The Role of Salmon in Middle Snake River Human Economy: The Hetrick Site in Regional Contexts

Cassandra R. Manning
Portland State University

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The Role of Salmon in Middle Snake River Human Economy: The Hetrick Site in Regional Contexts

by

Cassandra R. Manning

A thesis submitted in partial fulfillment of the requirements for the degree of

Master of Arts
in
Anthropology

Thesis Committee:
Virginia L. Butler, Chair
Kenneth M. Ames
Douglas Wilson

Portland State University
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Abstract

On the Columbia Plateau, the origin of the Winter Village Pattern has long been a focus of research. Intensification of resources such as salmon, roots, and local aquatic resources is often cited as the cause of declining mobility. To address this question in the middle Snake River region, I have re-analyzed fish remains from the Hetrick site (10WN469; Weiser, ID), with occupations spanning the Holocene. Expectations from foraging theory and paleoclimate data are used to address whether salmon and other fish use changed over time and if such changes are correlated with the development of the Winter Village Pattern. The results of my research indicate that there is no correlation between the timing of increased salmonid use at the Hetrick site and paleoclimatic change or the earliest evidence for the Winter Village Pattern. Further, these results are very similar to patterns of fish use seen at other sites on the Snake River, particularly those from the Early and Middle Holocene.
Acknowledgements

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Chapter 1: Introduction

My research examines the role of salmon in pre-contact diets on the Snake River over the past 11,000 years through an analysis of the fish remains from the Hetrick site (10WN469) (Rudolph 1995). I use background knowledge of paleoclimate reconstructions and optimal foraging theory to develop expectations about changing abundance of salmon and other fish use during the occupational history of the site.

At European contact, groups on the Columbia Plateau used a subsistence strategy involving a seasonal round and storage of resources for winter use, often called the Winter Village Pattern (WVP). Ethnographic groups living on the Snake River in western Idaho had similar practices, conforming to larger regional subsistence patterns seen across the Columbia Plateau, namely the use of salmon as a principle resource (Chatters and Pokotylo 1998; Kroeber 1939; Ray 1939; Steward 1938). The origin of this pattern has long been a focus of research questions. Some researchers have hypothesized that salmon intensification and storage were the primary cause for the shift from a mobile forager strategy to a semi-sedentary collector one (Nelson 1973; Schalk 1977; Schalk and Cleveland 1983), however other factors have been offered. Ames and Marshall (1980) suggest that the use of other resources led to increased sedentism, such as the intensification of root resources, or, as others argue, the year-round exploitation of local aquatic resources (eg. suckers [Catostomidae], minnows [Cyprinidae], freshwater mussels) (Gould and Plew 1996; Plew 2000; Plew and Plager 1999).
However, these hypotheses have not yet been systematically tested using the archaeological fish record.

To assess the role of salmon in regional human economies, I use archaeological fish remains from the Hetrick site, located in the southeast Columbia Plateau, which has occupations dating back c. 11,000 years. I compare fish taxa and their frequency through time to assess temporal trends in procurement. [All dates used will be uncalibrated radiocarbon years for ease of comparison with other sites from the region, unless otherwise stated.] Optimal foraging theory is then used to predict which resources should have been used in the area and these expectations are then compared with the results of my analysis. Further, I ascertain whether changes in fish use are coincident with climate change or other factors, such as regional settlement pattern fluctuation or demographic changes. This assemblage is then compared to other Early Holocene sites in the region to see if there are similarities in patterns of fish use over time. This examination clarifies the role of salmonid intensification in the development of the Winter Village Pattern on the Middle Snake River.

This thesis is organized into six chapters. Chapter 2 is a review of previous research into the WVP and provides background information on the theoretical framework I will use. Chapter 3 gives background on the Hetrick site materials and outlines my expectations and methods. I conclude this chapter with hypotheses about the proportion of species, body part representation, and body size as derived from optimal foraging theory predictions. Chapter 4 presents the results of this study. Here, I present data from my morphological analysis, which documents all
observed fish taxa and as well as skeletal body part representation and body size estimates. Chapter 5 discusses my observations and how they relate to the WVP, as well as expectations from foraging theory and the paleoclimatic models set forth in Chapter 2. Possible explanations for when and why certain resources were used or not are set forth, and the Hetrick site is put into a regional perspective by comparing the results of this analysis with those from other Early and Middle Holocene sites in the region. Chapter 6 provides my conclusions, and gives examples of further work that can contribute to the topics discussed here.
Chapter 2. Background

The earliest human populations on the Columbia Plateau were highly mobile, broad scale foragers with a wide subsistence base using locally abundant resources (Ames and Marshall 1980; Ames 2000; Butler and Campbell 2004, 2006; Chatters and Pokotylo 1998). In contrast, at contact, many groups on the Plateau were semi-sedentary collectors (*sensu* Binford 1980) (Ames and Marshall 1980; Ames 2000; Butler and Campbell 2004; Chatters and Pokotylo 1998). These groups used logistical strategies during the warm months, spreading across the landscape to procure surplus resources to store for use in sedentary winter residential camps (Binford 1980; Murphy and Murphy 1960; Nelson 1973). While there is evidence for the storage and use of various flora and fauna, salmon and camas are typically cited as critical resources for this strategy as these resources could easily be taken, processed, and stored *en masse.*

Mobility and land use patterns such as these are consistent with the ethnographic Winter Village Pattern (WVP) as it has been seen on the Columbia Plateau. The process of changing from one strategy to another can be risky, and researchers in the Pacific Northwest have long been intrigued by what inspired such a shift. Thus, the timing and cause for the change from earlier mobility patterns and subsistence strategies to the development of the WVP has long been a focus of research questions and debate. Most of these debates revolve around whether increased sedentism stemmed from the intensification of particular resources, such as salmon (eg. Nelson 1973; Fladmark 1975; Plew and Plager 1999). Past hypotheses use demographic change, technological changes, and environmental
pressures to explain why groups risked the shift from a foraging strategy to a collector one.

I begin this chapter with a review of foraging strategy models commonly employed when discussing mobility and subsistence change. I then review the different hypotheses proposed to explain the development of the WVP, including arguments against the use of salmon as a critical resource for developing sedentism. This is followed by a discussion of foraging theory, laying the foundation for the theoretical framework I will be using for most of this study.

**Foraging Strategies**

Most studies that seek to document and explain changes in mobility patterns and subsistence use Binford’s (1980) forager-collector continuum. At one end of the spectrum, foragers have high residential mobility, practicing an immediate return strategy by mapping-on to resources on the landscape for daily foraging needs (Binford 1980; Woodburn 1982). Immediate return can often involve an encounter-based procurement strategy, with foragers exploiting a wide resource base over time. Theoretically, this strategy does not invest energy into permanent housing or long-term storage because these groups move throughout the year as new resource patches become available (Binford 1990; Smith 2003; though see Chatters 1995).

Conversely, collectors position their residential camp within range of a number of different patches that are exploited at the same time by specially organized task groups. Collectors follow Woodburn’s (1982) concept of delayed-return by processing resources for storage. Storage allows these groups to remain in
a location longer than a forager by extending the period of resource availability in a
given area (Bettinger 1987; Binford 1980; Smith 2003). As such, this strategy often
involves a much narrower resource base, with a specific focus on those resources
that are optimal for storage against seasonal shortages (Chatters 1995).

