related issues, my research has involved several components. The first is to examine the archaeological literature and investigate the extent of prehistoric shellfish distribution at archaeological sites across the Interior Plateau. The second component is to compare the data generated by the reports with the ethnographic accounts of Post (1938), Ray (1933), Teit (1900, 1909), and others, and to use the results of this research to determine the relative importance of freshwater shellfish in Aboriginal subsistence and diet. The third is to study the freshwater shellfish species in the modern river systems and determine whether the existing species are consistent with
archaeological shellfish remains. The fourth component is to investigate the foraging and subsistence practices of hunter-gatherers\(^1\) on the Interior Plateau relative to the various theoretical models proposed by Bettinger (1991), Binford (1978, 1983), Kelly (1995), Winterhalder (2001), and others.

**Description of Project Area**

The area of investigation is the Thompson River drainage of south-central British Columbia, a geographic component of the Interior Plateau (Figure 1). The boundaries of the Interior Plateau are marked by the Coast Range on the west, the Monashees on the east, the great bend of the Fraser River in the north, and the International Boundary in the south. This region corresponds, in part, to the Plateau culture area (Walker 1998), which extends beyond these parameters.

\(^1\)The term “hunter-gatherer” is used throughout this thesis in reference to Aboriginal foragers on the Interior Plateau of British Columbia. Panter-Brick et al. (2001: 2) have categorized hunting and gathering societies as small-scale societies whose subsistence activities are based on the hunting of wild animals, gathering of wild foods, fishing and absence of plant and animal domestication (except dog). Winterhalder (2001:12) has further defined hunter-gatherer societies as peoples who derive their livelihood fully or predominantly by a combination of gathering, hunting, fishing, trapping, or collecting plant and animal resources from the surrounding environment.
Figure 1. The Interior Plateau Culture Sub-Area in British Columbia
(adapted with permission of Rousseau 2003)
The Interior Plateau has been described by Hebda (1995: 65-68) as a region of diverse physiography, climate, and vegetation, characterized by deep, steep-sided valleys filled with rivers and lakes. These valleys are surrounded by extensive upland zones that range between 1,000 to 2,000 m above sea level, and by mountain ranges that reach heights above 2,500 m. Frequent fluctuations occur in the climatic patterns and vegetation of the region as a result of these abrupt changes in elevation, and the shifts are evident in the form of relatively narrow and wide-ranging lowland vegetation belts that fringe the large patches of upland zones. Hebda (1982, 1983a, 1995) has divided the postglacial environmental record of the region into five periods based on his previous research at four locations on the Plateau (Table 1).

According to Stryd and Rousseau (1996: 180), by 10,000-8,000 BP grassland habitats on the Plateau may have supported a mixture of late Pleistocene and early Holocene fauna suitable for human predation. Faunal remains from Middle Period (7,500-3,800 BP) archaeological sites in the mid Fraser-Thompson River region identified a variety of mammals and other fauna that inhabited the Plateau at this time, including deer (*Odocoileus hemionus*), elk (*Cervus elaphus*), snowshoe hare (*Lepus americanus*), canis (*Canis* sp.), salmon (*Oncorhynchus* sp.), and freshwater mussels (*Margaritifera* sp.) (Kuijt 1989: 109). The association of these faunal remains with cultural material from archaeological sites is indicative of the faunal variation that was present in the region, and also demonstrated that Aboriginal peoples were harvesting these resources.
Table 1. Phases of Grassland Vegetation History and Climatic Interpretation for the Southern Interior of British Columbia and Adjacent Regions

<table>
<thead>
<tr>
<th>Years B.P.</th>
<th>Climatic Period</th>
<th>Grassland Vegetation History</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 – 4,500</td>
<td>Modern Climate</td>
<td>Grasslands at Modern Extent</td>
</tr>
<tr>
<td>4,500 – 8,000</td>
<td>Warmer than Present</td>
<td>Extent of Mesic Grasslands Reduced</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ponderosa Pine Forest Expansion</td>
</tr>
<tr>
<td>8,000 – 10,000</td>
<td>Warmer, Drier than Present</td>
<td>Grasslands at Maximum Extent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grasslands, Sagelands, Grasslands Zoned with Altitude</td>
</tr>
<tr>
<td>10,000 – 12,000</td>
<td>Cool, Moist</td>
<td>Valley Bottom Grasslands</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sage, Grass, Forests Established</td>
</tr>
<tr>
<td>12,000 – 13,000</td>
<td>Cold</td>
<td>Sedges, Sage, Grasses, Forbs</td>
</tr>
</tbody>
</table>
There is archaeological evidence that riverine resources were increasingly utilized during the latter portion of the Middle Period and throughout the Late Period up to European contact.


Although Clarke (1973) has identified and recorded approximately 50 species of freshwater bivalves in British Columbia, my interest is limited to the four genera found during archaeological investigations in this area. These are identified as: *Margaritifera falcata*, Western-River Pearl Mussel (Clarke 1981: 250), *Gonidea angulata*, Rocky Mountain Ridged Mussel (Clarke 1981: 254), *Anodonta kennerlyi*, Western Floater (Clarke 1981: 306), and *Anodonta nuttalliana* Winged Floater (Clarke 1981: 308). Because they are associated with prehistoric Aboriginal sites, archaeologists have concluded that these mollusc species were of some importance as a food resource, or a source of material for tools and ornamentation. The natural history, ecology, and biology of these four genera is presented in Chapter 3.
Shell Midden Research and its Contribution to Archaeology

Although shellfish remains and their relevance to prehistoric foragers in the Interior Plateau of British Columbia have not been studied in any detail, such research has been a major focus of archaeological research elsewhere. This section reviews examples of some major studies of both marine and freshwater shell research from around the world, and then summarizes pertinent studies conducted in the Plateau region of western North America.

A Brief Overview of Global Shell Midden Research

The extent of shell midden research in many parts of the world can likely be attributed to the size and extent of coastal shell mounds and to their relatively high visibility on the landscape. For example, large shell mounds along the California coast captured the attention of early researchers such as Nelson (1909) and Gifford (1912), each of whom attempted to estimate the age of the shell mounds by calculating how long it would have taken an “average-sized aboriginal band” to accumulate a given amount of food refuse. This work was expanded by later proponents of the “California School” (e.g., Shawcross 1967; Walsekov 1987: 141) whose research focused on the development of a sampling method that would enable them to calculate the total time of mound accumulation, the length of each occupation, the number of site occupants, and the relative contribution of foodstuffs to the diet by using weight, rather than minimum number of individuals (MNI), as an analytical method.

The focus of shell midden archaeology has continued to expand and diversify globally (Claasen 1998). Noteworthy examples of different types of shell research
include: (1) methods of analysis (Koike 1979; Koloseike 1969, 1970a; Meighan et al. 1958); (2) seasonality studies (Claasen 1982, 1984, 1986; Deith 1983a, 1983b, 1985, 1986; Killingsley 1981; Koike 1973, 1975, 1979); (3) resource selection (Anderson 1981); (4) formation and deformation processes (Marquardt and Watson 1983; Sanger 1981; Wessen 1982); and (5) changes in the composition of shellfish species, both spatially and temporally (Bowdler 1976; Braun 1974; Wessen 1982). Other investigators have addressed the role and importance of shellfish in the prehistoric diet (e.g., Koloseike 1970b; Meehan 1977b; Meighan 1969; Osborn 1977). Some ethnographic work has also been done on Aboriginal procurement, processing, and utilization of shellfish (e.g., Meehan 1977a, 1977b, 1982; Moss 1993).

Early research of shell mounds and middens was primarily concerned with species identification, compilation of species lists, and comparisons of the status of relic and modern molluscs in the region. In the 1960s, the focus began to shift, and more recent research has addressed dietary reconstruction (Duran et al. 1987; Meehan 1982; Walsekov 1987), the role of shellfish in the Aboriginal diet (Parmalee and Klippel 1974), classification of shell-bearing sites (McManamon 1984; Widmer 1989), and paleoenvironmental studies that include terrestrial habitat reconstruction (Thomas 1985), global climate change (Sandweiss 1996), and climate reconstruction (Barreis 1980; and Gould 1971).

**Freshwater Shell Midden Research in North America**

Although inland freshwater shell middens and shell mounds are less extensive than those along sea coasts, these shell accumulations also required explanation. The most extensive investigation of freshwater shellfish has been carried out in the eastern
United States. Important examples of this research include: (1) reconstruction of prehistoric environments (Matteson 1958); (2) use of freshwater molluscs as a prehistoric food resource (Parmalee and Klippel 1974); (3) the role of shellfish in prehistoric economies from a protein perspective (Erlandson 1988); (4) freshwater molluscs as paleoenvironmental indicators (Warren 1991); and (5) use of freshwater mussels as indicators of environmental change (Parmalee 1986, 1988; Warren 1991a, 1991b).

The 1974 Parmalee and Klippel study investigated freshwater shellfish as a prehistoric Aboriginal food resource, and compared the nutritional content of shellfish with other foods often represented in archaeological contexts in eastern North America. In his 1988 study, Erlandson reviewed the Parmalee and Klippel data from a protein perspective and concluded that shellfish can supply the essential protein component in human diet if ingested with vegetal foods rich in carbohydrates. These studies illustrate some important aspects of shell midden research that will be investigated in further chapters of this thesis.

**Freshwater Shellfish Research in the Plateau Culture Area**

While research carried out on coastal and interior shell middens around the world has ably demonstrated the value of shell midden investigation and analysis, shellfish-related research in the Plateau culture area has been largely confined to species identification. Examples of shell research in the region includes: (1) the identification and description of three genera of freshwater molluscs found along the Columbia River in Washington State by Lyman (1980); (2) the identification and investigation of various species of freshwater shellfish remains found during archaeological excavations along the Columbia River in Washington by Chatters (1982, 1986); (3) the recording of large
amounts of freshwater shellfish remains in archaeological excavations along the upper Columbia River by Lohse and Lohse (1986); (4) a description of the relative abundance of freshwater shellfish remains at various archaeological sites across the Columbia Plateau by Warren (1968: 26, 30, 31), and (5) the identification of shellfish remains from an archaeological site along the Missouri River in Montana by Lippincott (1995: 4).

Moving beyond species identification, Lyman (1984) recognized that freshwater shellfish remains were a potentially significant variable that needed to be included in studies of human adaptation on the Columbia Plateau, and so developed a research model based on mollusc ecology and life histories. It was anticipated that this model would illuminate particular aspects of regional settlement and subsistence systems by investigating and explaining prehistoric changes in archaeological bivalve faunas. Research into changes in bivalve faunas was expected to discriminate and explain changes caused by environmental fluctuations from those changes in prehistoric Aboriginal subsistence practices that are unrelated to climatic fluctuations, however Lymans’ hypothesis remains untested.

In the Interior Plateau of British Columbia, the remains of freshwater shellfish have frequently been found during archaeological investigations. As with other parts of North America, most of the attention devoted to such remains has been limited to species identification. More extensive research into shellfish usage by Aboriginal societies in the study area is limited to two brief papers presented at archaeological conferences. The first of these by Michael Blake (1973), briefly explored the ethnographic and prehistoric use of freshwater molluscs from the Plateau culture area, while Stanley Copp (1975) investigated the nutritional value of *Margaritifera margaritifera (falcata)* as a food
resource at the McCall archaeological site in the South Okanagan Valley of British Columbia.

Research Goals

The research and writing of this thesis has been motivated by the paucity of research carried out on shellfish remains in the region and the potential importance of this resource in Aboriginal subsistence and long-term land use. Four major goals have guided my research.

The first research goal is to investigate the extent of freshwater mollusc distribution and usage at archaeological sites on the Interior Plateau of British Columbia. To carry out this investigation, I have examined a sample of approximately 100 archaeological reports resulting from archaeological excavations conducted over the past 50 years, and reviewed descriptions and/or inventory records for over 2,000 archaeological sites in the region.

The second research goal is to study the role of freshwater shellfish in the culture sub-area and its potential importance in prehistoric Aboriginal diet and economies. This was accomplished by examining the archaeological records for information on the quantity, (if any), of shellfish remains recorded, and other evidence that may indicate widespread intensive harvesting and consumption of shellfish at archaeological sites. My analysis includes a detailed assessment of the data from three selected archaeological sites, which may provide insights into the uses of shellfish by Aboriginal societies.
The third research goal is to compare the various species of shellfish fauna found at archaeological sites on the Interior Plateau with species prevalent in modern river systems. To achieve this goal, I examined shellfish species from Kamloops Lake, the Thompson River, the North Thompson River from the confluence of the rivers in Kamloops to Rayleigh, and South Thompson River from its confluence with the North Thompson River to Monte Creek. Identification of species was classified according to the criteria presented in "The Freshwater Molluscs of Canada" (Clarke 1981).

The fourth goal is to examine the data generated by my research, and compare this information with ethnographic accounts of Post (1938), Ray (1933), and Teit (1900, 1909), that consistently define freshwater shellfish as "famine food," that was consumed only in the absence of other resources. The data from this research are expected to shed new light on the use of freshwater shellfish and its importance in prehistoric Aboriginal diet and subsistence.

**Famine Food Defined**

A key question addressed in this thesis concerns shellfish as "famine food." Given the importance and significance of this term, I define it here. Teit (1900: 513, 515, 517) has described "times of great famine" and "great scarcity" among the Shuswap Indians, as well as periods of famine due to seasonal fluctuations in salmon, deer and other game animals among the Thompson and Lillooet Indians of the Interior Plateau of British Columbia. Post (1938: 29) and Ray (1932: 107) also refer to food shortages, periods of starvation, and famine foods in their ethnographies of Aboriginal societies of the Plateau.
culture area in Washington. Freshwater shellfish are cited in the above ethnographies as “famine food”, consumed during times when all other foods were scarce or unavailable.

In her study of the role of plant foods as famine foods in northwestern North America, Turner (1993: 176) has cited a definition of famine food made by Paul Minnis in 1991. Minnis classified famine foods by four categories: (1) regular foods whose use became more important under certain circumstances, largely due to extended availability; (2) alternative or secondary foods, used minimally or casually in normal times, but never eaten except in times of extreme hunger; (3) true famine foods--those never eaten except in time of extreme hunger, and (4) hunger suppressants and thirst quenchers, generally used during short periods of food and water deprivation.

Ethnographically, the Indians of Interior British Columbia disdained shellfish. Teit (1900: 231; 1909: 513, 517), for example, wrote that among the Thompson Indians insects and shellfish were not eaten, while dogs and shellfish were only consumed by the Shuswap during times of famine. If Teit’s assessment is correct, then the consumption of shellfish by the Thompson and Shuswap peoples fits clearly with Minnis’ category of true famine food, consumed only in the absence of all other foods.

**Organization of the Thesis**

In this first chapter I have introduced the thesis statement, research questions, described the project area, reviewed shell midden research from around the world, presented the research goals, and defined some key terms. Topics and outline descriptions
of subsequent chapters are presented as a means to inform the reader about the contents and subject of the thesis.

Chapter 2 is devoted to the archaeological theories that guide my research, and the methodologies I have employed in this study. This chapter reviews some of the primary theoretical perspectives that have been used to illuminate hunter-gatherer foraging strategies and dietary patterns. The methodology section includes descriptions of, and justifications for, the research methods utilized, as well as discussions on pertinent topics and issues (e.g., sampling and sample size). Some problems associated with radiocarbon dating of shell and seasonality studies are also identified.

Chapter 3 explores the natural history, biology and ecology of freshwater molluscs, and significant environmental considerations for mollusc colonization on the Interior Plateau. Descriptive summaries are included for the four genera of large freshwater bivalves found in archaeological investigations on the Plateau.

Chapter 4 investigates some of the important ethnographic, cultural, and dietary issues concerning freshwater shellfish in the Plateau culture area. These include ethnographic accounts of shellfishing practices along the Columbia River in Washington State, as well as accounts from the Thompson River area of south-central British Columbia. The nutritional content of shellfish is reviewed relative to its use and importance in Aboriginal diet and subsistence.

Chapter 5 presents the results of my investigations into freshwater shellfish remains on the Interior Plateau of British Columbia. Data are summarized for the shell-bearing sites across the Plateau in terms of species represented, their cultural affiliation, and available radiocarbon dates. The material from three selected archaeological sites is
examined in detail and data from these sites are used to test specific aspects of the
research questions.

Chapter 6 reports on the results of investigations of sections along the Thompson
River, and the North and South Thompson rivers for evidence of shellfish colonization.
An important component of my research concerns collection of shellfish specimens from
present (i.e., modern) river systems, and their comparison to those found
archaeologically, to determine whether a species change in abundance/presence has
occurred over time.

In the final chapter, I discuss the data generated from this research in relation to
theoretical models guiding my research. The research results are reviewed in the context
of various research questions that pertain to the role of freshwater shellfish in prehistoric
and ethnographic Aboriginal subsistence on the Interior Plateau.

**Chapter Summary**

This chapter has introduced the thesis topic, the thesis statement, and the research
goals that frame my research. Overviews are provided that outline the extent and
importance of shell midden research around the world, and its importance in
archaeological investigations. The limited extent of shell research in the Plateau culture
area is highlighted, as well as the potential for this research to provide information on a
hitherto unknown component of Plateau subsistence.
CHAPTER TWO

THEORY AND METHOD
IN HUNTER-GATHERER SUBSISTENCE RESEARCH

This chapter focuses on major theoretical issues that have guided this study, and methodological approaches that were employed. Both are critical components of this thesis. The first part of this chapter reviews theoretical issues and approaches that archaeologists have developed, both to reconstruct prehistoric diet and economies and to explain hunter-gatherer foraging activities and subsistence practices. This set of theoretical models has particular relevance to my investigations into the role of freshwater shellfish in Aboriginal diet and subsistence on the Interior Plateau of British Columbia. The second part presents the research methods I have employed to investigate and identify archaeological data and ethnographic material for the region. Various research problems associated with radiocarbon dating of shell and site seasonality are also discussed.

Theoretical Perspectives on Hunter-Gatherer Foraging Strategies

Anthropologists, archaeologists, ecologists, and others have proposed various theories that seek to explain strategies and processes that human foragers have developed as they adapted to ever-changing environmental circumstances. This section briefly reviews a number of major studies that focus on adaptive processes.
Particular explicative models associated with or derived from cultural ecology, middle-range theory, and optimal foraging theory and related models were considered because they address various concepts and theories of foraging that may provide insights to hunter-gatherer foraging and subsistence activities and dietary stress in the Plateau culture area.

**Cultural Ecology**

Julian Steward (1955: 30-42, 1968: 337-344) defined cultural ecology as the core concept of the processes by which a society adapts to its environment. His study of the concept and method of cultural ecology examined the interactions of societies and social institutions with one another and with the natural environment. Steward focused on particular adaptive processes by which any society interacts with its environment, as well as on such biological factors as the nuclear family and sexual division of labour. In this framework women are food collectors because of the prolonged period of human growth and the responsibility of women for child care and child rearing. Stewards’ concept of societal adaptation to the environment laid the foundation for other subsequent theories of cultural adaptation including Lewis Binford’s forager and collector model (Binford 1978; 1980), optimal foraging theory, and other subsistence-orientated models, such as described by Bettinger (1991), Kelly (1995), and Winterhalder (2001). Prehistoric and ethnographic foragers on the Interior Plateau of British Columbia subsisted by hunting and gathering wild foods. I have considered these various theoretical concepts and models of hunter-gatherer foraging activities because they help to reconstruct and explain how prehistoric foragers in the region may have related to their environment.
Middle-Range Theory

Differentiating between hunter-gatherer societies and subsistence and settlement strategies is exemplified by Lewis Binford’s distinction between foragers and collectors. Through his investigations of hunter-gatherer settlement and land use, largely based on ethnographic observations of contemporary foraging societies, Binford (1978; 1980) describes two basic lifestyles which he termed foragers and collectors. Foraging systems are characterized by low logistical mobility and high residential mobility, while collector systems have high logistical mobility and low residential mobility. The strength of Binford’s model lies in the emphasis placed on strategies behind the observed patterns of foraging and collecting rather than emphasizing the patterns themselves (Fitzhugh and Habu 2002: 2). The forager/collector model attracted the attention of archaeologists who were searching for middle-range theories that would bridge the gap between archaeological data, the present, and the dynamic behaviours of past peoples.

An inherent limitation of the model is its inability to reveal long-term changes in hunter-gatherer settlement systems. For example, Fitzhugh and Habu (2002: 2) attribute this to Binford’s focus on short-term ethnographic observations based on annual cycles of subsistence and settlement. They noted that the addition of technological change to the forager/collector model leaves room for strategic input of individuals in the decision-making process, and thus becomes more appropriate for long-term evolutionary change. The forager/collector model has particular relevance for hunter-gatherer subsistence in the study area where Aboriginal peoples hunted, fished, gathered vegetal foods and collected freshwater shellfish during an annual cycle.
Optimal Foraging and Related Models

Archaeologists have employed a variety of approaches to define and interpret subsistence-related practices of hunter-gatherers. This section reviews different strategies that have been employed to explain the movement of foragers over the landscape, and the types of decisions that may have influenced resource collection or harvesting.

Although optimal foraging models were initially developed by ecologists as a means to explain nonhuman foraging behaviour, archaeologists were quick to recognize their potential to explain various components of human forager resource selection (Bettinger 1991: 73). Optimal Foraging models generally consist of a subsistence related goal, a currency, a set of constraints, and a variety of options (Bettinger 1991: 73). The goal is normally the food gathered per unit of time, and the unit of currency most often used is calories. Constraints include the maximum time that can be spent foraging, as well as a forager's capacity to process (and ultimately digest) gathered food. Options include potential available food resources in the area and other choices about how time is budgeted, (e.g., child care). The following four microeconomic optimization models have been developed within the framework of optimal foraging theory to explain how foragers arrive at subsistence decisions given their conscious choice of resources.