Archaeologically, foragers and collectors can be identified by assemblage
diversity and site type. Site types differ based on the types of activities that occurred
there, and include residential base camps, field camps, locations, stations, and
caches. Because they are mobile, Binford (1980) predicts that foragers will only
have two types of ephemeral sites, residential camps and locations. Residential
camps are the base of operations of foraging groups and are more likely to have a
wide range of activities associated with them, which results in larger and more
diverse assemblages (Binford 1980; Thomas 1989). Locations are sites of resource
procurement and field processing with a narrow range of activities, resulting in
smaller, less diverse assemblages. These sites can be difficult to see archaeologically
since their short-term use does not allow archaeological material to accumulate.

In contrast, collectors make fewer residential moves and, because they can
stay in one place for a longer period, have greater visibility (Binford 1980).
Collectors are also more likely to invest energy into permanent structures (Binford
1990; Smith 2003), and are predicted to create a larger number of site types than
foragers. Besides residential camps and locations, collectors also utilize field camps,
stations, and caches. Stations (information gathering sites with low assemblage
diversity) and caches (temporary storage sites) are rather ephemeral; of these three
additional site types, field camps are the most visible. Field camps are temporary
base camps for logistical groups while they are away from the residential site, as well as places where bulk resources are processed before being brought back to the residential camp. As such, they have a task-specific assemblage focused on acquiring and processing specific resources.

While Binford’s (1980) model is useful for discussing archaeological expectations and mobility strategies relating to resource distribution, Bettinger and Baumhoff (1982) have a similar model that uses optimal foraging theory (discussed in depth below) to explain mobility, with travelers more mobile than processors. Travelers focus on maximizing time spent foraging, pursuing high-ranked resources, while processors use time to maximize the yields of lower ranked resources that may be more abundant in cases of resource depression, competition, or population growth (also discussed further below) (Bettinger 1987, 1999; Bettinger and Baumhoff 1982). Groups are more likely to be travelers if it takes less energy to move than it does to use lower ranked resources, a trait common to Binford’s foragers. However, if travel costs increase, it may be more cost effective to shift to a processor strategy, remaining in the same patch and processing resources more intensively in order to get higher returns. Processing can lead to storing resources, which can tether groups to a particular area, thus decreasing residential mobility. This is similar to Binford’s collector pattern, where there is less residential mobility and caches are an expected site type.

Both of these models provide valuable reference points for discussing mobility and subsistence strategies. It is important to emphasize that these models are not dichotomies; they are spectra with highly mobile groups on one end and
increasingly sedentary groups on the other. Together, these models can provide a basis for explaining why groups would be likely to shift from one end to the other.

**Winter Village Pattern Background**

Many hypotheses have been developed for when and why groups on the Columbia Plateau switched from a mobile foraging strategy to the semi-sedentary collector strategy of the WVP. Many of these theories evoke salmon intensification (Fladmark 1975; Nelson 1973; Schalk 1977), storage (Schalk and Cleveland 1983), and year-round use of other resources (Ames and Marshall 1980; Gould and Plew 1996; Plew 2000; Plew and Plager 1999).

Early research into the development of the WVP on the Plateau focused on demographic change and invoked salmon as the proximate cause of the forager/collector shift. One of the earliest studies by Nelson (1973) used culture history to explain the appearance of pithouses and increased salmon exploitation through the migration of Salishan groups from the Pacific coast. He argued that the Salish moved into the area and were able to outcompete their neighbors because of the technology they brought with them, such as weirs, which allowed them to specialize in the mass harvest of anadromous resources. This technology then spread as a result of immigration and diffusion. Archaeologically, this would be seen as the sudden appearance of pithouses and increased use of salmon once Salish groups appeared, around 3,000 BP. This position has since been refuted, based on the discovery of evidence for older pithouses in the region (Ames and Marshall 1980; Ames 1991, 2000; Chatters 1995).
Fladmark (1975) suggests that once anadromous fish resources reach climax productivity, populations will change their subsistence practices and their mobility patterns to exploit the abundant resource. He states that the energy surpluses necessary for dense, seasonally sedentary populations occurred after sea levels stabilized around 5,000 BP. Until stabilization occurred, conditions for the development of salmon spawning habitat were unfavorable and an abundant resource is unlikely, which can also affect inland runs. Fladmark bases his argument on the appearance of what were then the oldest shell middens on the Northwest coast. In recent years, older shell middens have been found, and critiques of Fladmark’s arguments note that the effects of sea level stabilization must be constructed at local scales (Moss et al. 2007). Sea level stabilization is now also thought to have less of an impact on salmonid abundance at inland sites along major rivers. Further, the archaeological record for at least some areas of the Plateau does not show that there was increasing use of salmon over time (Butler and Campbell 2004), suggesting that other factors may have influenced the development of the WVP.

Many researchers argue against the focus on salmon when studying the development of increased sedentism, suggesting that other resources and/or changes in technology were far more important. Ames and Marshall (1980) note a weaker correlation between location near salmon streams and the size and density of Lower Snake River winter villages than that which is seen on the Plateau. They suggest that root resources, such as camas (Camassia quamash), were critical for village locations and that increasing evidence of plant processing tools, such as
groundstone, over time may indicate increased plant use. Ames and Marshall base their claims on proxy data for plant processing (e.g., groundstone tools) because botanical information is difficult to quantify and is often not preserved.

Others suggest that increased sedentism can result from year-round exploitation of resources, as well as changes in technology, such as the increasing use of storage (Gould and Plew 1996; Lohse and Sammons Lohse 1986; Plew 1990; Plew and Plager 1999; Schalk 1977; Schalk and Cleveland 1983). In favorable environments, small populations could be supported year-round without having to move a residential base camp (Chatters 1995). This is only possible if sufficient resources are available year-round, such as in a less-seasonal environment, and if the population is small enough to use those resources sustainably. If the population grows beyond this level, storage is necessary to adapt to seasonal shortages if the population is to survive. For these hypotheses, storage is considered for all resources, not just for salmon. Archaeologically, storage can be seen as storage structures, such as pits, or the geographic or temporal displacement of seasonally available resources (Chatters 1995). These hypotheses seem plausible, but they have not been systematically tested using the archaeofaunal record to ascertain if there was any intensification of resources.

In his 1995 study, Chatters analyzed assemblage structure and archaeofaunal material to determine the earliest evidence for the development of the WVP. After developing a chronology that includes the Late Cascade (6800-4400 BP), Pithouse I (4400-3900 BP), and Pithouse II (3500-2200 BP), he suggests that the shift to a collector strategy at 3,500 BP can be observed in the archaeological record through
faunal assemblages with limited diversity. While there is evidence of semi-permanent pithouse dwellings in both Pithouse I and Pithouse II, there is no evidence suggesting storage facilities or reliance upon salmon until Pithouse II. Groups from his Pithouse I phase may have had year-round occupation of permanent dwellings, however rich and even faunal assemblages from this time period show a diverse resource base, indicative of a foraging strategy. He further argues against hypotheses attributing the shift to population density or environmental factors alone, stating that population size was limited by the lack of storage technology in a period of increasingly seasonal resources. Once this technology was employed, however, Chatters notes an abrupt change to a collector strategy focusing on salmon exploitation. Thus, he suggests that sedentism was possible before the population began to employ all of the strategies typically associated with the ethnographic pattern.

Similarly, other scholars note the presence of sites linked with semi-sedentary occupation, but that lack evidence of storage. Lohse and Sammons-Lohse (1986) note the absence of storage associated with pithouses from 5200 BP which, coupled with a broad resource base, led them to conclude inhabitants were semi-sedentary foragers. Prentiss and Chatters (2003) also argue for a stage of semi-sedentary foragers prior to the development of a collector strategy that developed in response to the onset of neoglacial climatic conditions. As such, these studies argue against the need for storage of any resources in order to develop semi-sedentary settlement patterns.
Archaeological work on the upper Snake River also challenges the view that increased use and storage of salmon was the proximate cause for the development of the Winter Village Pattern (Gould and Plew 1996; Plew and Plager 1999). Ethnographic sources describe the WVP among native groups along the Snake River, including following a seasonal round and storage of salmon and root crops for winter consumption (Chatters and Pokotylo 1998; Kroeber 1939; Murphy and Murphy 1960; Ray 1939; Steward 1938). Plew and Plager (1999) state that many sites have not produced abundant evidence of fishing. These sites often lack fish remains and fishing gear, and those with fish remains are dominated by local, non-anadromous species (see Appendix). Similar to Chatters (1995), they suggest that year-round use of a variety of local species allowed for the development of increasingly sedentary populations. Further, those sites with evidence of fish use are primarily from the Late Archaic (ca. 2000 BP), suggesting that ethnographic patterns of fish use do not have great time depth (Plew 2009).

The addition of further Snake River assemblages, such as Hetrick, to this discussion can be beneficial, as there is regional variability in resource availability on the Plateau (Chatters 1995; Chatters and Pokotylo 1998; Kimball 2005). Archaeofaunal data could be used to examine the possibility of resource intensification along the Snake River (e.g., Butler and Campbell 2004). If intensification is observed, then the timing of such a pattern can be compared with established timelines for the WVP to see if intensification is a possible cause or result of increased sedentism.
Foraging Theory

Predictions regarding resource use, developed through Human Behavioral Ecology and optimal foraging theory, can explain aspects of the archaeological record by providing a basis for expectations. These predictions allow examination and evaluation of past human activity and address how inferred behavior diverges from theoretical predictions.

Foraging theory models assume that predators will act rationally, will optimize their energetic returns, and that natural selection will favor those who pursue this strategy. These models rank resources according to their energetic returns after subtracting costs for capture and pursuit, using time as a proxy for energy expended (Stephens and Krebs 1986). The prey choice model uses body size as a proxy for rank, assuming that large body size results in high energetic returns, and predicts when different resources will be added to the diet, often referred to as diet breadth (Broughton 1994; Stephens and Krebs 1986; Ugan and Bright 2001). However, smaller prey taken in aggregate through the use of mass capture technology (eg, nets) can lower the energetic costs of acquisition and, if other costs remain low, may be ranked higher than larger-bodied prey (Madsen and Schmidt 1998).

The patch choice model predicts how long a forager should stay in a particular area while searching for and acquiring resources (Stephens and Krebs 1986). This model assumes that the number of resources in a location, or patch, is fixed and is depleted through use. Under this assumption, the longer a forager stays in a single location, the more likely it is that encounters with higher-ranked prey
will decrease. As resources in a patch are depleted, more time and energy will be spent looking for new resources and return rates will decrease. The model predicts that if return rates drop below those of another patch, the forager will either move or will increase diet breadth. When considered using the mobility strategies previously discussed, the decision to move or use lower-ranked resources differentiates travelers from processors (Bettinger and Baumhoff 1982; Bettinger 1999).

These models can also be applied to central place foraging, where a forager with a home base may choose to travel farther to procure high-ranked resources rather than expanding diet breadth (Cannon 2003; Stephens and Krebs 1986). If this strategy is used, travel costs must also be taken into account when calculating energetic returns and rank. Central place foraging can often be seen in body part representation in a site: if a forager must include travel costs, they are more likely to bring back only the choicest parts rather than the whole animal, as they might do if it is procured locally (Cannon 2003).

Changes in abundances of specific taxa within archaeological assemblages have been explained using the basic diet breadth model. Declines in the abundance of high value resources, also known as resource depression, can be caused by human over-exploitation (e.g. Broughton 1994, 1997; Nagaoka 2002) as well as climate (e.g. Byers and Broughton 2004; Grayson 2001). Nagaoka (2002) argues for human over-exploitation of large, highly ranked flightless birds in New Zealand. Archaeological abundance of these large birds slowly decreases over time, and smaller, lower-ranked resources replace them. Archaeologically, resource
depression is seen as a decrease in the number of high-ranked, large-bodied prey and an increase in lower-ranked small-bodied prey. While Nagaoka’s study attributes the changes in abundance to human predation pressures, environmental change can cause similar patterns.

Byers and Broughton (2004) note that resource depression in some species can result from unfavorable habitat due to climate change. In their northern Great Basin study, they note that artiodactyl abundance decreases during periods of increased aridity and rebounds with increased moisture. As such, one must rule out the effects of environmental pressures on an archaeofaunal assemblage before one can attribute resource depression to human activity alone.

**Paleoclimate and Salmon Life History**

As Byers and Broughton (2004) demonstrated, climate change can have an effect on prey abundance. While their study focused on large mammals, other species can be affected as well. For the purpose of this study, it is particularly important to note that climatic fluctuations have been shown to greatly affect salmonid populations on the Columbia Plateau (Chatters et al. 1991, 1995; Neitzel et al. 1991; Schalk 1977).

The family Salmonidae includes both anadromous and freshwater species. While freshwater salmonids spend their entire lives in inland habitat, anadromous species spend most of their lives in the ocean, returning to their natal stream to spawn (Groot and Margolis 1991). Once hatched, young salmon, known as fry, live in freshwater before becoming smolts and migrating downstream to the ocean. The
timing of this process is genetically determined, and varies between (and within) species. After a few years in the ocean, adult salmon then migrate upstream, returning to their natal stream to spawn and then die. While various aspects of life history differ between species (eg., timing for each phase of the life cycle, periods of freshwater residence, etc.), most salmonid species have general environmental tolerances, such as water temperature and sediment load.

In general, salmonid species favor habitat with cool water and little sediment. Climatic conditions that result in warm water temperatures, low water flows, early freshets, and increased sedimentation have been shown to be detrimental to salmon survival, thus reducing abundance (Chatters et al. 1991, 1995; Neitzel et al. 1991). Increased sediment can smother eggs and displace fry, and warmer water temperatures increase the incidence and severity of disease in pre-spawning adults. The timing of freshets and the level of water flows can greatly affect anadromous salmonid migration patterns, both as smolts migrating to the ocean and as adults during spawning. Freshet timing is critical, as smolts have only a few weeks to reach the ocean once genetics determine that they must migrate. Chatters et al. note that “early or abbreviated freshet reduces the proportion of fish that are ready for out-migration, reducing the speed of downstream migration and increasing the effects of predation on out-migrating smolts” (1991, p. 83). Similarly, adults depend upon water flow levels in order to migrate upstream; insufficient flow can result in the failure of adults to reach their natal streams. Given that salmonid abundance is highly correlated with survival in early life stages, these factors can all result in smaller populations during periods of unfavorable climate, a pattern that seems to
be even more severe for smaller anadromous runs (Petersen and Kitchell 2001).