The Diet Breadth Model. In this model, prey or food selection is categorized as energy. Foragers are confronted with a wide variety of dietary (food) items from which they select a combination of food types (e.g., deer, moose, salmon, birds, freshwater shellfish) that maximize net energy input per unit of foraging time. The end result of this selection process is the net amount of energy expended to harvest the resource. The challenge for economy-minded foragers is to select a combination of food types that
maximizes the net amount of energy obtained from the foraging process. Abundance of a resource has no bearing on whether it is included in the optimal diet. This decision depends entirely upon abundance of all more highly ranked resources relative to their energy yield. As resource abundance declines, the search time spent to locate them increases, and the breadth or "spectrum" of food items in the diet increases to compensate for the change. The diet-breadth model is used to predict changes in resource selectivity as a function of changes in the environment, or in the forager's harvesting capabilities and specifically predicts only whether a resource will be gathered by groups when they encounter it while foraging (Bettinger 1991: 83-86; Kelly 1995 78-90; Winterhalder 2001: 13-14). Within this context, one could logically expect that freshwater shellfish on the Interior Plateau may have been included in the diet-breadth of food resources during periods when other foods were less abundant.

The Patch Choice Model. Although Bettinger (1991: 87) regards the patch choice model as a special case of the diet-breadth model, there are important differences. In this model, the food types are patches of resources rather than individual items, and the net energy returns from a patch include search and handling time in the patch. As patches frequently differ in terms of energy they contain and time needed to extract that energy, foragers will tend to rank the patch from highest to lowest expected returns to include the total time spent on searching and handling time in the patch. While the ranked patch type may produce the best return per unit of foraging time, if this patch time is widely spaced across the environment, then the net rate of returns relative to travel and foraging time may drop to unacceptable levels. Although the patch choice model implies that patch selectivity should increase with an increase in overall abundance which causes both travel
and foraging time to decrease, this model is ambiguous as to whether patch choice should expand, contract, or remain unchanged (Bettinger 1991: 90). This ambiguity may be reduced by different kinds of foragers who spend more time in pursuit and processing rather than in resource search. This type of foraging pattern may result in more uniform restricted patch use where resources are abundant and more uniform expanded patch use where resources are scarce.

The expectation of the patch choice model is that foragers who spend no time in search will become more selective in the use of patches than foragers who initially spend as much time in search as in pursuit. Both Bettinger (1991: 87-90) and Kelly (1995: 90-97) caution that there are no true anthropological tests of this model because foragers do not encounter patches randomly, but instead choose the foraging destination before they leave camp. While searching and pursuit are unavoidable for many types of food, in other cases it is simply a matter of going to where they are known to be available and harvesting them (e.g., berry patches, mussel beds). This model has relevance for Aboriginal foragers in the Interior Plateau in relation to anadromous salmon runs, migrating waterfowl (e.g., geese), and shellfish beds in the drainage systems.

Foraging Time: The Marginal Value Theorem. Diet breadth and patch choice models provide explanations for the locations where foragers target to collect, and once there, what they collect. However, they do not explain how long groups stay in a specific place or patch while collecting. Foraging time spent in a patch should depend on the quality and quantity of resources within the patch, the rate that resources are depleted and, overall abundance of resources within the environment. Kelly (1995: 90-93)
provides several examples of the marginal value theorem as a method to predict when foragers should leave a patch and move on.

The total energy intake for a given patch is considered a function of time spent there, overall energy intake relative to time expended on travel between patches in the itinerary, foraging time within patches, and on handling items in the diet. As resources within the patch become depleted, the rate of energy intake declines until it reaches a level where foragers have no prospects for acquiring any further energy from the patch. The theorem has determined that when the rate of return within the patch drops to the overall energy returns relative to all of the travel, search, and handling/processing times for all patches, then foragers should leave the patch and move on. It is assumed that travel time between patches is non-productive. There are no true tests for the marginal value theorem because of scarcity of data for return rates for all potential resource patches and the average travel time between patches (Bettinger 1991: 90-97; Kelly 1995: 90-93, 94).

*The Central Place Foraging Model.* Central place foraging (Kelly 1995: 93) focuses on a spatial dimension not found in other optimal foraging models. It is based on the concept of foraging activities that have a central place from which foragers depart and return to during foraging expeditions. This relates to Binford’s forager and collector model with respect to the movement of specially organized task groups on temporary excursions from a residential base camp (Fitzhugh and Habu 2002: 1). These central places are located near important resources of water, fuel, and food. Resources nearest the habitation site are expected to be exploited first, with depletion diminishing as the foragers move out from the central place to forage the surrounding area. Decisions to move centralized residential camps are based on several criteria. For example, hunter-
gatherers will move the central site more frequently if relocation costs are low, if
resources immediately adjacent to the site are rapidly decreasing, or if alternate sites offer
higher initial rates of energy returns.

Winterhalder (2001: 23) cites Metcalfe and Bristow’s technological approach to
central place foraging. They note some hunter-gatherers utilize butchering tools (e.g.,
choppers, blades) to cut up large food items (e.g., a buffalo carcass) and transport devices
(e.g., canoes, sleds, horses) to move the food to a central place for processing. The use of
butchering and transport technology allows the foragers to treat the processed (butchered)
and unprocessed (remainder of buffalo carcass) as separate food resources and to predict
when a resource will be processed in the field to remove portions of low energy returns
prior to transport to the central place. The unprocessed resource takes less handling time
in the field and allows for more round trips, but incurs the cost of transporting material
that has little or no value. Although processing takes time and lessens the numbers of
return trips possible, the transported resources include high-value items. Bettinger (1991),
Kelly (1995), and Winterhalder (2001) provide a variety of statistical models that
determine when central place foragers who travel from the central place to gather
resources should reverse the pattern and relocate to another site, which then becomes the
central place. These models may be pertinent to the prehistoric Aboriginal foragers on the
Interior Plateau during the past 4,000 years, a time when pit-house settlements may have
served as central places where shellfish were processed and consumed.
Hunter-Gatherer Foraging Diversity

Considerable diversity exists for those small-scale societies that we term hunter-gatherers. There was, in fact, considerable diversity in the social, economic, and technological characteristics of these peoples (Kelly 1995). Although the numbers of these societies and the populations they represent have dwindled, ethnographers and others have documented the presence of hunter-gatherers on most of the world’s continents. Lee (1979) for example, has recorded subsistence practices of !Kung San peoples of the Kalahari desert of southwest Africa. The !Kung have adapted to their environment by living in small groups around permanent water holes surrounded by land that contains a variety of food resources such as game animals hunted by male members of the group and vegetal foods gathered by women (e.g., mogongo nuts that provided up to half of the vegetal foods consumed). Lee cites the equitable sharing of hunted and gathered foods as the single feature that makes survival in this environment possible.

Mulvaney and Kamminga (1999: 293-296) describe seasonal movement and subsistence practices of Aboriginal hunter-gatherers living along Australia’s southwestern coast and cite several examples of such practices recorded in the journals of early 19th century explorers, such as Captain Collet Barker and George Grey. Their journals describe a seasonal subsistence strategy based on large groups of people converging along coastal wetlands and estuaries during the summer months when they harvested marine mammals, freshwater molluscs, and vegetal foods. In winter, groups dispersed into smaller units and moved into the interior where they exploited roots, tubers, and marsupials. This subsistence pattern has been successfully practiced in this
area for at least the past 2,000 years, as substantiated by archaeological data (Mulvaney and Kamminga 1999: 293).

The temperate rain forest of the Northwest Coast of North America provided a situation that some consider the other extreme of hunter-gatherer adaptation. This environment supported a variety of different cultural groups although with similar organization (e.g., large scale sedentary ranked societies). Matson and Coupland (1995: 125-143) describe a full-time coastal adaptation, with shellfish and coastal fish dominant in the faunal remains. They submit that it is the efficient and extensive use of these resources that allowed for increased populations, the development of cultural complexity, and the materially rich sedentary chieftains encountered along the Northwest Coast at the time of European contact.

Likewise, hunter-gatherer groups in the Interior Plateau of North America adapted and subsisted on the resources available in their surrounding environments. There, archaeologists and ethnographers have recorded a settlement and subsistence pattern covering some 8,500 years of human settlement in the area (Richards and Rousseau: 1987; Stryd and Rousseau 1996). Subsistence strategies for the past 4,000 years are related to semi-sedentary pit-house settlements and seasonal food collection dependent on readily available resources (Hunn and French 1998: 378-394; Walker 1998: 420-445). For example, groups living along the Columbia and Fraser rivers and their tributaries relied heavily on harvesting and storage of riverine resources, such as runs of anadromous salmon and water fowl, supplemented by hunting a variety of mammals and gathering vegetal foods and freshwater mussels. Groups lacking direct access to anadromous fish runs obtained this important source of protein through exchange systems.

Aboriginal peoples of the southern Interior of British Columbia participated in a similar and varied subsistence strategy that consisted of seasonally occupied pit-house villages, storage of anadromous salmon and gathered vegetal foods, supplemented by riverine resources such as waterfowl and freshwater mussels (Rousseau and Muir 1991; Stryd and Rousseau 1996; and Wilson 1991). Seasonal harvesting and storage of food in the area is well documented in archaeological reports that describe a hunter-gatherer lifestyle organized around the seasonal harvesting of resources that provided food, clothing and shelter from the surrounding environment.

Research Methods

In this section I describe various research methods employed to study both prehistoric and ethnographic Aboriginal shellfishing practices in the Plateau culture area. This includes a review of the literature that contains information on these practices, a description of the methods employed in my surveys of the modern river systems in the Thompson River valley and a discussion of methodological considerations concerning the dating of shellfish and seasonality issues.

Literature Survey

The research questions, problem orientation and thesis goals outlined in Chapter 1 were chosen to investigate and identify the role and importance of freshwater shellfish in Aboriginal diet and subsistence on the Interior Plateau of British Columbia. An important
component of my research is to investigate pertinent information from archaeological reports from all areas of the Plateau. To this end, a sample size of approximately 2,000 archaeological site reports were reviewed for data suitable for analysis. While a large sample base that includes site reports from across the entire Interior Plateau may bias the research results and show a lower percentage of shell-bearing sites relative to the total number of sites researched, the thesis goals can only be satisfied through a broad investigation that is representative of all areas. My research was not specifically focused on archaeological reports along rivers, lakes, and streams, but included reports covering all types of terrain (e.g., logging cut blocks, road construction and upland areas that crossed different ecological zones).

Archaeological reports were reviewed for information relating to the extent of freshwater shell remains across the Plateau, the age of the remains, their proximity to pit-house sites, and the species of shellfish remains reported in the literature. It is important to note that the study investigated not only well-defined shell middens, but also small shell heaps consisting of several or more shells such as those found at archaeological site EeRb 144 on the Kamloops Indian Reserve (Nicholas and Tryon 1999) a site discussed in Chapter 5.

Survey Methods

My investigations included an in-field visual site survey of the Thompson River systems to determine whether populations of freshwater shellfish are still present in the river system and, if so, whether these are the same species found archaeologically. My survey included a section of Kamloops Lake, and the Thompson River to its confluence with the North and South Thompson Rivers in Kamloops, a section of the North
Thompson River from Kamloops to Rayleigh, and a section of the South Thompson River from Kamloops to just east of Monte creek. The survey included most sections of the rivers that were both walkable and accessible. To carry out this survey, I walked lake and river shorelines over an extended period of a year, during late fall, early winter, and early spring, when water levels were low. I recorded my observations and observed data on site survey forms. Shellfish specimens collected were identified by species, using criteria presented in Chapter 3, to determine whether they are the same species as those described in the archaeological reports. Such comparative analyses can determine whether a species change has occurred over time. Specimens of both live and post-mortem shells were collected for comparison and analysis. Shells were placed in plastic bags, and locations where they were found were written both on the plastic bag and on the survey form. When the shells had been subsequently identified to species, this information was added to both the plastic bag containing the shell and the survey form.

**Methodological Concerns**

A number of factors may influence the project results of this study. Two are particularly noteworthy; dating methods and seasonality. Each is briefly discussed here.

**Dating Methods.**

Archaeologists frequently determine the relative and absolute ages of shellfish fauna at archaeological sites through their direct association with cultural remains. Although radiocarbon dating is a well-established procedure for determining the ages of faunal remains, there is a major problem associated with this method when dating
shellfish. Problems commonly associated with radiocarbon dating of freshwater shellfish are identified by Claasen (1998: 94) who cites a study by Goodfriend carried out in 1987 where multiple dates on a single sample provided a series of dates that ranged from a maximum of 3,000 years to a minimum of 700 years. Claasen also cites Goodfriend's study as a source of methods for cleaning secondary carbon from freshwater shell to help correct for radiocarbon dating problems associated with shellfish.

A common problem is that living shellfish may have consumed older carbon from a local river or lake, resulting in an older than actual radiocarbon date, and that the carbonate exchange in the shell may also have continued after the death of the organism (Arcas 1985: 54). An example of this is found in the dating results at archaeological site EeRh 61 near Ashcroft. Testing of charcoal (sample SFU-386) and freshwater mussel shell (sample SFU-397) from the same cultural layer of the site produced a temporal discrepancy of 1,500 years. Since there was no reason to suspect the methods used to derive this charcoal date, Dr. Erle Nelson, Director of the Radiocarbon Laboratory at Simon Fraser University, concluded that the shell date was older than actual by about 1,500 years (Arcas Associates 1985: 54). Based on the apparent discrepancy between the dates of these two samples, Arcas Associates (1985: 55) suggest that the older radiocarbon dates obtained from shellfish remains from archaeological site EeRh 61 may be due to the possible upstream presence of dead carbonates from the Marble Canyon Formation and the Hat Creek coal deposits. Thus, as indicated in this sample, the radiocarbon dating of shell, including the various dates cited in this study may be subject to temporal discrepancies.
Seasonality Concerns.

Although determining seasonality of shellfish at archaeological sites in the study area would have been useful for addressing the research questions, I have chosen not to do so because of problems found in the methods normally employed. While seasonality studies have frequently been conducted on shellfish remains, the results of these studies have been questioned in some cases (e.g., Classen 1998; Maxwell 2003). Archaeologists have often attempted to use growth-line analysis as a method to determine site seasonality from shells found at sites. However, there are two major factors that hinder effective application of this technique, or limit its reliability. These concerns are: (1) the effects of storms and other disturbances on shell growth, and (2) the condition of shell remains from archaeological sites.

The Effects of Disturbances on Shell Growth. Various articles published in the malacological literature of the late 1960s and 1970s indicated that mollusc activities can be determined by growth line analysis. For example, Clark (1968, 1969), Kobayashi (1969), Koike (1979), and Wilbur (1972, 1964) all stated that during cold weather mussels become inactive and secretion of shell is significantly reduced. As a result, distinct low-growth breaks separating fast warm-weather growth lines are evident in the shell. Claasen (1998: 146) posed a cautionary note concerning this pattern and notes that more recent biological literature clearly indicates that individual shells do not grow at a uniform rate throughout the growing season (i.e., they frequently do not grow similar amounts of shell during the same calendar period in different years).
Major studies by Claasen (1998, 1993, 1990) and Deith (1988b, 1986, 1985, 1983a and 1983b) described the growth cycles of shellfish and problems associated with growth line analysis as a method to determine the season of death. In these studies, annual growth cycles of shellfish were defined as a set of days when shell rich in calcium carbonate is deposited, and a set of days when shell poor in calcium carbonate but rich in conchiolin (mussel shell) is deposited. The seasonal growth of the shell is determined by measuring the amount of growth following the last major growth band. The degree to which the growth band is completed is assumed to indicate the season in which the shellfish died. Difficulties are encountered in recognizing and defining criteria for distinguishing between growth lines that are seasonally induced from those resulting from interruptions brought about by spawning, storms, predator attacks, periods of very hot weather and other environmental influences. For example, Deith (1988b, 1983) studied the growth lines in modern specimens of Cerastoderma edule from a Scottish estuary. In control samples of this species collected over a three-year period in April and September only, she found that growth-line counts were only suited for distinguishing the five-month period, from April through September, and that growth lines on the other seven months were indistinguishable. Studies such as these led Claasen (1998) to question the validity of using seasonal growth lines as a conclusive method to determine the season when the shellfish died. A more recent study of shellfishing seasonality in Coastal British Columbia (Maxwell: 2003: 175-188) supports these conclusions.

**Condition of Shell Remains.** The problems with growth-line analysis cited in the above paragraph have serious negative implications for this technique if employed for specimens from archaeological sites on the Interior Plateau. Shells of live freshwater
shellfish are fragile in comparison to those of marine species. These shells further deteriorate when they are buried in archaeological sites for long periods of time.

Although the valves of some shells are reasonably intact, at many sites the outer section of the shell containing the growth lines and annuli has frequently eroded until only the beak and hinge section are left. The result is that the shell margins are no longer intact. Determining seasonality of shell found at archaeological sites could have contributed significantly to the research questions, but the problems associated with currently available techniques indicate that the process is either impossible, unreliable or deceptive. For the reasons cited, I chose not to employ this technique for seasonality determination. James Chatters (pers. comm. 2004) recently informed me of a fast, non-destructive method that he has devised for measuring growth increments in unionid bivalves. He plans to publish the details of his methods and their application to seasonality of shellfish gathering in the Southern Plateau in the near future, but did not provide details of this method.

Chapter Summary

This chapter has investigated various theories relating to optimal foraging theory and microeconomic models that describe and explain the movement of hunter-gatherers around the landscape, and decisions that may have influenced resource collection and harvesting. These subsistence-related approaches have particular relevance to this study of Interior Plateau hunter-gatherers and their use of freshwater shellfish as a food resource.
The research methods employed in this study were designed to include all recorded archaeological sites from all areas of the study area, not just those situated along waterways (areas that have a high expectancy to contain shell sites). Subsequently, while this inclusiveness resulted in a lower ratio of shell sites relative to the number of sites investigated, it also produced a more representative sample that defines the extent and breadth of shellfish use in the area.

Methodological concerns pertinent to this study include problems associated with radiocarbon dating of freshwater shellfish remains from archaeological sites, and the use of growth line analysis as a method to determine seasonality. Radiocarbon dates on shell may be older than those obtained on other archaeological materials, as indicated by several studies in the project area. The use of growth line analysis as a reliable measure for determining site seasonality has also been questioned due to factors that influence growth bands of living shellfish. Due to the fragile condition of archaeological shell remains from the study area, and to problems associated with growth line analysis, no attempt was made in thesis research to determine seasonality using shell samples from the study area.
CHAPTER THREE

THE NATURAL HISTORY, BIOLOGY, AND ECOLOGY OF FRESHWATER MOLLUSCS

In North America, freshwater molluscs have existed since the Triassic Period, three hundred million years ago, and this long time span has provided ample opportunity for adaptation to new habitats and for diversification (Davis and Fuller 1981). While freshwater mussels are found all over the world, they are most diverse in North America where they are represented by two families: Margaritiferidae, which is represented by only five species, and Unionidae, which has over 300 species (Armstrong 1982: 1-5).

According to Brose (1972), there are four groups of freshwater bivalves, two of which occurred prehistorically in North America. The two groups that are found in bodies of freshwater throughout North America are the unionids and sphaerids. Sphaerids, also known as “pea,” “pill,” or “fingernail clams,” are frequently found in archaeological sites; however, due to their size (2 to 20 mm in length), they were apparently not a significant food resource, and their presence is considered to be incidental. Unionids are the largest of all freshwater shellfish, reaching lengths of 15 cm or more, many species live 20 to 30 years and some have been known to live up to 140 years (Watters 2002). While archaeologists have not made a correlation between size and age, Claasen (1998: 25, 26) has described juvenile shellfish growth as slightly more accelerated than that of mature shellfish, and attributes growth during the juvenile and mature stages as responsible for the majority of the shell length at maturity. The remains of unionid shells
are found in significant numbers in archaeological sites throughout North America where they were used by Aboriginal peoples as a food resource, and their shells as materials for food, tools, and ornamentation (Armstrong 1982: 5).

This chapter focuses on the four genera of freshwater shellfish found in both modern contexts and archaeological sites on the Interior Plateau of British Columbia: *Margaritifera falcata*, Western-River Pearl Mussel; *Anodonta kennerlyi*, Western Floater; *Gonidea angulata*, Rocky Mountain Ridged Mussel; and *Anodonta nuttalliana*, Winged Floater (Clarke 1981). I examine their biology, ecology, and distribution in the study area. First, however, I provide an overview of freshwater molluscs in general, describing their biology, shell formation, and other pertinent features.

Knowledge of the life histories of the genera described in this chapter has important implications for understanding and explaining Plateau subsistence-settlement systems and ecological change. Lyman (1980, 1984) has noted that because local shellfish populations can vary across space and time, familiarity with shellfish ecology and life histories is essential to determining whether the relative abundance of shellfish remains in archaeological sites reflects selective exploitation of resources or their ecological variability. To illustrate this point, he investigates change in a shellfish species (*Margaritifera falcata*) that occurred over time along the Columbia River in Washington State (Lyman 1984: 99), which he attributes to either a change in prehistoric harvesting practices affecting abundance (i.e., cultural selection) or environmental change. He believes these factors have implications for interpreting the sizes and available quantities of prehistoric shellfish populations, the intensity of exploitation, and/or the magnitude of environmental change. Lyman (1984) further notes that the life histories and ecology of
freshwater shellfish in the Plateau culture area are poorly known, an observation also true for the Interior Plateau of British Columbia. My research will contribute to the latter.

**Biology, Feeding, and Reproduction**

Molluscs are invertebrate animals that inhabit the bottom and substrate of rivers and other bodies of water. The soft body of the mollusc consists of a foot, a mantle, two siphons, and gills, all of which are encapsulated between the two shells. The gills of freshwater mussels are large and adapted for filter-feeding, gas exchange, and reproduction (Armstrong: 1981: 2; Claasen 1998: 16, 18, 21). Their body is surrounded by two shells or valves of calcium carbonate, which is known as the exoskeleton. The shell is made up of an outer layer called the *periostracum*, consisting of one to four calcareous sub-layers, and is lined with a shiny layer of *nacre* ("mother of pearl"). The two valves are joined by a flexible ligament (the adductor muscle) that opens and closes the valves.

Freshwater mussels are filter-feeders, which means that as water is passed through their gills, food such as plankton and other organisms carried with the water is filtered and digested. Because a current is needed to keep water flowing through their gills, most freshwater mussels are found in fast-flowing sections of rivers and streams (Armstrong 1982: 3).