Table 2.1 outlines different paleoclimatic conditions over the past 10,000 years on the Columbia Plateau- including the Snake River. By combining general climatic information such as temperature, vegetative communities, and habitat requirements, this information provides a general picture of the effect such conditions would have had on salmonid and terrestrial species. While these descriptions vary on the specific timing of each climatic shift, together they suggest that climatic conditions prior to \(\sim 5,000\) BP were not favorable for abundant salmon populations. After 4,000 BP, conditions would be optimal for salmon habitat, with cold-water temperatures, late freshets, and little sediment. As such, it is likely that salmon populations would be larger after 4,000 BP than they would have been previously. The effects on ungulates, often the highest ranked terrestrial mammals, are also included, and will be discussed further in Chapter 5.
Table 2.1. Holocene Paleoclimate Record and Effects on Animal Resources

<table>
<thead>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Source of Data</strong></td>
<td>Pollen</td>
<td>Pollen, vertebrate fauna, geomorphology</td>
<td>Paleohydrology, geomorphology</td>
<td>Isotopes, Geo-morphology</td>
<td>Pollen, geomorphology, paleohydrology, bivalves</td>
<td>Paleobotany, geomorphology</td>
<td></td>
</tr>
<tr>
<td><strong>C14 Years BP</strong></td>
<td>Grasslands, generally warm and dry.</td>
<td>Cold, dry winter, hot, dry summer</td>
<td>Low discharge, warm waters, early freshets</td>
<td>Warm, arid climate.</td>
<td>Warm water temperature, low water flows, early freshets, silt.</td>
<td>Good for ungulates, poor for salmonids</td>
<td></td>
</tr>
<tr>
<td>10,000</td>
<td>Spring rain, seasonal temperature.</td>
<td>Mild, dry winter, hot, dry summer</td>
<td></td>
<td></td>
<td></td>
<td>Poor conditions for salmonids and ungulates</td>
<td></td>
</tr>
<tr>
<td>9,000</td>
<td>Sagebrush starts</td>
<td>Warm and dry, low water flow, silt</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8,000</td>
<td>Cooling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7,000</td>
<td>Drought</td>
<td>Increasingly warm and dry</td>
<td>Cool, moist, delayed and prolonged freshets</td>
<td></td>
<td>Bad for both salmonids and ungulates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6,000</td>
<td>Warm, arid. End of sagebrush</td>
<td>Cool, wet winter, warm, moist summer</td>
<td>Winter aridity, overall increased moisture, delayed and prolonged freshet.</td>
<td>Salmon may be increasing, but sources are not unanimous. Conditions are better for ungulates.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5,000</td>
<td></td>
<td>Cool, moist.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4,000</td>
<td>Increased moisture</td>
<td>Cold water temperatures, low riverine productivity</td>
<td>Cool water, late freshet, little sediment</td>
<td>Good for both salmon and ungulates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3,000</td>
<td>Dry, warm winters, increased grasslands</td>
<td>Winter aridity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,000</td>
<td>More moisture</td>
<td>Warm and dry</td>
<td>Cool, moist winter, warm, moist summer</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,000</td>
<td>Drought</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Summary

Archaeofaunal remains can address questions regarding increased sedentism and the development of the Winter Village Pattern. Given that many of the hypotheses regarding the development of this pattern involve changing subsistence, often involving salmon, an examination of changing fish use over time is needed. This can be done using foraging theory models, which create predictions that can then be used to test archaeofaunal data. Paleoclimatic data should also be considered for its role in affecting the abundance of past resources that would have been used by prehistoric hunter-gatherers.
Chapter 3. Methods and Materials

The Hetrick Site

The Hetrick site (10WN469) provides a unique opportunity to address hypotheses regarding fish use on the Snake River throughout the Holocene. The site is located in southwest Idaho on the western border of the Lower Snake River Plain. This area is along the Middle Snake River, a section of the Snake River from Shoshone Falls through Hells Canyon, where the Snake River flows north toward its confluence with the Columbia River and then out to the Pacific Ocean. This region is underlain by Miocene deposits of basalt bedrock from the Columbia Plateau (Rudolph 1995). The site is located in Weiser, Idaho, and lies in alluvial deposits in both the Weiser River and Monroe Creek floodplains, approximately one mile from the confluence of the Weiser and Snake Rivers (Figure 3.1).

Given its location relative to several riparian habitats, the Hetrick site has access to many terrestrial and aquatic faunal resources. Larger terrestrial fauna include cervids such as Rocky Mountain elk (*Cervus elephas*), Rocky Mountain mule deer (*Odocoileus hemionus*), and white-tailed deer (*Odocoileus virginianus*), as well as carnivores such as the mountain lion (*Felis concolor*), black bear (*Ursus americanus*), and grizzly bear (*Ursus horribilis*) (Rudolph 1995). Several species of smaller carnivorous fauna were also available for use as food, however Rudolph (1995) states that most were primarily valuable for their fur. Of greater economic importance were small mammals native to the area, including beaver (*Castor canadensis*), porcupine (*Erethizon dorsatum*), the yellow-bellied marmot
(Marmota flaviventris), two species of pocket gopher, and several species of rabbits, hares, and ground squirrels.

Several species of birds would also have been available to the site's inhabitants, including waterfowl and game birds (Rudolph 1995). There are 45 species of waterfowl native to the area, most of which are migratory and are only available during certain seasons. Game birds were in the area year-round and consist of members of three families: Phasianidae (quail), Meleagrididae (turkey), and Tetraonidae (grouse).
Important aquatic resources include freshwater mussels (*Gonidea angulata* and *Margaritifera falcata*) and fish from five families native to the Snake River: Salmonidae (salmon/trout), Catostomidae (suckers), Cyprinidae (minnows), Acipenseridae (sturgeon), and Cottidae (Sculpins) (Rudolph 1995; See Table 3.1). Native salmonids include both anadromous and non-anadromous species. Anadromous inhabitants of the Snake River include Chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), and sockeye salmon (*O. nerka*).

Ethnographic sources emphasize anadromous salmonids as the critical resources available to inhabitants of the Snake River. Steward (1938) notes that small encampments, consisting of an average of three families, practiced fishing as the primary means of subsistence. He states that, other than deer, most of these groups did not hunt large animals. Instead, they stored fish, roots, and insects, and often preferred to transport collected foods near salmon caches. In the absence of other sources, Steward's observations are often at the root of hypotheses for sedentism that are based on ethnohistoric accounts.

**Hetrick Excavation**

The Hetrick site was excavated as part of a proposed realignment of U.S. Highway 95 (Rudolph 1995). Test excavations were conducted in 1992 and 1993, as well as data recovery excavation in 1994. Testing and data recovery resulted in a total of 43 m$^3$ of sediment excavated by hand, with another 68 m$^3$ excavated from backhoe trenches. Hand excavation was done in arbitrary 10cm levels and was water screened through 1/8” (3mm) mesh, which provides sufficient recovery for a
<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
<th>Habitat</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyprinidae</td>
<td>Chiselmouth (<em>Arocheilus alutaceus</em>)</td>
<td>Prefers warmer water. Temp. ranges 44-75°F</td>
<td>30.5 cm long</td>
</tr>
<tr>
<td></td>
<td>Redside shiner (<em>Richardsonius balteatus</em>)</td>
<td>Near shore May-July, deep water July-Aug, shallow water Sept-Oct, deep water Oct-May</td>
<td>12.7 cm long</td>
</tr>
<tr>
<td></td>
<td>Pike minnow (<em>Mylocheilus caurinus</em>)</td>
<td>Deep water in winter, near shore/shallow water in spring and summer. Prefer warm water</td>
<td>35.6 cm long</td>
</tr>
<tr>
<td></td>
<td>Northern squawfish (<em>Ptychocheilus oregonensis</em>)</td>
<td>Deep water in winter, near shore/shallow water in spring and summer. Prefer temps 68-73°F</td>
<td>63.5 cm long</td>
</tr>
<tr>
<td></td>
<td>Tui chub (<em>Gila bicolor</em>)</td>
<td>Deep water in winter, near shore/shallow water of lakes and large streams in spring and summer.</td>
<td>40.6 cm long</td>
</tr>
<tr>
<td></td>
<td>Longnose dace (<em>Rhinichthys cataratae</em>)</td>
<td>Swift running water, summer temps 55-70°F. Shallow water in spring and summer, deep pools in winter.</td>
<td>10.2 cm or less</td>
</tr>
<tr>
<td></td>
<td>Leopard dace (<em>Rhinichthys falcatus</em>)</td>
<td>Prefers deeper, slower moving streams.</td>
<td>10.2 cm long</td>
</tr>
<tr>
<td></td>
<td>Speckled dace (<em>Rhinichthys osculus</em>)</td>
<td>Prefers shallow, colder water.</td>
<td>10.2 cm or less</td>
</tr>
<tr>
<td>Catostomidae</td>
<td>Largescale sucker (<em>Catostomus macrocheilus</em>)</td>
<td>Bottom dweller, typically inhabits shallow water. Found in lakes and streams.</td>
<td>61 cm long</td>
</tr>
<tr>
<td></td>
<td>Mountain sucker (<em>Catostomus platyrhynchus</em>)</td>
<td>Bottom dweller, inhabits shallow water in colder streams. Prefers summer temps 55-70°F.</td>
<td>21.6 cm long</td>
</tr>
<tr>
<td></td>
<td>Bridgelip sucker (<em>Catostomus columbianus</em>)</td>
<td>Bottom dweller, inhabits shallow water</td>
<td>38.1 cm long</td>
</tr>
<tr>
<td>Salmonidae</td>
<td>Mountain whitefish (<em>Prosopium williamsoni</em>)</td>
<td>Streams and lakes, deep water in winter. Water temps 48-52°F.</td>
<td>30.5 cm long</td>
</tr>
<tr>
<td></td>
<td>Bull trout/Dolly varden (<em>Salvelinus sp.</em>)</td>
<td>Freshwater, various depths of streams, rivers and lakes with cool water temps (~59°F)</td>
<td>30.5-61 cm long, 2.3-6.8 kg</td>
</tr>
<tr>
<td></td>
<td>Cutthroat trout (<em>Salmo clarki</em>)</td>
<td>-</td>
<td>25.4 cm long, up to 99.1 g and 18.6 kg</td>
</tr>
<tr>
<td></td>
<td>Rainbow trout (<em>Oncorhynchus mykiss</em>)</td>
<td>Freshwater lifecycle. Cool water, less than 70°F.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chinook salmon* (<em>Oncorhynchus tshawytscha</em>)</td>
<td>Anadromous- freshwater and marine environments</td>
<td>Avg. 9.1 cm and 10 kg</td>
</tr>
<tr>
<td></td>
<td>Steelhead trout* (<em>Oncorhynchus mykiss</em>)</td>
<td>Anadromous life cycle- freshwater and marine environments</td>
<td>Avg. 4.5 kg, 64.7 cm</td>
</tr>
<tr>
<td>Acipenseridae</td>
<td>White sturgeon (<em>Acipenser transmontanus</em>)</td>
<td>Near the surface during the spring, otherwise in deep water</td>
<td>6.1 m long, 816.5 kg</td>
</tr>
</tbody>
</table>

representative sample of salmonids (Butler and Chatters 1994). Constant volume samples were also taken from each level and were water screened through 1/16” (1.5mm) mesh.

Site stratigraphy was divided into four primary layers, strata I-IV, with substrata further divided by cultural material found within the units (eg., strata IIIa). Rudolph (1995) defined four main occupation episodes (Weiser IV-I), each assigned to a single substratum of III or I, as shown in Table 3.2. Strata II and IV were not used in any analyses due to a lack of cultural material. Seven cultural (A-F, IIId bone layer) and two natural (G and H) features were uncovered within these strata (Table 3.3). Features A-D were uncovered during testing; a sample (.02 m³) was recovered from each and processed using flotation and 1/16” mesh. In addition to the sample, 1 m³ of feature C was also excavated using 1/8” mesh, resulting in the recovery of 40 bone fragments. Features G and H were encountered during data recovery and for each the entire feature was collected and processed using flotation and 1/16” mesh. Feature F and the IIId bone layer were also discovered during data recovery, however they were processed using 1/8” mesh. Where it was clearly defined, Feature E was collected and processed as a bulk sample, however sediment peripheral to the easily defined feature was excavated using 1/8” mesh (Rudolph 1995; p. 6-13).

Other than general descriptions and brief interpretations, the original study did not focus on the features as an analytic unit, rather strata and occupations were primarily used in discussing the results of testing and excavation. I was able to extrapolate the relationship between features, individual strata, and occupations
using information from the report. When discussing faunal material in each stratum, 
Rudolph states “Only four strata are discussed: I, IIa, IIc, and IIIId. The other strata 
are either mixed, natural deposits, or have extremely low frequencies of found data” 
(1995, p. 6-21). Because each feature represents human activity, I used this 
statement to assume that each feature must be assignable to one of these four strata 
(Table 3.3). Further, these strata should primarily consist of materials from only 
these features or sediments directly related to them.

Previous analysis of the site assemblage using tools and faunal remains 
suggests that the site was used as a foraging base camp for occupations Weiser I, II,

<table>
<thead>
<tr>
<th>Table 3.2</th>
<th>Chronology of Occupation Episodes at the Hetrick Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information from Rudolph (1995):</td>
<td></td>
</tr>
<tr>
<td>Occupation</td>
<td>Weiser IV</td>
</tr>
<tr>
<td>Years BP (cal)</td>
<td>3,000-300</td>
</tr>
<tr>
<td>Radiocarbon age</td>
<td>290 ± 60 BP</td>
</tr>
<tr>
<td>Diagnostic Projectile Point</td>
<td>Elko, Rose Spring</td>
</tr>
<tr>
<td>Associated Strata</td>
<td>I</td>
</tr>
</tbody>
</table>

C-14 ages from this analysis: 

<table>
<thead>
<tr>
<th>Catalog number</th>
<th>Het1</th>
<th>Het2</th>
<th>Het3</th>
<th>Het4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit</td>
<td>30N15W</td>
<td>30N15W</td>
<td>30N15W</td>
<td>30N15W</td>
</tr>
<tr>
<td>Level (cm)</td>
<td>10-20</td>
<td>130-140</td>
<td>220-230</td>
<td>250-260</td>
</tr>
<tr>
<td>UCI AMS#</td>
<td>87906</td>
<td>-</td>
<td>87907</td>
<td>87908</td>
</tr>
<tr>
<td>New date</td>
<td>110 ± 20</td>
<td>-</td>
<td>9830 ± 30</td>
<td>9835 ± 30</td>
</tr>
<tr>
<td>Mass (g)</td>
<td>8.07</td>
<td>6.76</td>
<td>1.59</td>
<td>7.28</td>
</tr>
<tr>
<td>Sample description</td>
<td>Medium mammal</td>
<td>Medium mammal</td>
<td>Medium mammal</td>
<td>Medium mammal</td>
</tr>
<tr>
<td></td>
<td>Juvenile scapula</td>
<td>Unidentified</td>
<td>Unidentified</td>
<td>Long bone shaft fragment</td>
</tr>
</tbody>
</table>
and III (Rudolph 1995). Using projectile points as temporal markers, Weiser IV appears to be a combination of three separate occupations, though these cannot be distinguished vertically or horizontally. As such, it is not possible to assign site function during the Weiser IV occupation, which was originally assigned a date range of 3,000 to 300 BP, though Rudolph (1995) notes that the generalized and diverse assemblage from this stratum is very similar to the other occupations and may indicate similar use as a short-term foraging base camp.