**Reproduction and Life Stages**

Production of sperm and eggs is initiated by changes in water temperature. A single gravid female can produce up to three million glochidea (larvae) in one brood.
Typically, sexes are either male or female, although small numbers of hermaphrodites have been found in most populations of many species (van der Schalie 1970a: 93-117).

As larvae, freshwater mussels are parasites, a stage they cannot bypass in their journey from glochidea to mature adult. The glochidea infest their hosts when they come into contact with fish in the water or on the substrate. Some mussels have light-sensitive areas that stimulate them to release their glochidea in the shadow of a passing fish. Hosts either take in suspended glochidea and pass them over their gills where they attach, or they contact the larvae on the substrate where the glochideal parasites attach to the fins or skin. A few mussel species bind numbers of glochidea into long, worm-like masses that lure host fishes into taking a bite. The glochidea infest the host’s gills when they are eaten (Armstrong 1982: 2, 3).

Although sunfish and bass are often cited as the most common hosts, the more species of fish the glochidea can invade, the greater their chance of survival. Host specificity varies among freshwater mussels, and some mussels are able to parasitize many species of fish. Glochideal infection does not generally harm the host fish, although younger fish may die from a secondary infection. Invading a fish host is not the end of the struggle for the glochidea; they must stay attached to their host long enough for the surrounding tissue layer to encyst them where they will be nourished and carried by the fish wherever it travels. After a period of 10 to 30 days, the glochidea rupture their surrounding cysts and drop to the bottom as tiny mussels. This host-parasite relationship suggests that fish must be present in the environment for their dispersal. By attaching themselves to a mobile host, such as fish, they are dispersed within and between drainage systems. Of the more than 300 species of freshwater mussels in North America, only one,
the salamander mussel (*Simpsonaias ambigua*) is known to use a non-fish host, the mudpuppy (*Necturus maculosis*) (Armstrong 1982: 2, 3; Claasen 1998: 26, 29).

**The Shell**

Given that the shell is the only durable element of shellfish, it requires careful consideration here since it is the only structure that preserves archaeologically. The main features of the shell are described in Table 2.

Freshwater mussel shell is formed as the result of: (1) the metabolic reactions associated with calcium carbonate formation and the synthesis of the organic matrix; (2) the secretion of components of the shell by the mantle; and (3) crystal growth and the formation of the crystalline layers. Nacreous unionaceans living in freshwater habitats have a very primitive simple shell structure (Claasen 1998: 22-23). A periostracum of medium thickness covers the prismatic layer, which overlies the nacreous layer (Claasen 1998: 22-23). The nacreous layer is made up of very fine layers of calcium carbonate that are deposited as crystals parallel to the surface in plate form (Claasen 1998: 23; Solem 1974: 10). Erosion or dissolution of the periostracum and prismatic layers is typical of stream or river-dwelling unionacea that burrow quite shallowly into the substrate. In some genera (e.g., *Margaritifera*), horizontal sublayers of the organic part of the shell can be found interspersed in the nacreous layer, with heavier concentrations in the umbonal region. These patches of shell appear to be laid down for both reinforcement and repair of the shell (Claasen 1998: 25; Tevesz and Carter 1980: 315).
<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Beak (umbo)</strong></td>
<td>The beak is the juvenile start of the shell. Its location and prominence can help identify a species.</td>
</tr>
<tr>
<td><strong>Ligament</strong></td>
<td>The ligament is an organic structure on the dorsal margin of the valve. The two valves pivot on the ligament when opening and closing. The ligament is not present in archaeological sites.</td>
</tr>
<tr>
<td><strong>Lateral Teeth</strong></td>
<td>Elongated raised structures located along the hinge line of the valve.</td>
</tr>
<tr>
<td><strong>Pseudocardinal Teeth</strong></td>
<td>These appear as raised, triangular structures. The number, shape, and placement of the teeth (cardinal and lateral) are often key identifying features. The two valves are hinged by an external ligament and teeth.</td>
</tr>
<tr>
<td><strong>Muscle Scars</strong></td>
<td>Depressions on the shell that occur anteriorly and posteriorly. These scars indicate the points of attachment for the adductor muscles, which are responsible for opening and closing the valves.</td>
</tr>
<tr>
<td><strong>Pallial Line</strong></td>
<td>The pallial line indicates where the muscle was attached to the shell. It is an extended groove running parallel with the ventral shell margin.</td>
</tr>
<tr>
<td><strong>Growth Lines</strong></td>
<td>Annual indications of growth that can be seen on the surface of most shells. Annual lines, spawning lines, and trauma lines are similarly registered on the surface of the shell and are difficult, if not impossible, to distinguish between.</td>
</tr>
<tr>
<td><strong>External Colour</strong></td>
<td>Many bivalves have a periostracum, an outer shell covering that may be a different color than the shell itself. The periostracum is often cracked, weathered, or abraded and flaked off itself. It may be thick, thin, transparent; light or dark, smooth or rough.</td>
</tr>
</tbody>
</table>
There are three growth stages visible in the bivalved shell cross-section: juvenile, mature, and senile. During each growth stage, the animal experiences a different overall growth rate. Juvenile mussels grow slightly more quickly and respond to environmental factors differently. The growth rate during juvenile and mature stages is responsible for the majority of the shell length and the mature shell consists of numerous annual marks closely packed together. Although there is a decrease in growth rate with age, growth marks remain rhythmic temporal markers (Claasen 1998: 25; Eldredge et al. 1976).

Ecology

Freshwater mussels are essentially relatively immobile filter-feeding animals that inhabit bodies of water such as rivers, lakes, ponds, and marshes. Their survival and growth rate is affected by a number of environmental factors determined by their need for respiration, food, and reproduction. A variety of physical and biological factors influence their distribution and reproduction. Some molluscs, for example, thrive in rivers and streams with swift-flowing water and sand or gravel substrates, while others prefer muddy or sandy bottoms. It is not uncommon to find several different species living in the same river drainage or lake (Clarke 1981: 250, 306). Most species are intolerant of waters that contain a high suspension of fine mud particles and are highly sensitive to temperatures and toxins, as well as to the amount of oxygen, carbon dioxide, and dissolved calcium carbonates in the water. Water current and water body type are important for removing fine particles and for providing a clean substrate composition for mussel habitation. In lakes, mussel beds are found close to the shore where wave action
circulates the water. Still waters in deeper sections of lakes do not allow the particles to settle out, and are thus avoided as mussel habitat (Baker 1928; Parmalee 1967).

Substrate composition is another major variable that affects the growth and survival of mussel populations. The bottoms of streams and lakes are composed of materials ranging from fine-grained clays and silts to coarse-grained cobbles and boulders. Freshwater mussels spend most of their lives partially or completely buried in these substrates. The stability of the substrates is a determining factor in their survival (Baker 1928: 24). Water temperature is a further determinant of mussel habitat and health as it affects both the amount of available plankton and the bodily functions of mussels. For example, although this factor is not well documented, when water levels in rivers and lakes are low during the colder months, mussels either migrate to deeper waters or burrow deeper into the substrate. While water temperatures must reach a critical temperature during warmer months before mussels can reproduce, the degree of water temperature change that they can withstand is not known (Matteson 1955: 135).

Mussel populations are not found in all rivers and lakes, nor do they inhabit all sections of rivers and lakes where they do occur. There can be a significant downstream variation in species composition from the headwaters of a river to its mouth. In his Ozark Mountain stream study, Warren (1991: 136) has related this to variation in the stream’s condition. He cited a downstream increase in species diversity that was inversely correlated with downstream decreases in the qualitative and apparent quantitative decrease of some taxa and individuals that favoured the upper reaches of the stream. Conditions changed along the stream’s course where springs and tributaries entered the main stream bringing about a considerable increase in stream discharge. Warren’s study
illustrates how ecology influences the biology of freshwater mussels, and has long-term consequences for their very survival.

Four Genera of Freshwater Molluscs in the Interior Plateau of British Columbia

Although Clarke (1973) has identified and recorded approximately 50 species of freshwater bivalves in British Columbia, only four genera found at archaeological sites in the Interior Plateau are of importance to my study. These are *Margaritifera falcata*, *Anodonta kennerlyi*, *Gonidea angulata*, and *Anodonta nuttalliana*. Because they are associated with prehistoric archaeological sites, archaeologists have concluded that these species were of some importance to early peoples as food resources, and, in some instances, as a source for tools and ornamentation (Arcas Associates 1985; Rousseau 1984; Wilson 1991). While each of these molluscs is still found in contemporary lakes and rivers throughout the Interior Plateau, their natural history, biology, and ecology are poorly known. However, brief descriptions of each have been published by Clarke (1981: 250, 254, 306, 308) which are summarized below.

*Margaritifera falcata*, Western-River Pearl Mussel (Figure 2) figure on next page

*Description.* *M. falcata* is similar to *M. margaritifera* except smaller (maximum length 125 mm). It has purple rather than white or whitish nacre; relatively smaller anterior pseudocardinal teeth in the left valve; and muscle scars in the beak cavity that are entirely visible from below. It is hermaphroditic, whereas in *M. margaritifera* the sexes are separate.
Figure 2: *Margaritifera falcata*.

Line Drawings of Component Parts: A) right valve, interior aspect. B) dorsal view. C) left valve, exterior aspect. Photograph (bottom): (a-c) modern shells collected from near Halston Bridge, North Thompson River, Kamloops; (d) prehistoric shell collected from site EeRg-43, Wallachin Bridge, Thompson River. (courtesy of M. Rousseau).
**Distribution.** M. falcata is found in Pacific drainages from California and New Mexico north to the southern interior of British Columbia, and farther north to Revillagigedo Island in Alaska. In favourable locations in British Columbia, the mussels may be so abundant and closely packed that they completely obscure the stream bottom.

**Ecology.** This mollusc occurs in running streams wider than 4 meters that have sand and gravel substrates. Unlike *M. margaritifera*, it occurs in hard as well as soft water. The gravid period is mid-May to late June. Although the glochidea have not been described, known host fish are the spring salmon (*Onchorhyncus tsawytscha*), rainbow trout, (*Salmo gairdneri*), brook trout (*Salvelinus fontinalis*), speckled dace (*Rhinichthys osculus*), and lahontan redside (*Richardsonius balteatus*). The greatest longevity so far determined for *M. falcata* is about 67 years, but older specimens probably occur.

**Source.** Clarke (1981: 250).

*Anodonta kennerlyi.* Western Floater (Figure 3) figure on next page

**Description.** Shells are up to 120 mm long and 65 mm wide (but commonly smaller), and up to about 1.5 mm thick at mid-anterior and 3 mm at antero-ventral pallial line. They are elliptical, bluntly pointed posteriorly, without a dorsal wing, and are relatively thin and fragile. The surface is roughened by growth lines, but shiny in many specimens. The periostracum is yellowish, yellowish brown, or brown, and tinged with green in some specimens, with prominent dark-brown rests. The nacre is whitish or blueish white, and in some individuals centrally suffused with a salmon-pink tinge. Umbones are flattened and barely projecting above hinge line. Beak sculpture consists of about 15 irregular concentric ridges that extend up to 10 mm beyond the umbonal apex. Hinge teeth are absent.
Figure 3: Anodonta kennerlyi.

Line Drawings of Component Parts: A. Right Valve, interior aspect. B. Dorsal view. C. Left valve, exterior aspect. Photograph (bottom) (a - d) modern shells collected from near Lefarge Cement Plant, South Thompson River, Kamloops, B. C.
(courtesy of M. Rousseau).
The elliptical shape and lack of a dorsal wing separate this species from the other *Anodonta* in Canada, namely *A. Nuttalliana*. It is similar to *A. beringiana*, but smaller with lighter periostracum.

*Distribution.* In British Columbia, this species occurs abundantly on Vancouver Island and other coastal islands (including the Queen Charlotte Islands) and on the mainland from the Columbia to the Fraser and Skeena systems. It is found across the continental divide and occurs in a few mountain lakes in the uppermost North Saskatchewan and Athabasca River systems in Alberta and in the southern Pacific drainages of Oregon.

*Ecology.* Often abundant within its range, it occurs in muddy or sandy substrates in rivers and lakes. *A. kennerlyi* is probably a long-term breeder, with the breeding period beginning in August. The glochidea are triangular with a straight hinge and a spine at the ventral apex of each valve, and measure approximately 0.30 mm in length and height. The host fish is unknown.

**Gonidea angulata**, Rocky Mountain Ridged Mussel (Figure 4.) figure on next page

*Description.* Shell is up to 125 mm long, 65 mm high, and 40 mm wide, shell walls are up to about 0.5 mm thick at mid-anterior. Shells are variable in form, but typically rather thin and trapezoidal in shape with posterior margin obliquely flattened and relatively broad, and with a sharp and prominent posterior ridge running from the umbo to the regular basal posterior margin of each valve. The shell has obscure radial sculpturing on the posterior slope and readily apparent growth rests. The periostracum is yellowish brown, without rays, smooth on the disc, and roughened on the posterior slope.

The nacre is centrally white or salmon-coloured, but pale blue along the posterior and near the margin. Beak sculpture is composed of about eight rather coarse concentric ridges that are straight in the center and curved at both ends. Hinge teeth are irregular and poorly developed, pseudocardinal teeth are compressed low, laterally expanded, (one in the right valve and none or one in the left); lateral teeth are absent.

*Distribution.* *G. angulata* is found in the Columbia River system of southern British Columbia (Okanagan and Kootenay rivers) and south in the Pacific drainage to southern California.

*Ecology.* In Vaseaux Lake, near Oliver, British Columbia, large specimens of *G. angulata* were found in mud at a depth of 0.6 to 0.9 m along the southward edge of a bed of Potamongen weed. Elsewhere, the species occurs in rivers on various substrates.
Figure 4: *Gonidea angulata*.

Four specimens were collected from Vaseaux Lake, none of which were gravid. Clarke (1981: 254) notes the absence of published material for this species on reproduction, glochidea, and fish host.

Anodonta nuttalliana, Winged Floater (Figure 5) figure on next page

Description. The shell may be up to about 110 mm long and 75 mm high, 45 mm wide with a mid-anterior shell wall thickness of about 3 mm. Shells are highly variable in shape, but ordinarily trapezoid-ovate, centrally inflated, with posterior margin obliquely flattened, and with a more or less prominent dorsal wing. Some specimens are relatively compressed; in others, the dorsal wing is not well developed. The periostracum is yellowish green, yellowish brown, or brown, and has prominent dark-brown growth rests in some populations. The nacre is white or bluish. The umbones are flattened and project only very slightly, if at all, above the hinge line. Beak sculpture consists of up to 20 or more fairly strong concentric ridges, which may be irregularly single or double-looped, and that extend about 10 mm beyond the tip of the umbones. Hinge teeth are absent.

The ovate and winged shape of A. nuttalliana easily distinguishes it from the other two Pacific-drainage species in Canada, namely A. kennerlyi and A. beringiana, which are elliptical and lack a dorsal wing. The numerous umbonal ridges are characteristic of both A. kennerlyi and A. nuttalliana and differentiate them from all other Canadian species except A. cataracta fragilis from the Maritime Provinces. Anodonta nuttalliana is also known as A. wahlamatenensis and A. oregonensis (Lea 1839).

Ecology. This species occurs in rivers and lakes on muddy and sandy bottoms. The largest Canadian specimens known are from Vaseaux Lake and Osoyoos Lake, both of which are drained by the Okanagan River, a tributary of the Columbia River, in British Columbia. Little is known about its breeding season, although gravid specimens with immature larvae have been observed in October.
Figure 5: *Anodota nuttalliana.*

The glochidea and host fish are unknown.


**Environmental Conditions and Mollusc Colonization**

The archaeological sequence for the Mid-Fraser Thompson River drainage (Figure 6) extends back for approximately 11,000 years (Stryd and Rousseau 1996). In a regional synthesis, Stryd and Rousseau (1996: 179) correlate cultural historical periods with the paleoclimatic conditions that existed on the Interior Plateau from the late Pleistocene to late Holocene. I utilize this scheme throughout this study.

Paleoclimatic studies by Fulton (1971) and Hebda (1982, 1983a) indicate that the beginning of the Middle Period (7,500-3,800 BP) is associated with a climatic trend towards slightly warmer and drier conditions than at present. Sometime between 4,500 and 4,000 BP, cool moist conditions were established. Modern climatic conditions began around 3,000 BP and continue up to the present.

Research by geologists, palynologists and others describe significant environmental changes that have taken place in the region since the end of the last glaciation. These changes would have profoundly affected the availability of food and other resources important to the subsistence of prehistoric peoples. For example, meltwater from deglaciation processes formed large glacial lakes in the Deadman and Thompson valleys.
Figure 6. Archaeological Sequence for the Mid Fraser-Thompson River Valley
(Stryd and Rousseau 1996, used with permission)
Following lake drainage, the Thompson River extended across the exposed lake floor as it downcut its way to its confluence with the Fraser River near the modern town of Lytton (Stryd 1984: 10-11). The climatic conditions described by Fulton (1971), Hebda (1982, 1983b), and Stryd and Rousseau (1996: 179) would have determined the amount of water flow, water temperature, and silt particles carried in the water.

As stream conditions became favourable, migrating fish ascended the waterways carrying molluscs in their parasitic forms. Formation of these river drainages provided a variety of riverine resources essential to the subsistence of prehistoric hunter-gatherers in the region.

The life cycles of freshwater molluscs are dependent upon a variety of fish species that carry molluscs along and between drainage systems (Clarke 1981: 250). Mollusc colonization was thus only possible after the river systems developed to the point where environmental conditions were favourable for migrating fish to ascend them, transporting the molluscs in their parasitic form. The remains of *Margaritifera falcata* recovered from the Zone 3 level at the Lochnore Creek site near Lillooet demonstrate that molluscs had successfully colonized drainage systems on the Plateau by the Middle Period (7,500-3,800 BP), (Sanger: 189-200). Presence of shellfish remains at this site indicate that climatic conditions in rivers and lakes were favourable for mollusc colonization and that Aboriginal peoples at this site were harvesting them as a food resource. Salmon fossils from Kamloops Lake dated to 15,000 – 18,000 B.P. (Carlson and Klein 1996) further suggest possible earlier colonization of molluscs, although this remains to be confirmed.
Chapter Summary

This chapter has focused on the natural history, biology and ecology of the four genera of freshwater shellfish found during archaeological investigations on the Interior Plateau of British Columbia. Since local shellfish ecology and life histories can vary across space and time, familiarity with these factors is essential to determining whether the relative abundance of shellfish remains in archaeological sites represents selective exploitation of a resource, and/or ecological variability. The research has important implications for understanding and explaining Plateau subsistence-settlement systems and ecological change.

Because remains of these four genera—*M. falcata, G. angulata, A. kennerlyi,* and *A. nuttalliana*—are found in association with cultural deposits, it is assumed that they were of some dietary importance in subsistence practices of Aboriginal hunter-gatherer societies in the region. Evidence of their harvesting not only has some antiquity in this region, but indicates the presence of salmon and other fish since shellfish can only colonize drainage systems as parasites transported by migrating fish. Thus, the remains of shellfish in cultural deposits dating to the Middle Period (7,500-3,800 BP) indicate that fish were present in the river systems by this time and that freshwater molluscs had successfully populated Plateau waterways where early peoples harvested them as a food resource. The presence of fossil salmon in Kamloops Lake at 15,000-18,000 B.P suggests a possible earlier appearance of molluscs (Carlson and Klein 1996).
CHAPTER FOUR
ETHNOGRAPHIC, DIETARY AND CULTURAL ISSUES SURROUNDING FRESHWATER SHELLFISH

This chapter examines and summarizes ethnographic accounts that describe Aboriginal shellfishing activities in the Pacific Northwest, particularly those that define freshwater shellfish harvesting by peoples in the Plateau culture area. Nutritional values of shellfish are investigated and compared to recognized dietary benchmarks that contain the daily human dietary requirements for protein, carbohydrates, and fats. Finally, the research moves beyond subsistence to review some cultural aspects of shell, including its use on the Plateau as currency, trade goods and tools, and relationship to gender roles.

Ethnographic Accounts of Aboriginal Shellfish Harvesting

Ethnographic accounts that describe shellfishing activities in various societies are often the primary source of information concerning Aboriginal practices related to shellfish procurement and processing. These early accounts were often produced by navigators, explorers, missionaries, and others who may have observed the practice first-hand or obtained the information from influential Aboriginal leaders.

One example of this is the various entries in the journals of Captain George Vancouver and Archibald Menzies, the first Europeans to explore the Puget Sound area of the Northwest Coast (Belcher 1998: 137). Entries in their journals made on May 10,
1772, suggest that shellfish formed a major component in the subsistence practices of Aboriginal peoples in the Puget Sound area of Washington. They described seasonal harvesting activities in which entire camps were engaged in the process of gathering, drying, and smoking clams, which were then stored as winter provisions or used as trade items (cited in Belcher 1998: 141-143).

In 1855, George Gibbs, a geologist and ethnologist on the 1853 Pacific Railway Surveys of the Cascades and Yakima River areas in Washington described the shellfishing practices of Aboriginal peoples living along Puget Sound during the winter months (Belcher 1998: 141-143). His account implies that village sites may have been located near areas where productive shellfish beds were present. The shellfish harvesting practices of Coast Salish peoples who lived along Puget Sound are further described by Batdorf (1990: 54–55) who, in discussing the importance of shellfish as a staple in their diet identifies the various species of shellfish collected, as well as the methods for preparing, drying, smoking, and storing them for winter use. Accounts such as these emphasize the importance of marine shellfish in Aboriginal diet and economies on the Northwest Coast.

Further south, Erlandson (1988: 105, 106) cites an archaeological example from Coastal California where early Millingstone Horizon hunter-gatherers (8,000-9,000 BP), appear to have survived for thousands of years on a diet that consisted primarily of shellfish and plant foods, supplemented by marine and terrestrial animals. Evidence recovered from CA-SBA 1807 and CA-SBA 2061 suggests that shellfish provided between 70 to 90 % of the meat protein consumed by site occupants. Although remains of fish, sea mammals, land mammals, and other vertebrates are present in the midden,
Erlandson contends that they represented only a minor contribution to the diet. He attributes this intensive utilization of shellfish meat in the diet to a variety of factors that include: (1) the presence of highly productive estuarine beds; (2) the relatively low risk and technological investment for their exploitation; and (3) a low human population density that prevented overharvesting of the shellfish beds (Erlandson 1988: 105). The biological productivity of mussel beds is very high, ranking among the most prolific rates of biomass production on earth (Jones and Richman, cited in Erlandson 2001: 294). He further elaborates on the low technological investment required to collect shellfish, and describes them as a relatively predictable and readily available meat source that could be easily gathered by all members of society, including children, women, and the elderly.