While the report notes that the site was undisturbed, the presence of a Windust point in stratum I (Weiser IV) suggests that there is likely to have been stratigraphic mixing, which is problematic given that some dates are assigned using only diagnostic projectile points. In order to clarify the occupational

<p>| Table 3.3 Feature assignments to strata and occupations based on Rudolph (1995) |
|---------------------------------|-------------------------------------|---------------------------------|---------------------------------|---------------------------------|</p>
<table>
<thead>
<tr>
<th>Occupation</th>
<th>Stratum</th>
<th>Feature</th>
<th>Mesh Size</th>
<th>Volume</th>
<th>Feature description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Historic materials</td>
<td>I</td>
<td>D</td>
<td>n/a</td>
<td>0.02 m³</td>
<td>Historic ditch</td>
</tr>
<tr>
<td>Weiser IV</td>
<td>I</td>
<td>A, B</td>
<td>1/16”</td>
<td>0.02 m³ each</td>
<td>-A is a small pit of unknown age. -B is a historic pit intruding into a prehistoric one.</td>
</tr>
<tr>
<td>Weiser III</td>
<td>IIIa</td>
<td>C</td>
<td>1/8” and 1/16”</td>
<td>1 m³ using 1/8”, 0.02 m³ using 1/16”</td>
<td>Prehistoric pit</td>
</tr>
<tr>
<td>Weiser II</td>
<td>IIIc</td>
<td>E, F</td>
<td>1/16” and 1/8”</td>
<td>E: bulk sample (1/16”) 0.855 m³, periphery of feature (1/8”) 4.237 m³. F: 0.396 m³ using 1/8”</td>
<td>- E is a layer of freshwater shell - F is a deposit of bone, lithic artifacts, shell, fire altered rock, and pebbles associated with feature E</td>
</tr>
<tr>
<td>Weiser I</td>
<td>IIId</td>
<td>IId bone layer</td>
<td>1/8”</td>
<td>3.803 m³</td>
<td>Cultural bone layer</td>
</tr>
</tbody>
</table>
sequence, one bone specimen from each of the four occupations was submitted to Dr. Doug Kennett (University of Oregon/UC-Irvine collaborators) for dating using high precision radiometric analyses (Table 3.2). Given both the rarity of charcoal at this site and sample size requirements, I selected bone from medium- to- large mammals (1-2 grams). Further, the use of bone avoids complications from old wood, and bone from cultural layers is more likely to be directly associated with human activity than charcoal. Of these samples, Het2 from the Weiser III occupation could not be dated due to poor bone preservation. As such, for my temporal analysis the previous age estimate for Weiser III, 6000 BP, is used based on the Cascade projectile point. Despite the lack of a date for Weiser III, the similarity between the original and new dates is noteworthy, as is the large gap in the timing of occupations at this site.

The Value of the Hetrick Site

The Hetrick site is valuable to addressing many regional questions about the prehistory of the Snake River because of its age, its intact features, the presence of faunal material, including fish, and the methodology used during excavation. The controls that this site provides are beneficial to larger regional issues because large-scale comparisons of regional information on the Snake are often complicated by problems of recovery, analysis, and reporting. Site reports can vary, with faunal remains listed to different taxonomic levels (eg. Family, Genus) and some sites only noting the presence of fish or salmon (see Appendix). Other reports use different quantitative measures for faunal material, such as NISP (Number of Identified
Specimens), MNI (Minimum Number of Individuals), or meat weights. This complicates comparisons of multiple sites, as different reporting methods can limit what analyses can be performed. For example, sites that report only presence/absence or derived measures, such as MNI or meat weight, cannot be used for analyses that require the use of NISP.

Further complications can arise when comparing sites with different functions, such as comparing a temporary resource acquisition site with a more permanent base camp. Different site types will reflect different activities, which can lead to problems concerning differential part representation and preservation in the archaeofaunal record (Butler and Chatters 1994). This makes it difficult to compare faunal assemblages between sites in order to assess if fish use was changing over time. Lyman (2003) further warns that comparing contemporary sites across space results in an average diet for a region or time period that does not take into account local resource variation.

For any evaluation of salmon use, recovery, taphonomy, and human behavior must be considered if one is to present a representative picture (Davis 2007). The excavation methods at Hetrick should give an accurate representation of faunal use at the site and, because the assemblage will be from a single site, preservation conditions should be consistent. Also, the site has been interpreted as having the same function for three occupation episodes, allowing for examination of change over time of similar activities during those occupations. While site activities at Weiser IV cannot be determined specifically, one can make the assumption that similarities between this assemblage and those from other occupations can indicate
similar site use. As such, under this assumption this component of the site can be
included for analytical purposes.

This site is particularly useful for examining fish use over time because it has
a relatively large fish assemblage and shows evidence for salmonid exploitation at
11,560 cal BP, the earliest evidence on the Lower and Middle Snake River (Rudolph
1995). While I analyzed the fish remains for this study, I also wanted to examine fish
use in a larger context of the entire animal-based diet, so I needed to employ the
non-fish faunal data from the original analysis. The original faunal analysis is
reported using different quantitative approaches. Faunal information from features
is tallied using NISP, while faunal remains within strata are reported as bone weight.
While this first appeared to be problematic, Rudolph notes that only information
from cultural strata is discussed. As such, I have operated under the assumption that
the bone weight provided for each stratum in the report corresponds with the NISP
values provided for the features from that stratum. For example, I assume that the
bone weight values for stratum IIIc correspond with the NISP values from features E
and F, which originate in stratum IIIc. Bone weight is converted to meat weight for
small mammals, large mammals, and fish, which Rudolph used to estimate dietary
contribution for each of these classes (see Table 3.4). As is discussed in more detail
below, it can be problematic to use quantitative methods such as meat weight to
discuss dietary contribution, and as such the original assessment of diet breadth
may differ from later analyses using other quantitative methods.

This assessment of the faunal assemblage suggests a broad diet base that
focuses on large mammals while still using small mammals, fish, and birds. Rudolph
Table 3.4 Percent Dietary Contribution of Faunal Categories by Bone Weight (g) and Meat Weight (g) for Each Strata, Based on Table 6-16 in Rudolph (1995), page 6-37

<table>
<thead>
<tr>
<th>Stratum</th>
<th>Small Mammal</th>
<th>Large Mammal</th>
<th>Fish</th>
<th>Bird</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bone (g)</td>
<td>Meat (g)</td>
<td>Bone (g)</td>
<td>Meat (g)</td>
<td>Bone (g)</td>
</tr>
<tr>
<td>I</td>
<td>28.4</td>
<td>179</td>
<td>29</td>
<td>64.1</td>
<td>404</td>
</tr>
<tr>
<td>IIIa</td>
<td>31.3</td>
<td>197</td>
<td>35</td>
<td>42.4</td>
<td>267</td>
</tr>
<tr>
<td>IIIc</td>
<td>338.1</td>
<td>2130</td>
<td>19</td>
<td>1179.4</td>
<td>7430</td>
</tr>
<tr>
<td>IIIId</td>
<td>87.5</td>
<td>551</td>
<td>4</td>
<td>2116.7</td>
<td>13335</td>
</tr>
</tbody>
</table>

*Adapted from Table 6-16 in Rudolph (1995), page 6-37.

(1995) argues that diet breadth expanded to include more small mammals and fish during the middle Holocene, but the large number of unidentified fish remains leave fish use practices over time unclear (Table 3.5). Further, previous reporting methods limit regional comparisons using fish remains from all contexts. Given the age of this site and the size of the fish assemblage, this information is invaluable and should be reported in a comparable manner. A re-examination of the fish remains from a site with this level of control is needed to ascertain changes in fish use over time, which will aid in addressing larger regional issues.

Table 3.5 Frequency (NISP) of Fish Remains by Feature from Rudolph (1995)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Screen size</th>
<th>Volume (m³)</th>
<th>Unid</th>
<th>Salmonidae</th>
<th>Catostomidae</th>
<th>Cyprinidae</th>
<th>Acipenser</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feature A</td>
<td>1/16&quot;</td>
<td>0.02</td>
<td>69</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>76</td>
</tr>
<tr>
<td>Feature B</td>
<td>1/16&quot;</td>
<td>0.02</td>
<td>396</td>
<td>41</td>
<td>3</td>
<td>10</td>
<td>0</td>
<td>450</td>
</tr>
<tr>
<td>Feature C*</td>
<td>1/8&quot; &amp; 1/16&quot;</td>
<td>1.0 &amp; 0.02</td>
<td>247</td>
<td>17</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>268</td>
</tr>
<tr>
<td>Feature E</td>
<td>1/8&quot;</td>
<td>4.237</td>
<td>160</td>
<td>1</td>
<td>12</td>
<td>11</td>
<td>1</td>
<td>185</td>
</tr>
<tr>
<td>Feature E</td>
<td>1/16&quot;</td>
<td>0.855</td>
<td>3,666</td>
<td>51</td>
<td>81</td>
<td>191</td>
<td>3</td>
<td>3,992</td>
</tr>
<tr>
<td>Feature F</td>
<td>1/8&quot;</td>
<td>0.396</td>
<td>10</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Stratum IId bone layer</td>
<td>1/8&quot;</td>
<td>3.8034</td>
<td>20</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td>Site total</td>
<td>4,611</td>
<td>146</td>
<td>108</td>
<td>222</td>
<td>8</td>
<td>5,095</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data from Rudolph (1995). *Forty specimens of bone came from the 1m³ excavated with 1/8" mesh in feature C, the rest from the bulk sample. I was unable to separate NISP values by screen size because the original report does not provide taxonomic information for those 40 specimens.
Expectations

For this study, foraging theory and paleoclimatic models can be used to create predictions that can be compared against archaeological faunal records. Foraging theory predicts that resources with the largest body size will have the highest rank because they provide the most calories for the energy expended in pursuit, capture, and processing. Typically, large terrestrial mammals will have the highest rank of all resources because they have a large body size and do not require specialized equipment, such as that required for fishing. While this study focuses on fish use, terrestrial resources were a significant contribution to the diet of site inhabitants. While current archaeofaunal analytic methods do not allow for direct comparisons between mammals and fish (Butler and Campbell 2004), the contribution of terrestrial resources will be considered further in Chapter 5.

Based on body size criteria from foraging theory, sturgeon should be targeted first, however they are rare in this assemblage. The next largest fish, salmonids, tend to attain a larger body size than fish from other families native to the Snake River and thus would have the highest rank. Optimal foraging theory predicts that, if high ranked resources are abundant, they will always be used. Thus, the abundance of salmonids in the assemblage should be representative of encounter rates with this family. Smaller-bodied species, such as local catostomids or cyprinids, should only be added to the diet if encounter rates for salmonids decline and diet breadth expands. Using this prediction as a basis, the following hypotheses and implications were developed.
H$_a$: Salmon is used more than smaller fish species in every occupation of the Hetrick site
H$_{1a}$: Salmon use relative to other fish species differs during different occupations of the Hetrick site.

These hypotheses can be tested using archaeological data. For H$_a$, fish use should not change over time, suggesting that fish resources were used in a similar manner for all occupations spanning the Holocene. If true, this hypothesis negates models based on the ethnohistoric record of the WVP that argue for increasing salmon use as a factor in sedentism. If H$_{1a}$ is accepted, then either salmon use is increasing or decreasing during the different occupations. These trends can be seen archaeologically by calculating abundance indices and evenness values for the fish assemblage. Grayson and Delpech (1998) note that one can determine how frequently lower-ranked resources were included in the diet by examining the distribution of specimens across taxa. Abundance indices illustrate changes in this distribution by showing relative changes in high-ranked versus low-ranked resources (Butler 2000; Nagaoka 2002). I calculated a Salmon Index, measuring the proportion of salmonids to all fish (NISP salmonid/NISP salmonid + NISP all other fish), for each occupation. Abundance index values closer to 1 indicate a higher proportion of salmonids in the diet relative to other fish species.

Further, measurements of diversity, such as Shannon's evenness index (H), can measure resource specialization using the equation H= $-\sum_{i=1}^{s} p_i \ln p_i$. In this equation, $p_i$ is the proportion of species $i$ relative to the total number of species. If all taxa are represented equally, then the index will have a high evenness value. If some taxa were used more frequently than others, then the evenness value will be low.
This method is good for showing general trends in the proportion of taxa used, however it does not indicate which taxa are used more than others. When used in conjunction with abundance indices, however, it can indicate changing resource use.

Using these methods, I was be able to ascertain if salmon use was changing over time, and if so, whether it was increasing or decreasing. A decrease in the proportion of salmon remains in the assemblage may be indicative of expanding diet breadth from resource depression. As previously discussed, resource depression can be the result of human predation, or climate change. If a change to unfavorable climatic conditions is a factor, then salmonid populations should rebound once climatic conditions improve, similar to the effect described by Byers and Broughton (1994). Human harvesting pressures have been shown to decrease the size of exploited fish species (Butler 2001), an effect that is visible archaeologically in the size of fish remains. Casteel (1972, 1976) has calculated regression equations for catostomids, cyprinids, and a joint cyprinid/catostomid category that recreates total body length based on vertebral measurements. Complete vertebrae widths were measured to estimate body size using Casteel’s equations, which can be used to support conclusions regarding resource depression. Thus, if resource depression is occurring due to human activity, I expect to see body size decreasing over time.

An increase in salmon use over time would appear to fit regional specialization models, suggesting that fish use changed over time to focus on salmonid exploitation (Nelson 1976; Fladmark 1975). If this is true, then evidence of increasing salmonid exploitation should precede evidence for decreased mobility. However, other factors may result in increasing use of salmonids over time.
In examining changing fish use in Oceania, Butler (2001) examines three reasons for changing fish use: environmental change, technological change, and human predation. As previously discussed, the environment can affect salmonid abundance and thus can be a contributing factor in changing encounter rates with salmonids. Improving climatic conditions throughout the Holocene would improve the probability of salmonid survival, thus increasing abundance and their potential value as a resource. As such, if climate change resulted in increasing salmon use, there should be a temporal correlation between improving climatic conditions and increasing presence of salmonids in archaeological sites. A similar temporal correlation can be expected for any technological changes that might lead to increased salmonid use.