**Freshwater Shellfishing Practices in The Plateau Culture Area**

Although freshwater shellfish are less abundant than their marine counterparts, there are several ethnographic accounts that describe Aboriginal procurement and processing of shellfish in the Plateau culture area. Ethnographic accounts recorded early in the 20th century describe shellfishing practices of three separate Aboriginal societies living along the Columbia River and its tributaries in Washington. Post (1938) describes subsistence practices of the Sinkaieth peoples, while Ray (1933, 1932) records those of the Sanpoil and Nespelm. The account by Spinden (1908) describes remains of shell middens found along the Clearwater and Snake Rivers, both of which are tributaries of the Columbia River system in eastern Washington and Idaho. Post’s (1938: 29) account is particularly important because it relates to a time of food scarcity:
When all the stored foods ran low in winter, or when they had neglected gathering because of preoccupation with the Dream dance, the people used other sources according to their proximity. Mussels (okokoi'na) were of first importance. Large beds of these were found in the Okanagan River every three or four miles [1.8 – 2.4 km], of which the two best known are just below the mouth of Omak Creek and a mile above Oroville. The mussel is three to four inches [15-21 cm] long, dark blue in color like the salt water varieties, and similar in shape, but with thinner shells. Starving people would camp by these beds and gather them with a forked stick through holes in the ice if wading was impossible. They were easily opened and were boiled. Some people liked them so much that they gathered them in times of plenty, though never in hot weather. Shell heaps have been reported all along the Okanagan River.

Although Post's ethnography does not identify the mussel species present in the river system, it does describe the colour, general appearance, size, and quantities of shellfish that were present at the time. The account suggests exploitation of molluscs as a "starvation food" gathered in late winter or early spring when ice covered the river. However, Post further indicates that molluscs were not always consumed as starvation food and were gathered and eaten by some people during times of plenty.

Ethnographies provided by Ray (1932: 58; 1933: 27) describe late winter/early spring subsistence practices of the Sanpoil and Neslepelm peoples of Washington:

Various kinds of shellfish were used as food to a limited extent. They were procurable at any time in the year, but were gathered chiefly during the winter and early spring months to supplement the stored foods.

Temporary camps were established for a change in surroundings and fresher air. This transfer of residence was usually made during the month called shen'umen ("time when the buttercups bloom"), which corresponds roughly to March. The new quarters were occupied for two to three weeks during which time the men gathered shellfish and hunted fowl and rabbits. At the same time the women were digging a few edible roots which had appeared on the warm sandy hillsides near the river, and were gathering prickly pears, which were eagerly eaten after the spines had been burned off and they were roasted.
These ethnographic accounts by Ray provide some descriptions of early spring subsistence activities. His 1932 ethnography appears to imply a seasonal reliance on shellfish towards the end of winter when stored foods were running low. His 1933 account describes a temporary, short term, seasonal camp occupied for the purpose of men procuring meat foods in the form of shellfish, small game and fowl, while women gathered early vegetal foods that had appeared along the river bank. In his ethnographic account, Ray (1933: 27) has recorded these subsistence activities under the general heading “the yearly cycle,” thus implying that shellfish were seasonally collected as part of the annual harvesting activities of these people.

Early accounts of subsistence practices of the Nez Perce Indians of Washington were recorded by Spinden (1907: 177; 1917: 206) and relate to his observations of shellfishing activities along the Clearwater and Snake Rivers:

No shell-heaps, except of very small size are in evidence. Occasionally heaps of a cubic foot or more in size (30 cm²) are found in the loamy banks of the rivers. A few of these were noted near the junction of the south and middle fork of the Clearwater river and also near the confluence of the north fork of the same stream. They seem to be the remains of a single meal that had been buried or cast into a hole.

The Unio also played a minor role in furnishing food. It has already been mentioned that small quantities of Unio shells have been found at the old village sites. These shellfish are rather rare on the Clearwater, but fairly common on the Snake. They were also obtained from the Coeur d’Alene region. They were steamed in a small pit and after this operation were often dried in the sun and kept for some time.

Here is evidence that shellfish were harvested across a limited section of the Southern Plateau, although sometimes in small amounts that may have been single meals. The small size of many of the shell middens led Spinden to assume that shellfish were
only of minor importance in the diet of the Nez Perce living along these two river
systems.

The accounts of Post, Ray, and Spinden summarized here provide a variety of
valuable/interesting informative descriptions relating to the early spring subsistence
activities of Aboriginal peoples living in the Plateau culture area of Washington and
Idaho. From information gleaned from these accounts it is apparent that while there is
evidence of shellfish harvesting in some areas of the Plateau, they played a fairly limited
role in the Aboriginal diet, at least during the ethnographic period and/or at least among
the groups observed by these individuals. There is considerable variability represented in
the ethnographic accounts described here. For example, within the relatively small areas
of the Plateau studied by the ethnographers, there were differences both in how shellfish
were harvested and processed, and in their relative importance in the diet. In some
localities, the shell middens are interpreted as the remains of single meals, while in other
areas they were of importance as a food resource to help stave off starvation. Although
the species of shellfish is not identified, they could have been any one, or all, of the three
species found in the region, *Margaritifera falcata*, *Gonidea angulata*, and *Anodonta
kennerlyi* (Lyman 1980: 122 [a classification supported by Clarke (1981)]).

**Ethnographic and Contemporary Mollusc Collectors of Interior British Columbia**

Despite ethnographic evidence that shellfish were usually disdained and
consumed only as famine food among the Shuswap and Thompson Indians of Interior
British Columbia (Teit (1900: 231), mussels are today occasionally consumed, although
not in large quantities. For example, Bouchard and Kennedy (1979: 137) recount a fishing story told by Ike Willard, a band member from the Niskonlith Reserve near Chase, who told ethnographers that the people gathered together in the springtime to harvest freshwater mussels, which were opened in boiling water and then fried.

In the summer of 1998, while a student at the SFU-SCES Archaeological Field School, I discussed the use of river mussels with a fellow student, Cliff Arnouse, from the Niskonlith Reserve in Chase. He recalled collecting mussels during low water in the springtime, and then went on to say that he had gathered “a feed” as recently as March of that year. I later had the opportunity to discuss the Aboriginal use of freshwater mussels with another Niskonlith band member, Les Williams, an elder from this band. He recalled his parents and grandparents collecting “clams” (river mussels) during late summer and fall when river levels were low. The mussels were prepared by placing them on top of other foods in a roasting oven for approximately 1 to 2 hours, after which time they were taken out and eaten and the oven was re-sealed to cook the remaining foods (Les Williams, pers comm. 2002).

In 2002, I visited the SFU-SCES Archaeological Field School in Kamloops, while excavations were underway at site EeRb 77, (see Chapter 5). During my visit, student Carrie Dan recalled gathering river mussels in the Thompson River as a child. Mussels were harvested along the river at the foot of Blanche Street in North Kamloops where two small streams discharged into the river. Here, mussels were picked by hand, taken home, steamed open and eaten. According to Carrie, mussel harvesting in this area ceased after the river bank was dyked in 1972, which diverted the natural discharge of the streams. Pollution of the river by the Weyerhauser Pulp Mill was cited by Carrie as a
further deterrent to mussel gathering in this area. She continues to harvest and consume mussels during the summer months by diving for them in Niskonlith Lake (Carrie Dan, pers comm. 2002).

I had an opportunity to discuss the presence of freshwater mussels in the North Thompson River with Harold Klein, a recreational hunter and fisherman who resides in Blue River. He informed me that he harvests river mussels from the Chinook Cove area north to Blue River several times each season. He described the mussels as very large, between 15 and 18 cm in length, and the water they come from as being “very clean and cold.” They are found at between 2 to 3 meters in depth and are harvested by inserting a long sapling into the open valves that immediately close. The mussels, which he notes are “fat and firm,” are prepared by breading and pan-frying, following which they are eaten with a condiment consisting of horseradish and ketchup (condiments Teit makes no mention of). He found them comparable to marine oysters when prepared in this manner.

**Dietary Issues**

While ethnographic accounts cited earlier in this chapter described various circumstances where molluscs were consumed as starvation food, and in other instances as a food of choice, it is also necessary to look at such factors as the nutritional and caloric value of freshwater shellfish. To this end, I now describe and summarize the nutritional value of shellfish relative to the daily nutritional requirements for maintaining a healthy body.
Nutritional Values of Shellfish

Canada’s Food Guide, (M.S.S: 1992), and the U.S. Senate Committee on Dietary Goals (Whitney et al. 1988: 29-45) each set out recommendations for the total number of calories that need to be consumed daily by various sex/age cohorts necessary to maintain a healthy body (Table 3). These guidelines provide recommendations as to the source of those calories: 10-15% protein, approximately 58% carbohydrates, and the remainder from fat. In addition, the recommended intakes during periods of growth are taken as appropriate for individuals representative of the midpoint in each group. The guidelines are designed to cover individual variation in essentially all of a healthy population subsisting upon a variety of common foods available in Canada and the United States.

Since the role and importance of freshwater shellfish in the Aboriginal diet is a central tenet of my research, the following section presents the nutritional values of freshwater shellfish and then compares these values with established daily recommended nutritional requirements as a means to determine whether freshwater molluscs meet these requirements. The relative importance of shellfish as a dietary resource is contingent upon their long-term sustainability in meeting these recommendations.
Table 3. Recommended Nutrient Intakes for Children and Adults
(Source: Canada Food Guide (1992))

<table>
<thead>
<tr>
<th>Age</th>
<th>Sex</th>
<th>Weight (kg)</th>
<th>Protein (g/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Months</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-2</td>
<td>Both</td>
<td>4.5</td>
<td>11</td>
</tr>
<tr>
<td>2-5</td>
<td>Both</td>
<td>7.0</td>
<td>14</td>
</tr>
<tr>
<td>6-8</td>
<td>Both</td>
<td>8.5</td>
<td>17</td>
</tr>
<tr>
<td>9-11</td>
<td>Both</td>
<td>9.5</td>
<td>18</td>
</tr>
<tr>
<td>Years</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-2</td>
<td>Both</td>
<td>11</td>
<td>19</td>
</tr>
<tr>
<td>2-3</td>
<td>Both</td>
<td>14</td>
<td>22</td>
</tr>
<tr>
<td>4-6</td>
<td>Both</td>
<td>18</td>
<td>26</td>
</tr>
<tr>
<td>7-9</td>
<td>Both</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>10-12</td>
<td>M</td>
<td>35</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>36</td>
<td>40</td>
</tr>
<tr>
<td>13-15</td>
<td>M</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>48</td>
<td>42</td>
</tr>
<tr>
<td>16-18</td>
<td>M</td>
<td>62</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>53</td>
<td>48</td>
</tr>
<tr>
<td>19-24</td>
<td>M</td>
<td>71</td>
<td>58</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>58</td>
<td>43</td>
</tr>
<tr>
<td>25-49</td>
<td>M</td>
<td>74</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>59</td>
<td>44</td>
</tr>
<tr>
<td>50-74</td>
<td>M</td>
<td>73</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>63</td>
<td>47</td>
</tr>
<tr>
<td>75+</td>
<td>M</td>
<td>69</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>74</td>
<td>47</td>
</tr>
</tbody>
</table>

Pregnancy
First Trimester 15
Second Trimester 20
Third Trimester 25
In Table 3, the recommended intakes during periods of growth are taken as appropriate for individuals representative of the midpoint in each group. All recommended intakes are designed to cover the individual variations in essentially all of a healthy population subsisting upon a variety of common foods available in Canada.

During the 1970s, several important studies were carried out on the nutritional values of shellfish. For example, both Bailey (1975, 1978) and Osborn (1977) studied marine shellfish nutritional values, while Parmalee and Klippel (1974) assessed those of freshwater shellfish. These studies concluded that, in comparison to other foods, shellfish were of marginal nutritional value, and were, at best, a borderline resource consumed only as a dietary supplement or food of last resort.

Parmalee and Klippels' (1974) study analyzed the nutritional content of freshwater molluscs found in the midwestern United States, comparing caloric values of two species of mussels, *Actinonaias carinata* and *Proptera alata*, with that of other meat sources utilized by prehistoric peoples in the study area. They concluded that: (1) in relation to the flesh of other aquatic and terrestrial animals, freshwater mussels provided a low caloric and protein yield; and (2) even when molluscs occurred in large amounts, such as at many Archaic shell mounds in the Southeast, the resource at best represented a minor supplement (Parmalee and Klippel 1974: 431).

In addition to the low caloric value of shellfish cited in their study, Parmalee and Klippel postulated on the quantities of molluscs that would be required to feed a hypothetical 25-member band for a single month. While they acknowledged that neither the archaeological evidence nor the descriptions from ethnographic accounts supported a model of prehistoric subsistence based solely on shellfish consumption, they nevertheless
based their calculations and conclusions on the hypothetical caloric sustenance of an Archaic band of this size. The study concluded that the group would require between 1,900 and 2,250 freshwater mussels per day, if they were the sole food source, or between 57,000 and 67,000 molluscs for a month. Each individual band member would thus require between 76 and 90 molluscs per day. The large amounts of shellfish required to sustain even very small bands, coupled with the low caloric content of the mussels, led the authors to conclude that shellfish were not an important resource in Archaic subsistence and economies of the region (Parmalee and Klippel 1974: 433). It should also be noted that shellfish are not a complete food and do not provide the necessary daily nutritional requirements to maintain human health (Noli and Avery 1988).

Contrary to their results, a number of more recent evaluations on the potential importance of shellfish in prehistoric diets have concluded that, under certain cultural and environmental circumstances, shellfish may represent a necessary and viable alternative to terrestrial protein resources (e.g., Claasen 1998: 184-185, 1986; Erlandson 1988; Glassow and Wilcoxon 1988; Perlman 1980; Yesner 1980). In addition, earlier studies by Jochim (1976) and Stein (1982: 1281) suggest that shellfish may have provided a dietary staple (e.g., “a basic necessary food item”) in many prehistoric economies.

Erlandson’s (1988) study reconsidered the Parmalee and Klippel data from a protein perspective, which led him to an alternative interpretation. Again using the hypothetical band size of 25 members, and assuming a minimum daily protein requirement of 40 g per person, it became apparent that only 7.5 individual freshwater mussels (in this case, of Proptera alata) could provide the daily protein needs of one individual. Erlandson extended this projection over a month for the entire band, and
concluded that a total of 5,625 mussels would supply the necessary protein requirements. He believes his data are significantly different from Parmalee and Klippels, and are consistent with long-term sustained yield for shellfish resources and with large shell middens that may reflect sedentary settlements where shellfish served as a long-term protein staple (Erlandson 1988: 105-106). This study also identifies another advantage of mussel harvesting as a protein source for prehistoric foragers. Once located, mussel beds can be harvested by all group members, including women, children, and the elderly (Erlandson 2001: 294; 1988: 108). Mussel gathering does not require a specialized technology, and this allows them to be processed in large quantities, which, in turn, reduces the time and labour involved. Participation in shellfish harvesting may confer greater social standing in a society relative to gender roles and degree of autonomy and respect associated with the roles of women in a society.

While protein requirements for various sex/age cohorts vary according to sex, age, and increased intake for pregnant and lactating females (Table 3), protein requirements were averaged by Claasen (1998: 183) and Erlandson (1988: 105) to arrive at an estimated 40 g per person. The average protein content of marine molluscs, by mass and percentage, clearly indicate that shellfish can provide a mean of 9.7 g of protein and an 8.9% average per 100 g of meat Claasen (1998: 184-186). The Classen analysis, based on a daily protein requirement of 40 g per person, appears to indicate that both marine and freshwater shellfish can provide necessary daily protein intakes. However, if ingested as the sole or primary nutrient, their protein is incompatible with human nutritional needs and can lead to death after even a few days (Claasen 1998: 182; Noli and Avery 1988). These studies clearly indicate that the human body cannot be sustained on a diet
consisting solely of protein for extended periods and suggests that protein from shellfish or any other source must be consumed in conjunction with carbohydrates and fats as recommended in Canada’s Food Guide or the U.S. Senate Committee on Dietary Goals.

**Cultural Aspects of Shellfish**

In his review article, “The Archeology of Aquatic Adaptations,” Erlandson (2001) noted the low importance attached to shellfish and other aquatic resources in the archaeological literature and cites examples from Claasen (1998: 175) and Moss (1993: 632) where shellfish gathering was done primarily by women. The authors of these studies have attributed the identification of women with shellfishing in ethnohistoric and ethnographic accounts as at least partly responsible for the designation of shellfish as a low-priority foodstuff, and of minimal importance in the diet and economies of foraging societies. There are, however, examples in the archaeological literature where shellfish had other uses in Aboriginal societies that extend beyond that of a mere food resource. I now cite examples where shellfish was used for other purposes.

The Yurok people of California used shells as a unit of currency and developed a monetary system based on the shell of dentalium (*Antalis pretiosum*), a tube or tusk-shaped mollusc found in Pacific coastal waters. The Yurok strung the shells into chains of dentalia in 80 cm lengths that formed the basic unit of currency (Kehoe 1992: 441). Dentalium shells were also used as a medium of exchange along the Columbia River in Washington State where they were strung in 40 shell-lengths. Beyond the Dalles/Celilo Falls trading center on the Columbia River in Washington, dentalia were not a medium of
exchange but were still widely traded inland where they were highly prized as items of wealth and adornment by both Plateau and Plains cultures (Stern 1998: 646).

Other shells, such as olivella (*Olivella baetica*), abalone (*Haliotis tschalkana*), and butter clam (*Saxidomus gigantean*) were highly prized as status items or for their aesthetic value (e.g., Stern 1998: 644-646). These were fashioned into necklaces and headdresses, or sewn onto clothing. Other items of adornment included necklaces of clamshell disc beads strung on fiber cords and sea scallop necklaces (Stern 1998: 644-646). The use of abalone, olivella, and dentalia appears as early as 9,000 BP at Marmes Rockshelter in Washington (Hunn and French 1998: 378). Shell remains found at this site are associated with mortuary practices (Chatters and Pokotylo 1998: 74). For the Middle Period in British Columbia, these marine shells are identified at archaeological sites EeRb 140 and 144 on the Kamloops Indian Reserve (Nicholas and Tryon 1999: 18).

In addition to its use as currency and ornamentation, and its association with human burials, shell could have more utilitarian uses. For example, Matson and Coupland (1995: 101-107, 123) have identified a number of Northwest Coast examples of adze and knife blades made from the shells of California mussel (*Mytilus californianus*), and mussel-shell celts and knives (species unidentified). The authors have noted that the presence of shell adze blades recovered from Prince Rupert Harbour which are dated to 5,000 BP, reflects a woodworking industry (Matson and Coupland 1995: 126).

Accounts such as these indicate the widespread use and/or importance of marine shell in Aboriginal cultures of the Northwest Coast and the Plateau culture area of North America. There is yet no evidence that shells of freshwater molluscs were used by Aboriginal peoples for any of the above described purposes. It is important to note,
however, that absence of ethnographic accounts of freshwater mollusc shell use does not exclude that they were used in a variety of ways, including as expedient tools. Evidence of such use in the archaeological record will likely be very difficult to ascertain due to the deterioration of shell edges over time. For example, Ames et al (1998: 119) cites Sanger (1970) for descriptions of mussel shell pendants or rattles at archaeological site EdRk 7 near Lillooet, British Columbia. The species of shellfish is not identified and may refer to either a marine or freshwater origin.

**Shellfish and Gender Issues**

Jurmain et al. (1987: 354, 355) have defined the sexual division of labour as a flexible adaptation by groups of people that allows both men and women to carry out certain activities that contribute to the overall group subsistence and economy. In general, men are in charge of hunting, fishing, trapping, tool making, weaponry, and warfare training of males, whereas women are in charge of such domestic activities as gathering, processing, food storage, the manufacture of clothing, and child care (Klein and Ackerman 1995). Shellfishing is defined as a gathering activity and, in most of the world’s societies, women gather the bulk of shellfish consumed (Claasen 1998: 175; Moss 1993: 632).

In her study of shellfishing practices of Anbarra women of Australia’s north coast, Meehan (1982) provides insights into shellfishing activities and behaviour that included women of all generations and their children. Gathering of shellfish provided an opportunity for the women to socialize as a group while collecting a food resource. Shellfishing was a social event involving a dozen or more women and sometimes as many as four generations. Collecting permitted a woman to be absolutely alone for short
periods of time, "alone" with other adult women, or "alone" with her children (cited by Classen 1998: 181).

Claasen (1998: 182) cites an example of women and children gathering shellfish on San Salvador Island, Bahamas. Their subsistence system included both agriculture and purchased foods, and shellfishing as a family group represented both recreation and family time together. Those family members present (women and children) participated in filling the container with shellfish and task specialization was carried out according to age group. The rewards from this activity provided a gathered dietary substance that was not available as a purchased food, and that temporarily thwarted the cash economy.

There are also more subtle dimensions to shellfishing. In Polynesia, for example, Kirch and Dye (cited in Claasen 1998: 176) observed a male taboo against shellfish collected by women. These were deemed unsuitable for banquets and ceremonial feasts and only a particular species collected by male divers was presented to attending guests. Although studies relating to the cultural aspects of shellfishing are not particularly common in the archaeological literature, the above examples representing very different culture areas serve to illustrate that the activity had other importance for women beyond subsistence, and that important activities included socialization, recreation, dietary preference of selected species, and taboos against shellfish collected by women.

Chapter Summary

This chapter reviewed ethnographic accounts of both marine and freshwater shellfish harvesting. These indicate that marine shellfish were sometimes harvested in large quantities and were a dietary staple for coastal peoples. However, information from
the Interior Plateau suggest that freshwater shellfish were not a significant food item on the Plateau, and were primarily consumed when other food was not available (e.g., during early spring). While the few accounts available may not be representative of shellfishing activities in the region, they do appear to support Teit’s observation that describes the use of molluscs as famine/starvation food, consumed only in the absence of other foods. However, accounts of shellfish harvesting by Post, Ray, and Spinden indicate their use as an alternative or secondary food, used casually in normal times, but in larger quantities in times of food scarcity, but some reports are ambiguous in this regard. Contemporary accounts indicate that shellfish are still collected and consumed. Dietary studies of the nutritional and caloric values of freshwater shellfish indicate that when used as a meat source ingested with carbohydrate-rich vegetal foods, shellfish could provide the necessary protein component to sustain a healthy body.
CHAPTER FIVE

ARCHAEOLOGICAL EVIDENCE FOR ABORIGINAL USE OF FRESHWATER SHELLFISH

This chapter presents the evidence available for documenting the Aboriginal use of freshwater shellfish in the Plateau culture area. It begins with an overview of the culture history of the Interior Plateau of British Columbia. This is followed by the results of my review of the archaeological literature and the data it contains on shell-bearing sites on the Plateau. The data from three selected mollusc-bearing sites are examined, and the data are used to test specific aspects of the research questions.

Cultural Overview of the Interior Plateau

The Aboriginal prehistory of the Interior Plateau of British Columbia is organized into three broad cultural historical periods by archaeologists (Figure 6)--the Early, Middle and Late Periods (Stryd and Rousseau 1996: 177-226). The Early Period covers the time span from deglaciation (12,000/11,000 BP) to the end of the Hypsithermal warm/dry climatic period (approximately 7,500 BP). The Middle Period extends from approximately 7,500 to 3,800 BP, a period that includes the beginning of the Plateau Pithouse Tradition. This is followed by the Late Period, which includes the remainder of the Plateau Pithouse Tradition that ended with European contact approximately 200 years ago.
The Early Period

On the Interior Plateau of British Columbia, the Early Period, 11,000-7,500 BP (Stryd and Rousseau 1996: 179) is the poorly known period of initial colonization. Studies of postglacial paleoenvironmental conditions indicate that vast areas of the Plateau were deglaciated, with pioneering grasslands present, by at least 11,000 BP (Table 1). These early grassland habitats may have supported a mixture of late Pleistocene and early Holocene fauna suitable for human predation (Stryd and Rousseau 1996: 180). Stryd and Rousseau posit that initial peopling of the Mid Fraser-Thompson river drainage probably began sometime between 11,000 to 10,000 BP, shortly after deglaciation and the establishment of flora and fauna.

All five of the major late Pleistocene-early Holocene cultural traditions known for British Columbia (Carlson 1996: 3-10) are found in the study area. These are: (1) the Pebble Tool; (2) Intermontane Stemmed Point; (3) Plano; (4) Fluted Point Tradition and (5) the Early Coast Microblade Complex. Information for the initial part of this period consists mostly of surface finds of cultural artifacts in museums and private collections that suggest affiliation with these early technological traditions (Stryd and Rousseau 1996: 180). Information on early technology from excavated sites is limited primarily to a sample of cultural materials recovered from the pre-Mazama component at the Landels Site (EdRi 11), located in the Oregon Jack Creek valley (Rousseau 1991: 6-9). The tool assemblage consisted of 13 microblades and microblade fragments, two utilized flakes, an unformed biface, and a core fragment. Lithic and faunal remains recovered from this site are limited to fragments of deer and rodent bones processed at the site (Stryd and Rousseau 1996: 184).
Analysis of the Gore Creek skeletal remains, near Pritchard, provides direct evidence of dietary patterns during the Early Period. Isotopic analysis of these remains, which date to 8,250 ± 115 BP, is suggestive of a terrestrial hunting subsistence pattern, likely supplemented by floral resources and to a minor degree by salmon (8-10%) of the dietary protein (Chisholm and Nelson 1983). There is no indication of Aboriginal utilization of shellfish during the Early Period. However, if the ice cover was reduced enough to allow salmon to migrate into Kamloops Lake (Carlson and Klein 1996: 274-280), then shellfish may have also colonized the waterways at that time.

The Middle Period

The Middle Period (7,500-3,800 BP) essentially spans the middle Holocene and includes two cultural periods: the Nesikep Tradition and the Lehman Phase (Stryd and Rousseau 1996: 179). Environmental conditions at the beginning of the Middle Period are characterized by a trend toward slightly warmer and drier conditions until around 5,500 BP when climatic conditions changed to slightly cooler and wetter than today. Throughout most of the Middle Period, the mid Fraser-Thompson River area was probably covered by continuous mesic grasslands at low and mid-elevations and by Douglas fir (Pseudotsuga menzieii) and Ponderosa pine (Pinus ponderosa) as major forest species (Hebda 1982). The fauna of the mesic grasslands was probably dominated by such ungulates as elk (cervus elaphus), antelope (Antilocapra americana), and bighorn sheep (Ovis canadensis). The effect of decreased water levels on local fish populations and anadromous salmon runs is unknown, although Stryd and Rousseau (1996: 186) posit that the Thompson River may have supported increased numbers of
freshwater molluscs during this period due to the slightly warmer climatic conditions present at this time. There are no reliable data to test this supposition.

The archaeological evidence indicates that people subsisted on a variety of terrestrial mammals including deer, elk, rabbits (Lepus americanus), a wide variety of rodents such as the hoary marmot (Marmota caligata), and riverine fauna that included freshwater molluscs, salmon, freshwater fish, and small birds (Stryd and Rousseau 1996: 186). There was no evidence for intensive utilization of anadromous salmon during most of the Middle Period, although this changed around 5,500 BP possibly due to slightly cooler and wetter climatic conditions (Stryd and Rousseau 1996: 179). A varied tool technology was present, including stone, bone, and antler assemblages (Carlson 1996: 3-10; Stryd and Rousseau 1996: 188-192).

A more sedentary trend is noticeable during the latter stages of the Middle Period which marks the beginning of the Plateau Pithouse Tradition. Although it is presumed that the population was relatively mobile and utilized only portable shelters, the remains of three Shuswap Horizon pithouses and associated cache pits were exposed at the Baker Site (EdQx 43), near Monte Creek in the South Thompson River valley. The food storage pits contained salmon bones and other food refuse, and have been interpreted as a case for at least seasonal sedentism in this area of the Plateau (Wilson 1991; Wilson et al. 1992).

The trend towards slightly cooler and wetter climatic conditions that occurred towards the end of the Middle Period may have increased water flow in the river systems, which in turn supported increased numbers of anadromous salmon. This may have led to more intensive utilization of salmon towards the end of the Middle Period, and to semi-
sedentism and sedentism in the form of pit-houses and pit-house villages (Richards and Rousseau: 1987; Stryd and Rousseau 1996: 197). As previously noted, salmon are identified as one of the host fishes for the freshwater mollusc *Margaritifera falcata* (Clarke 1981: 250). Freshwater mussels are obligatory parasites on fish during their young, or glochideal stages (Lyman 1980: 125), so an increase in anadramous salmon may have had a corresponding influence on mollusc colonization of Plateau waterways.

**The Late Period**

The Late Period extends from approximately the end of the Middle Period (3,800 BP) to the time of European contact and includes three cultural horizons (Richards and Rousseau 1987): the Shuswap Horizon, (3,800-2,400 BP), the Plateau Horizon, (2,400-1,200 BP), and the Kamloops Horizon, (1,200-200 BP). The Late Period is characterized as a semi-sedentary, logistically organized, seasonally regulated subsistence and settlement strategy; it includes intensive salmon utilization, a greater reliance on food storage, and use of semi-subterranean pithouses as winter dwellings in semi-permanent villages. Richards and Rousseau (1987: 50) concluded that the lifestyles of the Plateau Pithouse Tradition match the logistical or “collector” subsistence and settlement organizational strategy continuum proposed by Binford (1980).

It is apparent from the archaeological literature that deer, elk, a variety of small mammals, salmon, non-anadromous fish, freshwater shellfish, birds, and gathered roots and berries formed the basic diet (Richards and Rousseau 1987: 49-50). Freshwater mussels were extensively harvested during this period, although a marked decrease in harvesting of shellfish is evident by the Kamloops Horizon, and this trend continued throughout the Historic Period.
Investigations into Shellfish Use in the Region

The information obtained on the archaeological presence of shellfish in the project area was derived from a careful study of approximately 100 archaeological reports, as well as by conversations, phone calls, email exchanges, and written correspondence with archaeologists familiar with the region. As noted in the methodology section in Chapter 2, I have recorded such information as the location, type and number of cultural components, and (if available) mollusc species present, and radiocarbon dates.

Shellfish remains were identified at 124 sites. The distribution of those sites (figures 7-10) demonstrates that freshwater molluscs colonized all major drainage systems on the Interior Plateau. All are located along waterways. Most sites cluster along the Thompson and South Thompson rivers, with outliers in other areas (i.e., shell remains are more common along the Thompson than the Fraser river). The concentration of sites along these waterways may reflect the amount and degree of extensive archaeological investigations carried out there, but it could also be due to ideal conditions for mollusc habitat that may have existed along the waterways at the time. While shell-bearing sites are found in other areas, their concentration and numbers are less substantial. Outside of the immediate project area, shell-bearing sites are found in the Okanagan Valley from Enderby to Osoyoos (Copp 1975; Rousseau 1984), in the North Thompson River valley (Richards 1982), at Nicola Lake near Merritt (Wyatt: 1970), and in drainage systems near Lillooet (Sanger: 1970). Remains of freshwater shellfish are also present in the Slocan Valley.
Figure 7. Shell Bearing Sites: Oregon Jack Creek and Thompson River (Lytton to West End of Kamloops Lake).

(Base Map: Ministry of Environment, Lands and Parks, 1992, used with permission)
Figure 8.hell Bearing Sites: North and South Thompson River Valleys

(Base Map: B.C. Ministry of Environment, Lands and Parks 1992, used with permission)
Figure 9. Shell Bearing Sites: Nicola Valley.

(Base Map: B.C. Ministry of Environment, Lands and Parks 1992, used with permission)
Figure 10. Shell Bearing Sites: Okanagan Lake, South Okanagan Valley.

(Base Map: B.C. Ministry of Environment, Lands and Parks 1992, used with permission)
Shell-Bearing Sites by Cultural Affiliation and Age

In this section I present and discuss the results of my research. The data presented in the tables and graphs are based on my research of the 2,034 archaeological sites that I have examined records for. Shell is associated with 149 components at 124 sites. Figure 11 presents the breakdown of the components with shell cultural periods, based on association with diagnostic artifacts and/or radiocarbon dates. Shellfish remains are found at Middle Period (27 sites), indicating harvesting of shellfish by that time. Shellfishing then continued throughout the Shuswap Horizon (35 sites), peaked during the Plateau Horizon (41 sites), and declined during the subsequent Kamloops Horizon (13 sites), and Historic Period (3 sites). The Historic Period reflects the ethnographic use of shellfish described by Post (1938), Ray (1932, 1933), and Teit (1909, 1900).

Figure 12 shows the temporal distribution of the 37 radiocarbon dates associated with 21 of the sites that have shellfish remains present. Although the radiocarbon dates represent only 21 of the 149 identified site components, they match the trends evident in Figure 11 which is based on cultural affiliation based on diagnostic artifacts.

Table 4 summarizes the 2,034 sites I have investigated by location within the study area, and presents the number and relative percentages of shell-bearing sites. Freshwater mussel shell was found at 149 site components and was apparently absent at the remaining 1,885. Shellfish remains were located at only 7.3% of the total number of sites examined. There are many areas listed on Table 4 where shellfish remains are entirely absent. This is not surprising given these settings. For example, there are no shellfish remains found at sites in the Arrowstone Hills area, which is not only some distance from shell-bearing waterways but also at relatively high elevations.
Figure 11. Freshwater Shellfish Sites by Cultural Affiliation and Radiocarbon Age
Source: (Appendices A. to E.)
Figure 12. Distribution of Radiocarbon Dated Shell Sites by Cultural Period.
Source: Appendices (A – E)
Table 4. Regional Distribution of Sites with Shell Included in this Study

<table>
<thead>
<tr>
<th>Location of Sites</th>
<th>No. of Sites Investigated</th>
<th>Sites in Areas without Shell Components</th>
<th>Sites in Areas with Shell Components</th>
<th>Shell Sites Relative to Total Sites Examined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anahim Lake</td>
<td>10</td>
<td>10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Arrow Lakes</td>
<td>5</td>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Arrowstone Hills/Quarry Sites</td>
<td>60</td>
<td>60</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bonaparte Valley/Cache Creek/Clinton</td>
<td>76</td>
<td>76</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cache Creek/Thompson Plateau</td>
<td>16</td>
<td>16</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cache Creek/Boston Flats</td>
<td>91</td>
<td>91</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Highland Valley</td>
<td>54</td>
<td>54</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lillooet/Lochmore/Gibbs/Oregon Jack Creek</td>
<td>22</td>
<td>22</td>
<td>9</td>
<td>41</td>
</tr>
<tr>
<td>Lower Adams River/Adams Lake</td>
<td>66</td>
<td>-</td>
<td>66</td>
<td>-</td>
</tr>
<tr>
<td>Nicola Lake/Nicola Valley</td>
<td>19</td>
<td>-</td>
<td>19</td>
<td>3</td>
</tr>
<tr>
<td>N. Thompson River Valley</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Okanagan Valley</td>
<td>110</td>
<td>-</td>
<td>110</td>
<td>6</td>
</tr>
<tr>
<td>Thompson River Valley</td>
<td>954</td>
<td>-</td>
<td>954</td>
<td>83</td>
</tr>
<tr>
<td>(Lyttton to Kamloops Lake)</td>
<td></td>
<td></td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>S. Thompson River Valley</td>
<td>259</td>
<td>-</td>
<td>259</td>
<td>42</td>
</tr>
<tr>
<td>Shuswap River, Enderby, Part of Shuswap Lake</td>
<td>230</td>
<td>-</td>
<td>230</td>
<td>5</td>
</tr>
<tr>
<td>Similkameen River Valley</td>
<td>5</td>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sketchesm Indian Reserve (Deadman River)</td>
<td>9</td>
<td>9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Upper Hat Creek Valley</td>
<td>45</td>
<td>45</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Totals</td>
<td>2,034</td>
<td>371</td>
<td>1663</td>
<td>149</td>
</tr>
</tbody>
</table>

Notes:

(1) The 149 component sites are from areas of the plateau (1663 sites) that contain freshwater mussel shell.

Source: (Appendices D to E).
The relative percentage of shell-bearing sites increases substantially near waterways—to a value of 21%. This indicates that Aboriginal peoples harvested shellfish from the Middle Period to the present, sometimes in substantial amounts. However, it is difficult to assess the relative importance of the resource from the limited available data. By this I mean that shell sites in the region are largely identified during survey work and actual quantities at the majority of these sites are unknown (i.e., either not counted or tabulations not included in reports). The resource was obviously of some importance in the overall subsistence pattern.

The significant number of site components identified along the Thompson and South Thompson Rivers that have shell present \((n = 149)\) are attributed to the major surveys carried out in the Thompson River Valley by Arcas Associates in 1985 (site surveys on file with the Archaeology Branch, Victoria) and on the South Thompson River by Gordon Mohs in 1981.

No shell is reported for sites recorded along major bodies of water such as Anahim Lake, Arrow Lakes, the Similkameen river valley, and Deadman river. Their absence may be due to a variety of reasons such as: (1) the paucity of archaeological exploration in these areas or (2) the inability of these waterways to support shellfish colonization.

Although determining the number of components or sites for each cultural period is clearly of interest, the fact that they vary in length of time precludes using such numbers to identify trends. Cultural periods on the Plateau vary substantially—from 3,700 years in duration for the Middle Period to only 200 years for the Historic Period.
This problem can be addressed in two ways. The first is by looking at the distribution of radiocarbon-dated site components at which shell is present (Figure 12). The second is by dividing the length of each cultural period by the number of components with shell. Such a standardization is presented in Table 5, which presents the number of components per 500-year intervals. The Middle Period has 27 identified component sites, or 3.65 sites every 500 years. For the Late Period, which has 89 identified component sites, this number increases to 10 sites per 500-year interval.

If we look only at the Late Period, there is better resolution. During the Shuswap Horizon, there were 35 component sites, or 10.94 sites in each 500-year period. The number of components with shell increases slightly during the Plateau Horizon to 41, or 12.81 occurring in each 500 years. What is most interesting is that the apparent decrease in number of sites with shell remains present is evident by the Kamloops Horizon with only 13 component sites, or 5.41 sites each 500 years. Standardizing the 200-year Historic Period to a 500 year span by multiplying it by 2.5 increases the number of sites to 18.8 each 500 years--a huge increase, albeit based on a very small sample. There are an additional 30 sites at which shell is present, but the cultural affiliation is unidentified.

Figure 13 shows the distribution of identified shell sites by species present. The remains of *Margaritifera falcata* dominate the shell remains represented. A significant number of sites with shell (n = 30) did not have species listed in the reports. During the Middle Period *M. falcata* remains were present at 20 sites (13%), at 59 sites (40%) during the Late Period, and at 7 sites (4.7%) during the Historic Period. The shell species is unidentified at 14 sites (9%).
<table>
<thead>
<tr>
<th>Cultural Period</th>
<th>Duration of Cultural Period in Years</th>
<th>Number of Sites</th>
<th>Number of Shell Sites/500 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle Period</td>
<td>3,700</td>
<td>27</td>
<td>3.65</td>
</tr>
<tr>
<td>1 Nesikep/Lochore Horizons (6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lehman Horizon (3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Lehman/Lochore Horizons (15)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lochore Horizon (2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nesikep Horizon (1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late Period</td>
<td>1,600</td>
<td>35</td>
<td>10.94</td>
</tr>
<tr>
<td>Shuswap Horizon</td>
<td>1,600</td>
<td>41</td>
<td>12.81</td>
</tr>
<tr>
<td>Plateau Horizon</td>
<td>1,200</td>
<td>13</td>
<td>5.41</td>
</tr>
<tr>
<td>Kamloops Horizon</td>
<td>200</td>
<td>3</td>
<td>7.5</td>
</tr>
<tr>
<td>Historic Period</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unidentified Cultural Periods</td>
<td>-</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>149</td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1 Shell associated with either component.
Source: (Appendices A to E).
Figure 13. Freshwater Mussel Bearing Sites Identified by Species

(Source, Appendices (A – F) N = 124)
Although extensive large surveys have taken place along major rivers on the Interior Plateau of British Columbia, exploration work has largely been confined to visual exploration along areas such as railway tracks, rivers and lakeshores. The shell sites identified in my research sample are largely the result of this process. The limited archaeological work carried out in the region may thus explain the relatively small numbers of shell sites. Large shell middens along the Columbia River in Washington were found during construction of hydroelectric dams and site mitigation work in the reservoirs. This, however, has not taken place along the Fraser and Thompson river systems. It is also possible that these rivers did not support large populations of freshwater shellfish. Such factors as these may help to explain the relatively low numbers of shell sites in comparison to the identified archaeological sites examined in my research sample.

In addition to the trends noted here in shellfish harvesting during the Middle and Late Periods, some recent research carried out on the southern Plateau by James Chatters suggests that seasonality of mussel harvesting also varied through time. According to Chatters (pers. comm. 2004), collection took place throughout the seasons in the middle Holocene, but became more seasonally restricted thereafter. By late prehistoric times, most harvesting occurred in the winter/earliest spring. However, the concerns I reviewed in Chapter 2 still stand, and Chatters attributions of seasonality cited here are based on techniques that have not yet been published and thus remain unscrutinized by other archaeologists.
Shell Remains at Three Sites in the British Columbia Interior

In this section I examine three archaeological sites in the Plateau that contain substantial deposits of freshwater mussel shell. These sites are used as case studies in which details of shellfish-bearing sites can be examined and/or can be used to test specific aspects of the identified research questions.

The three selected sites each provide different types of information. The first, the Rattlesnake Hill site (EeRh 61), was selected for analysis because it represents a Middle Period site in the mid Fraser-Thompson River area that consisted of several intermittent occupations in which substantial quantities of identified shellfish remains were found. The second site, DiQv 39 on Okanagan Lake, was selected because it represents an apparently single occupation Late Period site located along a major lake in the Okanagan Valley. The third site, EeRb 77, represents a large, multiple component site (Middle through Late Period) located along the South Thompson River in Kamloops, in proximity to a late prehistoric pithouse village.

EeRh 61—The Rattlesnake Hill Site, Ashcroft

The Rattlesnake Hill site (Figure 14) is located on the east bank of the Thompson River 5.2 km northwest of the town of Ashcroft. Site mitigation excavations were undertaken by Arcas Associates in 1985 for a railway tie-processing and treatment center for Canadian Pacific Railways. Excavations indicated that the site was intermittently occupied over a 6,000-year time span and consisted of four occupation zones that contained cultural material. The occupational history was determined by studying the stratigraphic profile and the horizontal and vertical distribution of artifacts.
Figure 14. EeRh 61. The Rattlesnake Hill Site, Thompson River Valley,

(Arcas Associates 1985: 121, adapted with permission)
The oldest cultural deposits were present in Zone 4, layer 9, which produced a radiocarbon date of \(-5,870 \pm 500\) BP. This occupation zone consisted of bone artifacts distributed within a homogeneous matrix of carbonate-flecked, coarse Aeolian sand. Shell remains were present in this zone but only in trace amounts (Arcas Associates 1985: 102, 114).

Radiocarbon dates of \(4,470 \pm 120\) BP, \(5,870 \pm 120\) BP, and \(6,290 \pm 120\) BP from Zone 3, layers 7 and 8, were derived from charcoal for the earlier dates and shell for the latter. The archaeological evidence suggests that a lapse of several hundred years occurred between the occupation of Zone 4, and the first occupation of Zone 3. Layer 8 of Zone 3 was represented by small quantities of lithic and bone artifacts and by significant amounts of discarded shellfish remains (not identified to species) that occurred in a thick layer.

The Zone 2 occupation, layers 4-6 has a radiocarbon date of \(6,290 \pm BP\) based on shell. The archaeological evidence indicates that the first occupation of this zone probably occurred shortly after the end of Zone 3 occupation, and is interpreted as a continuum of site use by peoples of the same cultural affiliation. The cultural deposits consisted of large quantities of lithic artifacts, charcoal, and fire-altered rock, along with a thick layer (5 to 25 cm) of broken and whole valves of freshwater mussel shell. Over 90% of the shellfish remains recovered from this site came from Zone 2, layers 4 and 6. The shell remains consisted primarily of large valve pieces and outer rings that were not well preserved. Arcas Associates (1985: 101) posit that the molluscs may have been harvested during late winter and early spring when water levels in the river were low and mussels could be collected by wading into the river and gathering them by hand.
Zone 1 was identified as the most recent occupation, and the cultural deposits consisted of both primary and secondary refuse resulting from several undated occupations. There was evidence that a time lapse occurred between the end of Zone 2 and the occupation of Zone 1. Freshwater mussel shell remains were present only rarely during the Zone 1 occupation.

Zones 2, 3, and 4 were assigned by Arcas Associates to the Lehman Phase of the Middle Period on the basis of cultural affiliation with diagnostic artifacts. While Zone 1 contained evidence for the most recent occupation, the absence of diagnostic artifacts made it difficult to determine specific cultural affiliation. The Zone 1 occupancy has been interpreted as unrelated to the earlier occupations of Zones 2, 3, and 4 (Arcas Associates 1985: 78).

Shellfish remains from this site were identified as *Margaritifera margaritifera* (Arcas Associates 1985: 101), but this is incorrect as *M. margaritifera* is indigenous to Atlantic drainages of North America. If the remains are indeed *Margaritifera*, then they must be *M. falcata*, a species distributed in Pacific drainages from California north to the southern interior of British Columbia (Clarke 1981: 250). An estimated 150 kg of shell material was recovered during site mitigation (Arcas Associates 1985: 32), but these remains were not available to me for study.

The Rattlesnake Hill site was interpreted to be a Middle Period site that contains evidence of numerous short-term, medium to long-term occupations that extended intermittently over several thousands of years. Foraging activities were evident in the form of mammal bone, salmon vertebrae, and large quantities of freshwater mussel shell presumably (*M. falcata*). While the archaeological excavations provide an archaeological
time frame for mussel harvesting that dates from 6,290 ± 120 BP onwards, it fails to
answer the research questions crucial to my research concerning the importance of
shellfish in Aboriginal culture and the ethnographically defined use of the resource as
famine food only. The evidence for shellfish utilization at this site indicated that shellfish
were of some importance as a food resource, although the quantities consumed are known
for the excavated portion of the site only. Other recovered faunal material in the form of
mammal bones and salmon vertebrae indicate that during occupation of this site foragers
relied on a variety of meat protein that included protein derived from freshwater shellfish.

DiQv 39—Tsinstikeptum Indian Reserve, Okanagan Lake

DiQv 39 is located on the Tsinstikeptum Indian Reserve on the west side of
Okanagan Lake (Figure 15), on a small truncated lake terrace approximately 75 m south
of the old government dock. The site was investigated during the Westbank Indian
Council Heritage Project (Rousseau 1984: 108), and was interpreted as a prehistoric
campsite that contained evidence of a single intensive occupation. Although the site has a
radiocarbon date of 2370 ± 80 BP, which places it at the transition of the Shuswap and
Plateau Horizons, diagnostic artifacts recovered from the site are characteristic of the late
Shuswap Horizon (Rousseau 1987: 35). The predominant use of basalts and other locally
available raw materials is a further characteristic of the Shuswap Horizon (Rousseau
1984: 115). The site matrix was comprised of a medium brown silt and clay that changed
to a medium grey-brown silt, with large quantities of cultural materials both vertically
and horizontally dispersed throughout the site deposits.
Figure 15. DiQv 39. Tsinstikeptum Archaeological Site, Okanagan Lake

(Rousseau 1984: 1a, adapted with permission)
Excavations were carried out to a depth of 70 cm; the single occupation level occurred at between 25 and 45 cm.

Faunal remains recovered from the occupation level consisted of a small amount (144.2 g) of freshwater mollusc, and the remains of large and small mammals, birds, and several unidentified fish species. The mollusc remains ranged in size from 1.0 to 6.0 cm in length; an estimated 60% to 70% of the shells consisted of extremely small valves that measured only 1.5 cm (Mike Rousseau, pers comm. 2002). The excavated sample contained a total bone weight of 274.8 g. of which only 11.2 g were identifiable.

Identified bone fauna consisted of the femur of a diving duck (Aythyina aneriformes), an incisor belonging to the yellow-bellied marmot (Marmota flaviventris), northern pocket gopher (Thomomys talpoides), muskrat (Ondatra zibethica), elk, trout (salmo sp.), and northern squawfish (Ptychocheilus oregonensis) (Rousseau 1984: 116).

Rousseau posits that exploitation of the very small mussels is significant and may demonstrate the possibility of a food shortage during site occupation. He further submits that during periods of food abundance, the very small mussels would not have been taken, thus conserving the resource for future use. Rousseau (1984: 117) also refers to several lines of evidence that may contain hints of food scarcity during occupation of the site. These are: (1) the largest percentage of the sample assemblage consisted of the projectile point/preform tool class, which he interprets as a possible reflection of increased hunting-related activities, stimulated by the relative lack of immediately available vegetal resources; (2) the small quantity of fragmented bone remains measuring less than one cm in diameter may have been intentionally smashed to supplement the diet (its possible use as bone gruel is suggested); and (3) consumption of the very small
mussels would have been necessary during periods of famine. Resource availability in the area is low in late fall and early spring when Rousseau (1984: 116) suggests that the site was occupied.

During the Shuswap/Plateau Horizons, Aboriginal peoples spent a large portion of the year in centrally-located, semi-subterranean pithouses. The single occupation level at this site suggests short-term occupancy by an Aboriginal group who harvested and consumed freshwater shellfish, small mammals, and birds available in the area.

**EeRb 77—Kamloops Indian Reserve, Kamloops**

This site is located on the Kamloops Indian Reserve, on the north bank of the South Thompson River (Figure 16), approximately 3 km east of the confluence of the North and South Thompson rivers in the city of Kamloops. In 1986, Mike Rousseau conducted an overview of this site on behalf on the Kamloops Indian Band when plans were being prepared for construction of the Pow-Wow Arbor and other related projects in the general area (Nicholas 1999: 9). In the summer of 1991, the SCES-SFU Archaeology Field School excavated four 1-m² excavation units along the terrace edge to depths of 3.5 m (Nicholas and Lawhead 1991: 12). Shell remains were not identified in the excavations.

The 1991 Archaeological Field School also recovered significant shell remains at nearby archaeological site EeRb 75 (Figure 16), where a shell midden was exposed and a 1-m² portion excavated. The shell recovered from this site was cleaned from its matrix and analyzed in June and July of 2001. Over 21 kg of shell was recovered and identified as *Margaritifera falcata* by Nicholas and Carlson.
Figure 16. EeRb 77, Kamloops Indian Reserve

(Rousseau 1991:7, adapted with permission)
During the late winter of 1999, Nicholas conducted additional work at EeRb 77 as part of a river-bank stabilization project undertaken for the Secwepemc Cultural Education Society and Golder Associates (Nicholas 1999). Excavations in survey sector 740-750 exposed a series of thin shell lenses at a depth of 100 cm. The shell species was not identified as they were essentially represented only by “smears,” but the age of the shell remains was determined by its association with a temporally diagnostic Plateau Horizon point and radiocarbon date of 2,070 ± BP (Nicholas 1999: 38).

As part of the same project, irrigation trenching on the site exposed scattered shellfish remains in the central portion of the site. The surface of the site along the irrigation trench was described by Nicholas (1999: 44) as a light veneer of debitage and shell fragments. Two Plateau Horizon diagnostic points were recovered from a feature exposed by the excavation of an irrigation trench (Nicholas 1999: 53).

Additional excavations at EeRb 77 were conducted by Nicholas in 2002. The 2002 SFU/SCES Archaeological Field School excavated a 6 by 16 m block in the northeastern aspect of the site which exposed a large shell midden. The shell midden was encountered at a depth of 65 to 70 cm below surface, and is highly visible across the entire north wall of the excavation trench. The midden follows the contours of the river bank in a northeasterly direction. Shellfish remains were exposed in a matrix of dark-stained organic soil that was interspersed with fire-altered rock. Shell remains were found in the midden, represented by valves ranging in sizes between 2 to 9 cm in length. A 2-m² unit excavated immediately southwest of the main excavation unit contained a small assemblage of intact shells, along with fire-altered rock, mammal bone, fish bone, beaver incisors, worked bone and antler tools, and projectile points.
An AMS date of 2,970 ± 50 BP was obtained on a sample from the midden (Nicholas, pers. comm. 2003). However, Plateau Horizon diagnostic artifacts were well represented in the midden, and the shell lens varied between 2 to 14 cm in thickness. Although only partially excavated, this large shell midden indicates that shellfish at this site were extensively utilized as a food resource at that time. The large concentration of shellfish and other faunal material in proximity to a pithouse village dated to the Plateau Horizon may indicate that villagers used this location to process mussels and consume other foods. Radiocarbon dating of bone and charcoal from lower levels of the site produced dates of 6,210 ± 60 BP, and 6,560 ± 90 BP (Nicholas, pers comm. 2003). Shell remains were not identified at these depths. There is also evidence for even earlier occupations of this site based on other information recovered during site excavations (Nicholas, pers comm. 2003).

Chapter Summary

This chapter reviewed the available archaeological evidence for Aboriginal usage of freshwater shellfish on the Interior Plateau of British Columbia. The evidence indicates that by the Middle Period (7,500-3,800 BP) freshwater shellfish had colonized Plateau waterways where they were consumed as a food resource by Aboriginal peoples. The early presence of salmon in Kamloops Lake may indicate a possible earlier colonization, however, archaeological evidence does not support this supposition.

Results of the research on shellfish remains at archaeological sites in the region indicate that prehistoric usage of shellfish was widespread in all areas of the Plateau. The shell sites are identified based on their association with diagnostic artifacts and/or
radiocarbon dates. For example, there are 149 site components identified by cultural periods based on association with diagnostic artifacts and/or radiocarbon dates, and a temporal distribution of 37 radiocarbon dates associated with 21 of the site components. Regional distribution of the sample sites included 149 site components with shell and 1,885 sites which did not contain shell remains. Standardization of the site components by 500-year periods shows the numbers of sites present during each cultural period. The breakdown of shell sites by shell species shows that prehistorically *Margaritifera falcata* was present at 71% of the sites, shell remains at 30 sites (n = 30) (25%) were unidentified, and other shellfish species were present in only trace amounts.

Three shell sites were examined from widely separated areas of the Plateau. The research data from these sites show different types of site usage covering the time span from the Middle Period to the present. Site EeRh 61 located in the Thompson River valley was interpreted to be a Middle Period site that contains evidence of numerous short-term, medium to long-term occupations that extended intermittently over several thousands of years. Site DiQv 39 in the Okanagan valley was interpreted as a Late Period prehistoric campsite that showed evidence of a single intensive occupation. Site EeRb 77 located on the South Thompson River in Kamloops showed long-term occupation over the past 6,200 years with a large shell midden associated, dating to the Late Period. Although archaeological investigations at these and other sites in the study area indicate the use of shellfish as a food resource, it is not possible to define their overall importance in prehistoric diet and subsistence due to the paucity of available evidence.
CHAPTER SIX

FRESHWATER SHELLFISH IN THE MODERN RIVER SYSTEM

This chapter describes investigations along sections of the modern river system as a means to locate and identify freshwater shellfish, and if present, to determine whether these are the same species as those found archaeologically. The archaeological reports investigated during my research indicated that the South Thompson River drainage contained relatively significant numbers of sites at which remains of freshwater shellfish were found. My recent survey of the modern river system demonstrates that significant shellfish colonization is present in those areas where it is possible to access the river. By this, I mean that large sections of the river shoreline are not easily accessed because of private homes and ranches that bar access to the river. During the late summer, fall, winter, and early spring of 1999, 2000 and 2001, I investigated several locations along the shoreline of Kamloops Lake, and sections of the Thompson River, and the North and South Thompson Rivers. These investigations confirmed the presence of freshwater shellfish along these waterways.

Survey Results

Kamloops Lake Area

A section of Kamloops lake was included in my survey because it forms part of the Thompson River drainage system. The North and South Thompson Rivers meet in
Kamloops, to form the Thompson River which then flows into Kamloops Lake, flowing in a southwesterly direction, joining the Fraser River at Lytton. My investigations of the river system originated at Cooney Bay on the north end of Kamloops Lake. Although live mussel species were not found, numerous empty shell valves of *Anodonta kennerlyi* were found along the lakeshore indicating their presence nearby. The empty valves ranged in size from 3 to 7 cm. Holes in the valve near the hinge suggested predation. Several archaeological sites containing shellfish remains were identified along Kamloops Lake (Appendix B).

**Kamloops Lake to Confluence of the North and South Thompson Rivers**

Sections of the Thompson River were surveyed between Kamloops Lake and the confluence of the rivers in Kamloops. Empty valves of *M. falcata* and *A. kennerlyi* were found scattered along the shoreline and on river bars. Holes in the shells near the hinge section suggested that predators had extracted the animal from its shell.

**North Thompson River**

A section of the North Thompson River was surveyed from the confluence of the rivers in Kamloops to Rayleigh. Large empty valves of *M. falcata* were found on river bars near the Halston Street Bridge; remains of this shellfish were fairly numerous along the shoreline and on river bars as far as the CN Railyards. The empty valves were large and mature, measuring between 8 and 12 cm. Small particles of mussel flesh adhering to the empty shells indicated that they were only recently deposited on the river-bank. The valves were intact and still joined together, further suggesting that they may have washed
ashore during the recent spring freshet. No specimens of *A. kennerlyi* were found along this section of the North Thompson River.

Remains of *M. falcata* along the North Thompson River are consistent with shells identified at the CN Railyards in Kamloops (Arcas Associates 1983: 54), and at the Chinook Cove archaeological site (Appendix B), on North Thompson Reserve No 1, located 6.6 km north of the town of Barriere (Richards 1982: 18).

**South Thompson River**

Sections of the South Thompson River were surveyed from its confluence with the North Thompson River in Kamloops to an area slightly beyond Monte Creek. Large amounts of empty valves of both *M. Falcata* and *A. kennerlyi* were found along the shoreline and particularly on the extensive river bars that extend for several kilometers upstream from the Lafarge Cement Plant Bridge. Several small beds of both *M. falcata* and *A. kennerlyi* were found in separate locations along the river. Beds of *M. falcata* were found to occur on gravel or sandy substrates along sections of the river where there was a fast flowing current. The beds were approximately 1.5 to 2 m in diameter and occurred at depths ranging between 1- 2 m. In contrast, *A. kennerlyi* were found on muddy or sandy substrate, in slow flowing sections of the river. I was able to collect live specimens at depths of a meter or less. Water levels in the river were extremely low and empty shells of *A. kennerlyi* littered the small muddy-bottomed pools on the river bottom left by the receding river.

The constant sorting action of the river frequently washes live mussels to shallow waters along the river where they are preyed upon by gulls, crows, and eagles. This may explain the hundreds of empty valves along the river bars, many of which show signs of
predation in the form of holes near the hinge. Shellfish predation is evident all along the river, and gulls and crows can frequently be seen carrying live shellfish in their beaks and consuming them on the river-bank. At Monte Creek, for example, the remains of a small bed of *A. kennerlyi* showed evidence of predation in the form of broken shells, and shells with holes near the hinge. The remains of this small bed on the dry river-bank suggested that the river level had subsided leaving the mussels vulnerable to predation before they could burrow into the substrate.

**Discussion**

There are several key points relative to my observations along the modern river system. These include: (1) identifications of prehistoric shell remains and their relationship to modern species distribution and density; (2) the degree to which difference in species representation can be attributed to a natural change in species ecology, and/or shifts in subsistence preference, and (3) possible effects of historic dredging upon shellfish populations.

**Distribution and Density of Modern Species**

The presence of both *M. falcata* and *A. kennerlyi* along the South Thompson river is consistent with the remains of prehistoric specimens of these shellfish identified during archaeological excavations along this river, (e.g., Mohs (1981: 1979; Nicholas 1999; Rousseau 1986; Rousseau and Muir 1991; and Wilson 1991). Although archaeological reports consistently describe the presence of *M. falcata* in the excavations, the remains of *A. kennerlyi* were identified at only two sites. However, empty valves of *A. kennerlyi* in
the modern river system appear to dominate the shell remains by a ratio of 3 to 1. This may represent a species change, a prehistoric dietary Aboriginal preference for *Margaritifera*, or a variety of other explanations that require further investigation. The evidence concerning a possible species change from *M. falcata* to *A. kennerlyi* along the South Thompson River is not conclusive.

**Changes in Species Representation**

There is evidence that such a change (from *M. falcata* to *G. angulata*) occurred along the Columbia River in Washington State. Lyman (1980: 122) has examined a study of shellfish remains at the Vantage site carried out by Swanson in 1962 and has suggested that the preponderance of *Margaritifera* in archaeological samples may be due to human preference in mussels and habitats exploited, or that shifts in shellfish populations may be responses to changes in stream regimes and/or climatic change. Citing from ethnographic data for the region, Lyman (1984: 127) has indicated that subsistence practices as a whole were oriented towards exploiting what was available when it was available, and that people probably harvested the species of shellfish available near their habitation site.

Lyman tested this hypothesis by selecting archaeological sites adjacent to different shellfish habitats and identifying the shell species from each site. For example, shell-bearing sites located near muddy-bottomed habitats would be expected to contain a species that thrives in such an environment (e.g., *A. kennerlyi*). Assuming that no change in immediate river habitats has occurred through time, shell-bearing sites located near fast flowing currents and gravel bottoms would be expected to contain *M. falcata*. Changes in shellfish species through time would suggest local variations in shellfish habitats and perhaps different stream regimens and environments.
While Lyman’s study represents a possible methodology that may be applicable for testing whether a change in shellfish species has occurred, testing of this hypothesis may not be appropriate for shellfish remains in my study area. For example, along the South Thompson River, the remains of *M. Falcata* are found in the floors and walls of prehistoric house pits that are located near both muddy-bottomed and fast-flowing sections of the river and, in the modern river I observed small beds of both species separated by a distance of only several meters. This close proximity of the habitats of these two species would make it difficult to test Lyman’s hypothesis with any degree of accuracy, at least along the South Thompson River.

**Possible Effects of Historic Dredging Upon Shellfish Populations**

There is evidence of historic dredging along the South Thompson River for at least 10 to 12 km of shoreline. I was advised by a long-term resident (C. Long, pers. comm. 1999) that following the disastrous flooding that occurred in the spring of 1948, the South Thompson River was dredged from below Campbell Creek (where there is an old hop farm) to approximately Monte Creek. Evidence of dredging operations along this section of the river is confirmed by the presence of dredge-tailings. Dredging of the river bottom may have adversely affected shellfish beds and may offer a possible explanation for the discrepancy between the large numbers of *A. kennerlyi* visible in the modern river system in comparison to the two samples of this shellfish reported at archaeological sites EdQx 2 and EdQx 14 (Appendix B).
Chapter Summary

Investigations along sections of the Thompson, North and South Thompson rivers, and Kamloops Lake confirm the presence of *Margaritifera falcata* in the North Thompson River and both *M. falcata* and *A. kennerlyi* in the South Thompson river. The presence of these shellfish in the modern river systems is consistent with shellfish remains identified in the archaeological record.

Although live specimens and empty shells of both species are present in the South Thompson River, empty valves of *A. kennerlyi* dominate the shellfish remains by a ratio of 3 to 1. This contrasts with the archaeological literature where the remains of *A. kennerlyi* are identified at only two sites. Possible explanations for this discrepancy may be attributed to human preference in mussels and habitats exploited, climatic change, changes in the stream regime, and/or historic dredging operations along the South Thompson River.

Prehistoric shellfish populations and ratios in the river systems are unknown and may have always existed at present levels. Because the extent of prehistoric shellfish populations remain unknown, it cannot be concluded that a possible species change has occurred over time.
CHAPTER SEVEN
SUMMARY AND CONCLUSION

Over the past 100 years or so, the ethnographic and prehistoric significance of marine shellfish resources at coastal archaeological sites has been extensively researched and published. Indeed the importance of shellfish and its utilization by indigenous peoples world-wide is well known. In the southeastern United States, for example, extensive studies by archaeologists have been carried out that examine and document the use of freshwater shellfish. In comparison, research into freshwater molluscs in the Plateau culture area of North America is poorly known; for the Interior Plateau of British Columbia, the resource has not been closely studied or investigated.

My thesis provides the first systematic study into the use of freshwater molluscs by Aboriginal peoples of this region. To accomplish this goal, I have collected and researched data from over 2,000 archaeological sites, as well as numerous ethnographic accounts of explorers, missionaries, and ethnographers, to achieve what is hoped to be a representative overview of prehistoric shellfishing activities in the Interior Plateau.

What I found is that, despite some ethnographic accounts indicating that freshwater shellfish were a famine food, consumed only in the absence of other resources—a characterization that has now permeated some of the archaeological literature, the remains of shellfish clearly indicate that prehistoric utilization of the resource was a long-lived cultural trait of varying intensity carried out on the Interior
Plateau over the past 7,500 years. I believe the results of my study successfully augment the existing body of knowledge concerning freshwater shellfish in the region, and raise new questions about its potential importance in prehistoric Aboriginal cultures.

In this chapter I review the results of my research and discuss them in terms of some of the theoretical and methodological issues introduced in previous chapters. I also discuss some of the implications these research results have for developing a better understanding of pre-contact subsistence patterns.

Results of the Research

My examination of the archaeological data for the Interior Plateau indicates that by the beginning of the Lehman Phase of the Middle Period (7,500) BP, freshwater molluscs were included in the prehistoric Aboriginal diet. The data further indicate that mollusc harvesting intensified during the Shuswap and Plateau Horizons, peaking during the latter horizon. During the Kamloops Horizon and Historic Period, shell remains are less abundant in the archaeological record, although they continued to be harvested. Table 4 presents the number and percentage of shell component sites relative to the total sites examined. Table 5 shows the average number of shell component sites when these sites are standardized by 500-year time periods.

What is the possible antiquity of shellfishing in the region and how does this relate to past environmental conditions? The identification and dating of late Pleistocene fossil remains of *Oncorhyncus nerka* (sockeye salmon) in Kamloops Lake in the Thompson River watershed (Carlson and Klein 1996) suggests that the ice cover was
more limited than previously presumed. Although there are no shellfish remains known for this time, the presence of anadromous salmon in Interior waterways may have allowed freshwater shellfish in their parasitic from to colonize river systems in the region, but this remains to be shown. Climatic conditions during the late Pleistocene and Holocene periods (Figure 6) would have affected shellfish habitat. For example, cool and moist conditions prevailed until around 11,000 BP, and then gave way to a pronounced climatic episode warmer and drier than today over the next 3,500 years. Such factors would have affected water temperature and flow in the river systems, both of which are important to the various fish species that would have carried freshwater shellfish into Interior drainage systems and to shellfish habitat thereafter.

By the start of the Lehman phase of the Middle period (7,500 BP), shell remains found at archaeological sites indicate their use as an Aboriginal food resource. Climatic conditions over the next 2,000 years were slightly cooler and wetter than today and Aboriginal shellfish harvesting increased and peaked during this period. This increase in archaeological shell remains may indicate that climatic conditions favourable for mussel habitat may have persisted at this time. Shellfish utilization continued to decrease during the next 2,500 years under modern climatic conditions, although shellfish continued to be harvested during the Historic Period.

Although shellfish remains are identified at 124 sites, the extent and volume of shell at many of these sites is largely unknown, thus making it difficult, if not impossible to determine their importance in the overall subsistence and economies of the region. However, the frequency at which shell appears at sites situated in riverine settings
suggests that it was a common element of the diet, although the amount collected or season of collection cannot be determined.

The question of collection time is very important because of suggestions that shellfish were a starvation food. Ethnographic accounts from the Southern Plateau in Washington describe Aboriginal peoples harvesting shellfish during seasonal periods when other foods were scarce, while for the Interior Plateau of British Columbia, Teit (1909, 1900) has stated that among the Shuswap and Thompson Indians, shellfish were regarded as famine food, eaten only during times of starvation. However, my review of seasonality studies for shellfish indicated that current methods are not reliable, even if the condition of shell remains from the study area were in pristine condition. I have thus chosen to approach the question of the role of shellfish in the diet through other means.

My research also examined how the shellfish species found in archaeological contexts relate to those in the modern river system? Such a target question may shed some light on species preference and/or past environmental conditions. My investigation of the archaeological record shows that four species of freshwater molluscs are indigenous to the region: *Margaritifera falcata*, *Anodonta kennerlyi*, *Gonidea angulata*, and *Anodonta nuttalliana*. All continue to inhabit Plateau waterways. The remains of *M. falcata* dominate the archaeological assemblages along the South Thompson river although specimens of *A. kennerlyi* dominate modern shellfish assemblages by a ratio of 3 to 1. However, because the extent and composition of prehistoric shellfish populations in this river system is unknown, it cannot be assumed that a species change has occurred over time. The archaeological preponderance of *M. falcata* may thus only reflect an Aboriginal dietary preference.
Discussion

This section examines the various theoretical models relative to shell remains on the Interior Plateau. Both archaeological and ethnographic material will be discussed as a means to determine the applicability of certain theoretical models to this topic and to substantiate or disprove certain hypotheses relating to hunter-gatherer subsistence in the region. Further discussion will include the research goals and the extent that the research material has contributed to the stated goals. A major component of my research concerns the use of freshwater shellfish as starvation food and the extent that the archaeological and ethnographic material can help to shed some light on the importance of shellfish to Aboriginal peoples in the region. I begin with a discussion of the theoretical models.

The Theoretical Models

The various models described in Chapter 2 may have some application in respect to hunting and gathering practices in the region. My research data indicate that the highest utilization of shellfish occurred during the Shuswap and Plateau Horizons of the Late Period, however shellfish continued to be harvested during the subsequent Kamloops Horizon and Historic Period. What criteria can be employed to evaluate these data?

The Diet-Breadth Model

How might the diet-breadth model be used to explain some aspects of prehistoric foraging practices? Shellfish are not high in caloric content, but do supply protein. This might suggest that they were added to the diet at times of the year when resources containing high levels of protein and fat were in short supply. Such times may have
occurred during late winter/early spring when supplies of stored protein foods (salmon) were low and when other protein sources (deer) have very low fat levels after surviving the winter. Some of the ethnographic accounts from the southern Plateau appear to substantiate this hypothesis. For example, the ethnographies describe Aboriginal women gathering prickly pear and other roots and shoots during early spring (March) while the men hunted rabbits and gathered freshwater mussels. This combination of carbohydrate-laden vegetal foods, shellfish protein and rabbit meat (even if larger game or fish is not available) would provide a nourishing balanced diet.

Shellfish are lower in protein and fat content than foods such as salmon and deer. A further hypothesis suggests that they may have been added to the diet-breadth when deer decreased in abundance, during low cycles of anadromous salmon, or when human populations increased to the point where deer and salmon were in short supply. Does this help to explain the increase in shellfish use during the Shuswap and Plateau Horizons of the Late Period and the decrease in its use during the Kamloops Horizon and Historic Period (after Aboriginal populations crashed due to European diseases)? James Chatters (pers. comm. 2004) has indicated that the seasonality of mussel collection varies through time on the Southern Plateau. He suggests that collection was widespread in the Columbia region, across the seasons in the middle Holocene, but became more seasonally restricted thereafter, being evidenced at the most sites during winter/earliest spring. This may be a possible explanation for larger numbers of shell sites during the Middle Period, Shuswap and Plateau Horizons, and the identification of fewer shell sites in later periods.
The Patch Choice Model

Were beds (patches) of freshwater shellfish a known food resource that were relied upon and only harvested when all other foods were depleted? Shellfish are essentially immobile animals that inhabit and occupy specific beds (i.e., patches) in the waterways. The location of shellfish beds would have been well known to Aboriginal hunter-gatherers. Search and pursuit time would not have been a factor and shellfish could have been harvested and added to the diet when/and as, they were required to supplement other food resources. The annual spring freshet would have played a determining role as to when patches of shellfish could be harvested. For example, in interior rivers and streams, snow melt-water increases the stream-flow around mid-March, and stream discharge continues to rise through April to June, gradually subsiding during July and August, and returning to low water levels in September and October. Water levels are at their seasonal low during November through February. In most years at this time, shore ice covers the rivers and lakes. The annual freshet and build-up of winter shore ice restricts harvesting of mussel patches to either late summer/early fall or late winter/early spring.

Ethnographic evidence from the Southern Plateau indicates that shellfish were harvested during both of these periods. This time frame is also indicated by Les Williams from the Niskonlith band in his ethnographic description of some early shellfishing activities along the South Thompson River. There is no archaeological or ethnographic evidence that indicates the season when shellfish were collected in the region.
Central Place Foraging

How do ideas about central-place foraging relate to the semi-sedentary patterns subsistence practices carried out on the Interior Plateau during the 4,500 years prior to European contact? The remains of pithouse villages are found along streams, rivers, and lakes near important resources of water, fuel, and food. During archaeological investigations at some of these sites, (e.g., the Baker site, EdQx 43, [Appendix A]), storage pits were adjacent to, or were part of the house pits. Ethnographic accounts for the region all describe Aboriginal peoples gathering and collecting winter food supplies during an annual cycle and storing these foods in the village sites. The location of these pit-house villages with their associated storage pits indicate their use as central places from which foragers departed, and returned to, with their gathered and collected foods. These village sites appear to fit within the context of both central place foraging and the logistical collector model proposed by Binford. Shell remains found, at or near, prehistoric village sites (e.g., EeRb 77, EeQw 3, EdRa 9, [See Appendices B., C., and E.]) indicate that shellfish were gathered from patches in the waterways and removed to these central places as a food resource.

Review of the Research Goals and Research Questions

In this section I discuss the four goals that have driven my research, the research questions and the extent that the research may or may not have provided information that substantiates them.
Research Goal 1: Determining Mollusc Distribution and Usage

What is the extent of mollusc distribution and usage at archaeological sites on the Plateau? Examination of archaeological material from all areas of the Interior Plateau of British Columbia shows 124 sites that contain shell remains. Although these sites represent only 7.3% of the archaeological sites researched, they nonetheless appear representative in terms of both shell usage and the archaeological periods during which they were harvested.

In Chapter 5, several assumptions were considered to explain the relatively low percentage of shell sites relative to the total number of those investigated. These included the use of site surveys for the major percentage of investigative work described in archaeological reports for the region. Archaeological surveys cover all areas and are not restricted to river and lake shores, areas that might be expected to have shell remains. However, when only shell sites along waterways are considered relative to the total sites examined (Table 4), then the percentages increase dramatically. For example, the percentage of freshwater mussel shell in riverine associated sites produced the following values relative to the total sites examined; (1) Lillooet/Lochnore/Gibbs Creek, 9/22 shell sites (41%); (2) Nicola Lake 3/19 shell sites (16%); (3) North Thompson River valley 1/3 shell sites (33%); (4) Okanagan valley 6/110 shell sites (6%); (5) Thompson River valley 83/954 shell sites (9%) South Thompson River valley 42/259 shell sites, and (5) Shuswap River area 5/230 shell sites (2%). Although freshwater mussel shell was found at only 149 sites of the 2,034 sites examined in my sample, the above percentages from riverine environments demonstrate the relatively high values of shell present in archaeological sites located in close proximity to shellfish habitats along Plateau waterways.
Research Goal 2: The Role of Shellfish in Past Subsistence Patterns

What is the role of freshwater shellfish in the region and its potential importance in prehistoric cultures? Were molluscs only of importance as famine food, or did they play a larger or more important role in Aboriginal cultures? If so, what was this role and how is it evident in the archaeological record? What criteria can be used to evaluate its possible importance to Plateau peoples?

One approach is to examine a sample number of sites, the relative percentage of overall shell-bearing sites represented, and if reported, the volume of shell remains present. My research indicates that in many archaeological reports the amounts of shell remains at these sites are not reported for various reasons. For example, the shell remains are often surface finds, located during site surveys and road construction. These sites are not excavated and descriptions of shell remains vary from estimates of large deposits to a few scattered valves and shell flakes. I was unable to evaluate in any meaningful way the relative importance and the overall contribution of shellfish to overall Aboriginal subsistence because of the paucity of information cited in this paragraph.

A second approach is to examine the ethnographic descriptions of shellfishing in the region using dietary values to measure the food resources consumed. For example, Canada's Food Guide (1992) has published standards for protein, fats and carbohydrates that must be consumed on a daily basis in order to maintain health. Is there evidence to support the use of freshwater shellfish in the Aboriginal diet in association with other food groups cited as dietary requirements? The ethnographies of Post (1938), and Ray (1933, 1932) have illuminated some important aspects of shellfish harvesting in a small area of Washington. The ethnographies all describe Aboriginal peoples harvesting
molluscs and gathering late winter and early spring vegetal foods in conjunction with hunting of small mammals and mollusc gathering. This balance of vegetal carbohydrates and the protein derived from freshwater molluscs and other sources would have adequately provided the required amount of daily nutrients. These explanations only partially satisfy this research goal. While they provide evidence that shellfish were of some importance as a food resource, the amounts consumed, and the seasons of harvest are largely unknown.

**Research Goal 3: Comparing Prehistoric and Modern River Conditions**

Are shellfish fauna recovered from archaeological sites the same species as those present in the modern river system? The research determined that shellfish collected from modern waterways were the same species as those found archaeologically and identified in Clarke (1981) and thus meets this research goal. My investigations along the South Thompson River indicated a preponderance of *Anodonta kennerlyi* by a ratio of 3 to 1, however, shell remains of *Margaritifera falcata* dominated the archaeological defined shell sites. There is no evidence to substantiate that a species change has occurred over time and these shellfish ratios may have always existed along this river.

**Research Goal 4: Evaluating the Ethnographic Accounts**

How have the accounts of shellfishing found in the ethnographies of Post (1938), Ray (1933, 1932) and Teit (1900, 1909) influenced interpretations of the more distant past? Seasonal availability undoubtedly was an important determinant in the role that freshwater shellfish played in the annual subsistence system. The archaeological evidence from site EeRh 61 along the Thompson River near Ashcroft, and from site DiQv 39 on
Okanagan Lake near Kelowna suggests that molluscs were a seasonal resource that could be easily gathered in late winter/early spring. This suggested season for shellfish harvesting is supported by the ethnographies of Post (1938) and Ray (1933, 1932) who describe Aboriginal peoples harvesting shellfish during this season when other food resources were scarce. It also falls within the periods when the annual spring freshet and the build up of winter shore ice would allow Aboriginal peoples to harvest shellfish. One account from the southern Plateau (Post 1938: 29) describes “starving people gathering shellfish with a forked stick through holes in the ice”: In this context shellfish may have been used as famine food, consumed in the absence of all other foods.

On the Interior Plateau of British Columbia, Teit (1909, 1900) has stated that the Thompson did not eat insects and shellfish, and among the Shuswap Indians, shellfish and dogs were eaten only during times of starvation. These ethnographic accounts of late winter/early spring shellfishing activities during food shortages offers some support for the notion that shellfish were a starvation food in some areas, at least during ethnohistoric times, and may have led to Teits’ categorization of freshwater shellfish as famine food consumed only when all other food resources were unavailable.

Conclusion

While research of the available archaeological and ethnographic material has met some of the research goals, it has not provided satisfactory explanations concerning the importance of shellfish as an Aboriginal food resource, including the amounts harvested and the use of shellfish as starvation food, consumed only in the absence of other
resources. Despite such shortcomings, this thesis has made valuable contributions to the archaeology of the region in the following areas:

- This thesis is the first systematic attempt to identify, inventory and evaluate the presence of freshwater shellfish at archaeological sites in the region. For example, the research has investigated 100 archaeological reports covering the past 50 years of archaeological investigation on the Interior Plateau.

- This thesis has examined and identified the shellfish species present in modern Plateau waterways according to Clarke (1981). Comparison of modern shellfish to archaeological specimens has confirmed that a species change has not occurred over time.

- This thesis has investigated, identified and recorded ethnographic material for the region relative to the use of shellfish as an Aboriginal food resource. Some ethnohistoric accounts for a small area of the Southern Plateau have described freshwater shellfish as a starvation food, consumed when all other foods were scarce.

- This thesis has correlated the archaeological, ethnographic and research data into a comprehensive document that can be used as the basis for further investigations into shellfish research in the region.

The topic of shellfish in past subsistence practices in the Interior Plateau is one that can be pursued much farther in several areas. Recommendations for future research topics include:
• That a sample of shell remains recovered from all archaeological sites on
the Interior Plateau be identified, curated, and made available for future
study. During my research of shell fauna in the region only shell remains
from the Kamloops Indian reserve on the South Thompson river were
available for study

• When a reliable procedure becomes available to determine seasonality
from shellfish remains, that shellfish remains recovered from
archaeological sites in the region be examined to determine season of
harvest. The primary reason for this recommendation is that the single,
most desired information--season of shellfish harvest--cannot be reliably
ascertained. There are reports of new methods that may overcome present
problems associated with determining the season when shellfish were
harvested.

• That future shellfish studies be expanded beyond the South Thompson
river valley to include the entire Interior Plateau of the province.

Recommendations two and three will only be possible if samples of shell remains
from all archaeological sites in the region are preserved for future study.

This thesis is the first systematic study of archaeological and ethnographic data to
identify and evaluate the prehistoric and ethnographic use of freshwater shellfish in the
region. Although volumes of shell remains identified in archaeological reports were only
recorded and tabulated in a few instances, nonetheless the research has made significant
contributions to understanding the role and importance of freshwater shellfish in
Aboriginal diet and subsistence. It is my hope that the research and writing of this thesis
has shed some light on this relatively unknown aspect of prehistoric Aboriginal subsistence and by so doing has provided a strong foundation for future shellfish research in the region.
### Appendix A: Middle Period Sites with Freshwater Mussel Shell

<table>
<thead>
<tr>
<th>Site</th>
<th>Shellfish Species</th>
<th>Years BP</th>
<th>Radiocarbon Years</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Nicola Valley</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EbRd 3</td>
<td>Unidentified</td>
<td>7,500-4,000</td>
<td></td>
</tr>
<tr>
<td>EeRc 6</td>
<td>Unidentified</td>
<td>7,500-4,000</td>
<td></td>
</tr>
<tr>
<td><strong>Thompson River Valley</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EeRh 3</td>
<td><em>Margaritifera falcata</em></td>
<td>7,500-4,000</td>
<td>4,448 ± 144 BP</td>
</tr>
<tr>
<td>DiRa 9</td>
<td><em>Margaritifera falcata</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Anodonta nuttalliana</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Gonidea Angulata</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EeRh 61</td>
<td><em>Margaritifera falcata</em></td>
<td></td>
<td>4,470 ± 400 BP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5,870 ± 120 BP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6,290 ± 120 BP</td>
</tr>
<tr>
<td>EdRi 6</td>
<td>Unidentified</td>
<td>7,500-4,000</td>
<td></td>
</tr>
<tr>
<td><strong>South Thompson River Valley</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EdQx 14</td>
<td><em>Margaritifera falcata</em></td>
<td>7,500-4,000</td>
<td></td>
</tr>
<tr>
<td>EeQx 5</td>
<td><em>Margaritifera falcata</em></td>
<td>7,500-4,000</td>
<td></td>
</tr>
<tr>
<td>EdRa 14</td>
<td>Unidentified</td>
<td></td>
<td>5,750 ± 60 BP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4,940 ± 50 BP</td>
</tr>
<tr>
<td>EdQx 41</td>
<td><em>Margaritifera falcata</em></td>
<td></td>
<td>5,840 ± 100 BP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5,100 ± 110 BP</td>
</tr>
<tr>
<td>EdQx 42</td>
<td><em>Margaritifera falcata</em></td>
<td></td>
<td>5,920 ± 130 BP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6,290 ± 100 BP</td>
</tr>
<tr>
<td>EdQx 43</td>
<td><em>Margaritifera falcata</em></td>
<td></td>
<td>5,100 ± 100 BP</td>
</tr>
<tr>
<td>EeRb 144</td>
<td><em>Margaritifera falcata</em></td>
<td></td>
<td>6,140 ± 50 BP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5,170 ± 60 BP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5,250 ± 50 BP</td>
</tr>
<tr>
<td><strong>CNN Double Tracking Survey</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EdRh 17</td>
<td><em>Margaritifera falcata</em></td>
<td>7,500-4,000</td>
<td></td>
</tr>
<tr>
<td>EdRh 19</td>
<td><em>Margaritifera falcata</em></td>
<td>7,500-4,000</td>
<td></td>
</tr>
<tr>
<td>EdRh 22</td>
<td><em>Margaritifera falcata</em></td>
<td>7,500-4,000</td>
<td></td>
</tr>
<tr>
<td>EdRh 27</td>
<td><em>Margaritifera falcata</em></td>
<td>7,500-4,000</td>
<td></td>
</tr>
<tr>
<td>EdRa 40</td>
<td><em>Margaritifera falcata</em></td>
<td>7,500-4,000</td>
<td></td>
</tr>
<tr>
<td>EdRh 45</td>
<td><em>Margaritifera falcata</em></td>
<td>7,500-4,000</td>
<td></td>
</tr>
<tr>
<td>EdRh 49</td>
<td><em>Margaritifera falcata</em></td>
<td>7,500-4,000</td>
<td></td>
</tr>
<tr>
<td>EdRh 67</td>
<td><em>Margaritifera falcata</em></td>
<td>7,500-4,000</td>
<td></td>
</tr>
<tr>
<td>EdRh 79</td>
<td><em>Margaritifera falcata</em></td>
<td>7,500-4,000</td>
<td></td>
</tr>
</tbody>
</table>
Appendix A (continued)

EdRh 211  Unidentified  7,500-4,000
EdRf 38  Margaritifera falcata  7,500-4,000
EeRg 42  Margaritifera falcata  7,500-4,000
Edri 1  Margaritifera falcata  7,500-4,000
EdRh 11  Margaritifera falcata  7,500-4,000

Summary Data

Shell Species Present
Margaritifera falcata  Anodonta nuttalliana  Gonidea angulata  Unidentified  Total

<table>
<thead>
<tr>
<th></th>
<th>20</th>
<th>1</th>
<th>1</th>
<th>5</th>
</tr>
</thead>
</table>

Types of Site Represented
Multi-Component Sites  Single Component Sites

<table>
<thead>
<tr>
<th></th>
<th>12</th>
<th>15</th>
</tr>
</thead>
</table>

Number of Radiocarbon Dates = 14

1 Based on association with diagnostic artifacts
### Appendix B: Shuswap Horizon Sites with Freshwater Mussel Shell

<table>
<thead>
<tr>
<th>Site</th>
<th>Shellfish Species Years BP</th>
<th>Radiocarbon Years</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Thompson River Valley</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EdRk 7</td>
<td><em>Margaritifera falcata</em></td>
<td>3,280 ± 135 BP</td>
</tr>
<tr>
<td><strong>Slocan Valley</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vallican Site</td>
<td><em>Margaritifera falcata</em></td>
<td>3,800-2,400</td>
</tr>
<tr>
<td><strong>Kamloops Lake</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EeRf 1</td>
<td><em>Margaritifera falcata</em></td>
<td>3,800-2,400</td>
</tr>
<tr>
<td>EeRf 16</td>
<td><em>Margaritifera falcata</em></td>
<td>3,800-2,400</td>
</tr>
<tr>
<td><strong>North Thompson River Valley</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EeRc 44</td>
<td><em>Margaritifera falcata</em></td>
<td>3,800-2,400</td>
</tr>
<tr>
<td><strong>Lillooet Area</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EeRk 4:1</td>
<td>Unidentified</td>
<td>2,945 ± 95 BP</td>
</tr>
<tr>
<td><strong>Okanagan Valley</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DiQv 39</td>
<td><em>Margaritifera falcata</em></td>
<td>3,800-2,400</td>
</tr>
<tr>
<td>DiQv 17</td>
<td><em>Gonidea angulata</em></td>
<td>2,540 ± 60 BP</td>
</tr>
<tr>
<td><strong>South Thompson River Valley</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EdRb 14</td>
<td>Unidentified</td>
<td>3,800-2,400</td>
</tr>
<tr>
<td>EeQw 3</td>
<td><em>Margaritifera falcata</em></td>
<td>3,800-2,400</td>
</tr>
<tr>
<td>EeQw 4</td>
<td><em>Margaritifera falcata</em></td>
<td>3,800-2,400</td>
</tr>
<tr>
<td>EeQw 5</td>
<td><em>Margaritifera falcata</em></td>
<td>3,800-2,400</td>
</tr>
<tr>
<td>EeQw 7</td>
<td><em>Margaritifera falcata</em></td>
<td>3,800-2,400</td>
</tr>
<tr>
<td>EeQw 45</td>
<td><em>Margaritifera falcata</em></td>
<td>3,800-2,400</td>
</tr>
<tr>
<td>EeQw 51</td>
<td><em>Margaritifera falcata</em></td>
<td>3,800-2,400</td>
</tr>
<tr>
<td>EeQw 53</td>
<td><em>Margaritifera falcata</em></td>
<td>3,800-2,400</td>
</tr>
<tr>
<td>EeQw 79</td>
<td><em>Margaritifera falcata</em></td>
<td>3,800-2,400</td>
</tr>
<tr>
<td>EdRa 1</td>
<td><em>Margaritifera falcata</em></td>
<td>3,800-2,400</td>
</tr>
<tr>
<td>EdRa 35</td>
<td><em>Margaritifera falcata</em></td>
<td>3,800-2,400</td>
</tr>
<tr>
<td>EdRa 5</td>
<td><em>Margaritifera falcata</em></td>
<td>3,800-2,400</td>
</tr>
<tr>
<td>EdQx 6</td>
<td><em>Margaritifera falcata</em></td>
<td>3,800-2,400</td>
</tr>
</tbody>
</table>
Appendix B (continued)

| EdQx 10 | Margaritifera falcata | 3,800-2,400 |
| EdQx 32 | Margaritifera falcata | 3,800-2,400 |
| EdQx 37 | Margaritifera falcata | 3,800-2,400 |
| EdQx 2 | Anodonta kennerlyi | 3,800-2,400 |
| EdQx 14 | Margaritifera falcata | 3,800-2,400 |
| EeRb 75 | Margaritifera falcata | 3,360 ± 70 BP |
| EdRh 19 | Margaritifera falcata | 3,800-2,400 |
| EdRh 22 | Margaritifera falcata | 3,800-2,400 |
| EdRh 25 | Margaritifera falcata | 3,800-2,400 |
| EeRh 211 | Unidentified | 3,800-2,400 |
| EdRI 72 | Unidentified | 3,800-2,400 |
| EeRf 38 | Margaritifera falcata | 3,800-2,400 |
| EeRg 34 | Unidentified | 3,800-2,400 |
| EdRh 1 | Margaritifera falcata | 3,800-2,400 |

Summary Data

Shell Species Present
Margaritifera falcata  Anodonta kennerlyi  Gonidea Angulata  Unidentified

27  2  1  5  (35)

Types of Site Represented
Multicomponent Sites  Single Component Sites

9  26  (35)

Number of Radiocarbon Dates = 5

1 Based on association with diagnostic artifacts
### Appendix C: Plateau Horizon Sites with Freshwater Mussel Shell

<table>
<thead>
<tr>
<th>Site</th>
<th>Shellfish Species Years BP</th>
<th>Radiocarbon Years</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Thompson River Valley</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EdRk 7</td>
<td>Margaritifera falcata</td>
<td>1,610 ±140 BP</td>
</tr>
<tr>
<td>EeTh 10</td>
<td>Margaritifera falcata</td>
<td>1,200-1,200</td>
</tr>
<tr>
<td><strong>Lillooet Area</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EeRk:1</td>
<td>Unidentified</td>
<td>1,525 ± 80 BP</td>
</tr>
<tr>
<td>EeRk:6</td>
<td>Margaritifera falcata</td>
<td>1,495 ± 80 BP</td>
</tr>
<tr>
<td>Unidentified</td>
<td></td>
<td>1,590 ± 90 BP</td>
</tr>
<tr>
<td>Unidentified</td>
<td></td>
<td>1,420 ± BP</td>
</tr>
<tr>
<td>Unidentified</td>
<td></td>
<td>1,680 ± 85 BP</td>
</tr>
<tr>
<td><strong>Okanagan Valley</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DiQv 48</td>
<td>Margaritifera falcata</td>
<td>2,050 ± 80 BP</td>
</tr>
<tr>
<td>Gonidea angulata</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Western Shuswap Basin</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EfQv 2</td>
<td>Unidentified</td>
<td>1,360 ± 90 BP</td>
</tr>
<tr>
<td><strong>South Thompson River Valley</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EdRa 9</td>
<td>Margaritifera falcata</td>
<td>2,400-1,200</td>
</tr>
<tr>
<td>EeRb 10</td>
<td>Unidentified</td>
<td>2,400-1,200</td>
</tr>
<tr>
<td>EdQx 41</td>
<td>Margaritifera falcata</td>
<td>2,400-1,200</td>
</tr>
<tr>
<td>EeRb 64</td>
<td>Unidentified</td>
<td>2,400-1,200</td>
</tr>
<tr>
<td>EeRb 67</td>
<td>Unidentified</td>
<td>2,400-1,200</td>
</tr>
<tr>
<td>EdRb 68</td>
<td>Unidentified</td>
<td>2,400-1,200</td>
</tr>
<tr>
<td>EeRe 20</td>
<td>Unidentified</td>
<td>2,400-1,200</td>
</tr>
<tr>
<td>EeRe 21</td>
<td>Unidentified</td>
<td>2,400-1,200</td>
</tr>
<tr>
<td>EeRb 77</td>
<td>Margaritifera falcata</td>
<td>2,400-1,200</td>
</tr>
<tr>
<td>EeRb 130</td>
<td>Margaritifera falcata</td>
<td>2,400-1,200</td>
</tr>
<tr>
<td>EeRb 140</td>
<td>Margaritifera falcata</td>
<td>1,490 ± 80 BP</td>
</tr>
<tr>
<td>EeRb 144</td>
<td>Margaritifera falcata</td>
<td>2,310 ± 60 BP</td>
</tr>
<tr>
<td>EeRb 149</td>
<td>Margaritifera falcata</td>
<td>2,140 ± 60 BP</td>
</tr>
</tbody>
</table>
Appendix C (continued)

EeRb 159  Margaritifera falcata  2,400-1,200
EeRb 173  Margaritifera falcata  2,400-1,200
EeRb 177  Margaritifera falcata  2,400-1,200
EeRb 178  Margaritifera falcata  2,400-1,200
EeRb 179  Margaritifera falcata  2,400-1,200
EeRb 184  Margaritifera falcata  2,400-1,200
EeRb 190  Margaritifera falcata  2,400-1,200
EdRh 17   Margaritifera falcata  2,400-1,200
EdRh 19   Margaritifera falcata  2,400-1,200
EdRh 22   Margaritifera falcata  2,400-1,200
EdRh 25   Margaritifera falcata  2,400-1,200
EdRh 27   Margaritifera falcata  2,400-1,200
EdRh 31   Margaritifera falcata  2,400-1,200
EdRh 40   Margaritifera falcata  2,400-1,200
EdRh 49   Margaritifera falcata  2,400-1,200
EeRh 211  Unidentified         2,400-1,200
EeRh 98   Unidentified         2,400-1,200
EeRg 26   Unidentified         2,400-1,200
EdRh 2    Margaritifera falcata 2,400-1,200

Summary Data

<table>
<thead>
<tr>
<th>Shell Species Present</th>
<th>Gonidea Angulata</th>
<th>Unidentified</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Margaritifera falcata</td>
<td>25</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>Unidentified</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Types of Site Represented

<table>
<thead>
<tr>
<th>Multi-component Sites</th>
<th>Single Component Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>26</td>
</tr>
</tbody>
</table>

Number of Radiocarbon Dates = 11

*Based on association with diagnostic artifacts*
Appendix D: Kamloops Horizon Sites with Freshwater Mussel Shell

<table>
<thead>
<tr>
<th>Site</th>
<th>Shellfish Species</th>
<th>Years BP</th>
<th>Radiocarbon Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nicola Valley</td>
<td>EbRd 3</td>
<td>Unidentified</td>
<td>1,200-200</td>
</tr>
<tr>
<td>Lillooet Area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EeRk 7:1</td>
<td>Unidentified</td>
<td></td>
<td>920 ± 90 BP</td>
</tr>
<tr>
<td>EeRk 4:1</td>
<td>Unidentified</td>
<td></td>
<td>1,080 ± 80 BP</td>
</tr>
<tr>
<td>EeRk 40:1</td>
<td>Unidentified</td>
<td></td>
<td>395 ± 80 BP</td>
</tr>
<tr>
<td>South Thompson River Valley</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EdRa 9</td>
<td>Margaritifera falcata</td>
<td>1,200-200</td>
<td></td>
</tr>
<tr>
<td>EeQw 6</td>
<td>Margaritifera falcata</td>
<td>1,200-200</td>
<td></td>
</tr>
<tr>
<td>EdQx 20</td>
<td>Margaritifera falcata</td>
<td>1,200-200</td>
<td></td>
</tr>
<tr>
<td>EdRa 11</td>
<td>Margaritifera falcata</td>
<td>1,200-200</td>
<td></td>
</tr>
<tr>
<td>EeRb 140</td>
<td>Margaritifera falcata</td>
<td>860 ± 60 BP</td>
<td>210 ± 50 BP</td>
</tr>
<tr>
<td>EdRh 70</td>
<td>Margaritifera falcata</td>
<td>1,200-200</td>
<td></td>
</tr>
<tr>
<td>EeRh 119</td>
<td>Unidentified</td>
<td></td>
<td>1,200-200</td>
</tr>
<tr>
<td>EeRb 101</td>
<td>Unidentified</td>
<td></td>
<td>1,200-200</td>
</tr>
<tr>
<td>EeRf 38</td>
<td>Margaritifera falcata</td>
<td>1,200-200</td>
<td></td>
</tr>
</tbody>
</table>

Summary Data

<table>
<thead>
<tr>
<th>Shell Species Present</th>
<th>Unidentified</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Margaritifera falcata</td>
<td>Unidentified</td>
<td>(13)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Types of Site Represented</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multi-component Sites</td>
</tr>
<tr>
<td>6</td>
</tr>
</tbody>
</table>

Number of Radiocarbon Dates = 5

1 Based on association with diagnostic artifacts
Appendix E: Historic Period Sites with Freshwater Mussel Shell

<table>
<thead>
<tr>
<th>Site</th>
<th>Shellfish Species</th>
<th>Years BP</th>
<th>Radiocarbon Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Thompson River</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EeRb 3</td>
<td>Unidentified</td>
<td>200 BP</td>
<td>- Present</td>
</tr>
<tr>
<td>EdRa 9</td>
<td>Margaritifera falcata</td>
<td>200 BP</td>
<td>- Present</td>
</tr>
<tr>
<td>EeRb 140</td>
<td>Margaritifera falcata</td>
<td></td>
<td>160 ± 50 BP</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>140 ± 50 BP</td>
</tr>
</tbody>
</table>

Summary Data

<table>
<thead>
<tr>
<th>Shell Species Present</th>
<th>Unidentified</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Margaritifera falcata</td>
<td>2</td>
<td>(3)</td>
</tr>
<tr>
<td>Unidentified</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Types of Site Represented

| Multicomponent Sites | 3 |

Radiocarbon Dates = 2

\(^1\text{Based on association with diagnostic artifacts}\)
Appendix F: Archaeological Sites with Unidentified Freshwater Mussel Shell Species and/or Association with Diagnostic Artifacts

<table>
<thead>
<tr>
<th>Site</th>
<th>Shellfish Species</th>
<th>Years BP</th>
<th>Radiocarbon Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>EdRa 3</td>
<td>Margaritifera falcata</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Lillooet Area</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EeRk 9:3</td>
<td>Margaritifera falcata</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Okanagan Valley</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EcQi 3</td>
<td>Unidentified</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper End Okanagan Lake</td>
<td>Unidentified</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EdQr 4</td>
<td>Unidentified</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Western Shuswap Basin</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EfQx 92</td>
<td>Margaritifera falcata</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EfQx 95</td>
<td>Margaritifera falcata</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EfQv 12</td>
<td>Margaritifera falcata</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EeQv 12</td>
<td>Margaritifera falcata</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>South Thompson River Valley</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EdRa 22</td>
<td>Unidentified</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EeQw 30</td>
<td>Margaritifera falcata</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CNN Double Tracking Survey</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EeRh 14</td>
<td>Margaritifera falcata</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EeRh 15</td>
<td>Unidentified</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EdRh 35</td>
<td>Margaritifera falcata</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EdRh 39</td>
<td>Margaritifera falcata</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EdRh 61</td>
<td>Unidentified</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EeRh 120</td>
<td>Unidentified</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EeRh 121</td>
<td>Unidentified</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EeRh 206</td>
<td>Unidentified</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EbRI T21</td>
<td>Margaritifera falcata</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EeRb 16</td>
<td>Margaritifera falcata</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EeRf 31</td>
<td>Margaritifera falcata</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EeRf 35</td>
<td>Margaritifera falcata</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EeRf 42</td>
<td>Unidentified</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(Appendix F (continued))

<table>
<thead>
<tr>
<th></th>
<th>Unidentified</th>
</tr>
</thead>
<tbody>
<tr>
<td>EbRg 6</td>
<td></td>
</tr>
<tr>
<td>EeRg 9</td>
<td></td>
</tr>
<tr>
<td>EeRh 27</td>
<td></td>
</tr>
<tr>
<td>EeRg 28</td>
<td></td>
</tr>
<tr>
<td>EeRg 37</td>
<td></td>
</tr>
<tr>
<td>EeRg 38</td>
<td></td>
</tr>
</tbody>
</table>

Summary Data

<table>
<thead>
<tr>
<th>Shell Species Present</th>
<th>Unidentified</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Margaritifera falcata</em></td>
<td>14</td>
<td>16</td>
</tr>
</tbody>
</table>

1 Based on association with diagnostic artifacts
**Summary of Sites with Freshwater Mussel Shell**

**Cultural Period Represented**

<table>
<thead>
<tr>
<th>Cultural Horizon</th>
<th>Middle Period</th>
<th>Shuswap Horizon</th>
<th>Plateau Horizon</th>
<th>Kamloops Horizon</th>
<th>Cultural Historic</th>
<th>Unid.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>27</td>
<td>35</td>
<td>41</td>
<td>13</td>
<td>3</td>
<td>30</td>
<td>(149)</td>
</tr>
</tbody>
</table>

Total Sites Represented: 149

**Shell Species Present**

<table>
<thead>
<tr>
<th>Shell Species</th>
<th>Margaritifera falcata</th>
<th>anodonta kennerlyi</th>
<th>Gonidea angulata</th>
<th>Anodonta nuttalliana</th>
<th>Unidentified</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td></td>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td></td>
<td>1</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td></td>
<td>1</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td></td>
<td>1</td>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>95</td>
<td></td>
<td>3</td>
<td>3</td>
<td>48</td>
</tr>
</tbody>
</table>

Total: 149

**Types of Sites Represented**

<table>
<thead>
<tr>
<th>Types of Sites</th>
<th>Multi Component Sites</th>
<th>Single Component Sites</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12</td>
<td>15</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>26</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>26</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>7</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>7</td>
<td>37</td>
</tr>
</tbody>
</table>

Total: 149

**Number of Radiocarbon Dates**

<table>
<thead>
<tr>
<th>Cultural Horizon</th>
<th>Middle Period</th>
<th>Shuswap Horizon</th>
<th>Plateau Horizon</th>
<th>Kamloops Horizon</th>
<th>Cultural Historic</th>
<th>Unid.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>14</td>
<td>5</td>
<td>11</td>
<td>5</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Total Freshwater Mussel Shell Sites Recorded: 124

Total Freshwater Mussel Shell Component Sites Recorded: 149
REFERENCES CITED


Anderson, A. J.

Arcas Associates

1985 Excavations at the Rattlesnake Hill Site (EeRh 61) Ashcroft, B.C. Report prepared for the Heritage Conservation Branch, Ministry of Provincial Secretary and Government Services, Victoria, B.C. and Pinette and Therrien Mines Ltd., Williams Lake, B.C.

Armstrong, M.

Baerreis, D.

Bailey, G. N.


Baker, F. C.
Batdorf, C.

Belcher, W. R.

Bettinger, R. L.

Binford, L. R.


Blake, T. M.

Bouchard, R., and D. I. D. Kennedy
1979 *Shuswap Stories*. Concept Publishing Ltd., Vancouver, B.C.

Bowdler, S.

Braun, D. P.

Brose, D. S.

Carlson, C. C., and K. Klein
Carlson, R. L.  

Chatters, J. C.  


Chatters, J. C., and Pokotylo, D. L.  

Chisholm, B. S. and D. E. Nelson  

Claasen, C.  


Clark, G.  

Clarke, A. H.


Copp, S.
1975  *Men, Mussels, and Malnutrition*. Paper Presented at the Archaeology of Western Canada Conference, Calgary

Davis, G. N., and S. L. H. Fuller

Deith, M. R.


Duran, R., J. Castilla, and D. Oliva

Erlandson, J.


Eldredge, P., A. Eversale, and J. Whetstone

Fulton, R. J.

Fitzhugh, B., and J. Habu

French, D. H., and K. S. French,

Gifford, E. W.

Glassow, M. A., and L. R. Wilcoxon

Gould, S.
Harbo, R. M.
1986 *Shells and Shellfish of the Pacific Northwest.* Harbour Publishing
Madeira Park, B. C.

Hebda, R. J.
1995 British Columbia Vegetation and Climate History with Focus on 6 ka BP. *Geographie Physique et Quaternaire* 49(1): 55-79.


Hunn, E. S., and French, D. H.

Jochim, M.

Jurmain, R., H. Nelson and W. Turnbaugh,

Kehoe, A. B.

Kelly, R. L.

Killingley, J. S.

Klein, L. F., and L. E. Ackerman,
Koike, H.


Kobayashi, I.


Koloseike, A.


Kuijt, I.


Lee, R. B.


Lippincott, K.


Lohse, E. S., and D. Lohse

Lyman, R. L.


McManamon, F.

Matteson, M. R.


Marquardt, W. H., and P. J. Watson

Matson, R. G., and G. Coupland

Maxwell, D.

Meehan, B.


1982 *Shell Bed to Shell Midden*, Australian National University, Canberra.
Meighan, C. W., D. M. Pendergast, B. K. Schwartz Jr., and M. D. Walker


Ministry of Supply and Services

Mohs, G.
1979 The Heritage Resources of the Western Shuswap Basin. Heritage Conservation Branch, Province of British Columbia, Victoria, B.C.


Moss, M.

Mulvaney, J., and J. Kamminga
1999 Prehistory of Australia. Smithsonian Institution Press, Washington, DC.

Nelson, N. C.

Nicholas, G. P.
1999 Archaeological Investigations at EeRb 77: A Deep Floodplain Site on the South Thompson River, Kamloops, British Columbia. Archaeological Research Reports 3, Secwepemc Cultural Education Society-Simon Fraser University program, Kamloops, B.C.

Nicholas, G. P. and S. Lawhead
1991 Archaeological Investigations at EeRb 77: A Deep Floodplain Site on the South Thompson River, Kamloops, B.C. Archaeological Research Reports 1, Secwepemc Cultural Education Society-Simon Fraser University program, Kamloops, B.C.
Nicholas, G. P., and A. Tryon
1999 Investigations at EeRb 140 and 144: Evidence from Two Long-Term Holocene Sites, Kamloops, B.C. *Archaeological Research Reports* - 4, Secwepemc Cultural Education Society-Simon Fraser University Program, Kamloops, B. C.

Noli, D. and G. Avery

Osborn, A. J.

Panter-Brick, C., R. H Layton and P. Rowley-Conwy.

Parmalee, P. W.


Parmalee, P. W., and W. E. Klippel

Perlman, S. M.
Post, R. H.

Ray, F. V.


Richards, T. H.

Richards, T. H., and M. K. Rousseau
1987 Late Prehistoric Cultural Horizons on the Canadian Plateau. Publication 16, Archaeology Press, Simon Fraser University, Burnaby, B.C.

Rousseau, M. K.


Rousseau, M. K., and R. J. Muir
1991 The 1991 Archaeological Shovel Testing Program Conducted Within and Near Prehistoric Site EeRb 77, Kamloops Indian Reserve No 1, Kamloops, B.C. Report Prepared for the Kamloops Indian Band, Kamloops, B.C.

Sandweiss, D.
Sanger, D.


Shawcross, W.

Solem, A.

Spinden, H. J.

Stein, J.

Stern, T.

Steward, J. H.


Stryd, A. H., and M. K. Rousseau

Tartaglia, L. J.
Teit, J.


Tevesz, M., and J. Carter


Thomas, K.


Turner, N. J., and A. Davis


Van der Schalie, H.


Walker, D. E., Jr.


Walsekov, G.


Warren, C. N.


Warren, R. E.


Watters, G. T.

Wessen, G. C.


Wilbur, K.


Wilson, I. R.
1991 Excavations at EdQx 41 and 42 and Site Evaluation at EdQx 43, Monte Creek. Report prepared for B.C. Ministry of Transportation and Highways, Kamloops, B.C.
Wilson, I. R., B. Smart, N. Heap, J. Warner, T. Ryder, S. Woods, and S. McNab
1992 Excavations at the Baker Site, EdQx 43, Monte Creek. Report on file, Ministry of Tourism and the Minister Responsible for Culture, Victoria, B.C.

Winterhalder, B.

Winterhalder, B., and E. A. Smith

Wyatt, D.

Yesner, D. R.