Technological change can refer to either methods of capture (eg., nets, weirs) or use (eg, storage). While mass capture can give smaller-bodied species a higher rank than individually caught large fish (Madsen and Schmitt 1998), salmonids aggregate temporally and spatially during spawning, allowing for the mass capture of large fish. Butler and Campbell (2004) argue that if mass capture technology were used, salmonids would have been procured in this manner and would still have higher rank than smaller species. Thus, regardless of procurement technology, salmonids should have a high rank and should be used whenever available, and technological change should not impact whether salmonids were used more frequently than other fish. However, the development of technology such as storage should make it more efficient to capture and process larger fish rather than smaller ones, which could explain increased use of salmonids relative to other species.
Methods

In order to test these hypotheses, the Hetrick fish assemblage was borrowed from the Archaeological Survey of Idaho-Western Repository in Boise, Idaho. The assemblage was analyzed in the zooarchaeology laboratory at Portland State University. Fish remains were identified to the finest taxonomic category possible using morphological characteristics and were quantified using Number of Identified Specimens (NISP) (Grayson 1984). V. L. Butler reviewed all the taxonomic assignments and presence/absence of burning before recording. The family level was used during analyses due to most of the assemblage only being identifiable to this level. Identification protocols followed similar methods as described in Butler (2010); specimens were further identified to element, with complete vertebrae described as abdominal or caudal. Due to morphological similarities, a joint minnow-sucker category was used for vertebrae from those two families. Burning was only noted if specimens were completely black or calcined (bluish-white color) due to the possibility of staining. Complete vertebrae were measured to aid in body size reconstruction, as outlined in Casteel (1972, 1976).

These data were then entered into SPSS and grouped by occupation episode to examine changes in fish use over time using the strata assigned to each occupation by Rudolph (1995). The ability to clearly relate features, strata, and occupations is particularly important for comparison with the original analysis. Given the original reporting method and difficulties comparing derived measures (discussed in Chapter 5), only materials associated with features can be used in
comparisons with this study. Stratigraphic information in the report (Rudolph 1995:Table 5-9) allowed me to assign data recovery materials to a particular stratum, and thus occupation, using the provenience information listed in each bag. Most of these remains only have unit/level information included; features were only explicitly mentioned in materials from the testing phase and feature E. Testing phase materials were more difficult to assign using unit/level since the report does not provide test unit stratigraphy as explicitly. I attempted to locate these materials stratigraphically using information from different sections of the report (eg. Weiser III was primarily identified in unit 32N5W, and stratum IIIa extends to 130-150 cmbs; therefore remains from unit 32N5W at a depth of 140-150 cmbs are from that stratum and that occupation), but most were placed using feature association.

Lyman (2008) notes that specimens that cannot be identified beyond taxonomic levels such as class (eg. Mammalia) are generally of little analytic value other than gross measures of dietary contribution; as such, any remains that could not be assigned to taxonomic order, family, genus, or species were omitted from all analyses beyond descriptions of the general assemblage. Also, in order to compare change over time, only identified materials that were clearly associated with a single stratum associated with a single occupation were included (eg. materials from Stratum IIIb were omitted as it is not associated with a single occupation). Given that few data came from outside of occupation strata (in both the report and this study), the omission of material from outside of features should not affect results here. Small sample size was also considered to be problematic as it can skew the results of statistical analysis. Other than general descriptions for the assemblage as
a whole, materials from the family Acipenseridae were omitted from analyses given small sample size (n=2). The Weiser I occupation also had a small sample size (n=8), however these were combined with those from Weiser II due to the nearly identical radiocarbon dates obtained from bone from the two occupations (Table 3.2). These combined occupations are referred to as Weiser I/II, though the two occupations are referred to separately for general descriptions of the site.

Once I recorded faunal data, I compared taxonomic results by occupation episode and looked for patterns that would indicate change, including the relative contribution of salmonids and non-salmonids in the diet, body part representation, body size, and burning. The proportion of salmonids to non-salmonids over time can be used to infer diet breadth for each occupation, which can be used to discuss intensification of specific resources. Given the expectations above, salmonids should be used if available. Inclusion of lower-ranked catostomids and cyprinids in the diet shows increased diet breadth. Differential body part representation can provide information on butchery practices. It has often been argued that higher numbers of cranial elements are found at acquisition sites than at resource processing sites, thus any observed changes may indicate changes in behavior or site use over time (Butler 1993; Butler and Chatters 1994). Burning can also provide information about processing and can also be directly associated with human behavior.

These results were then compared to expectations of changing resource abundance derived from foraging theory and paleoclimate data, as well as reports from other contemporary sites in the region in order to place Hetrick in a larger regional context. Data were gathered from twenty-six published sites along the
Lower and Middle Snake River that had fish noted as present in order to compare species representations and trends over time at sites within the same region.

**Summary**

The Hetrick site is a very important site for addressing regional questions, in particular questions involving subsistence. Fish, and anadromous salmonids in particular, are considered to be one of the most important resources on the Columbia Plateau and many hypotheses regarding culture change invoke this resource as a proximate cause. This site has a relatively large fish assemblage and early evidence of salmonid use, which together allow me to address the use of fish and salmon in prehistoric diets. This research identifies archaeofaunal remains to the finest taxonomic category possible using morphological characteristics, and then groups them according to occupational episode. These data are then analyzed with relation to hypotheses derived from foraging theory and paleoclimatic models to observe if there are any patterns of change over time.
Chapter 4. Results

General Frequencies

For this analysis, I examined a total of 5,269 fish bones. The assemblage was highly fragmentary, with only 595 (11%) identified to taxon and element. Most specimens were identifiable only to the family level (or joint family, Table 4.1), with only one specimen identifiable to species (an abdominal vertebrae identified as *Prosopium williamsoni*). Cyprinid/catostomids dominate the identifiable portions of the total assemblage, with salmonids making up only 9.6%. Of the identifiable remains, 27 specimens were omitted from this analysis based on the criteria outlined in Ch. 3, resulting in a filtered total of 568 specimens.

Descriptive Summary of Fish Remains

**Order Cypriniformes**

Family Cyprinidae- minnows

**Materials:** Weiser II: 1 ceratohyal, 2 quadrate, 3 pharyngeal, 22 teeth, 1 2nd vertebra, 2 1st or 2nd vertebra

Weiser IV: 1 otolith, 1 pharyngeal

Family Catostomidae- suckers

**Materials:** Weiser I: 1 pharyngeal

Weiser II: 3 angular, 2 basioccipital, 14 ceratohyal, 2 dentary, 1 epihyal, 3 hyomandibular, 1 maxilla, 1 opercle, 1 palatine, 6 quadrate, 1 vomer, 2 cleithrum, 26 pharyngeal, 2 expanded dorsal spine, 6 teeth, 4 vertebra 1 (atlas), 1 2nd vertebra

Weiser III: 1 angular, 1 basioccipital, 1 hyomandibular, 1 basioccipital, 1 pharyngeal, 1 premaxilla

Weiser IV: 2 ceratohyal, 1 pharyngeal, 1 2nd vertebra

Cyprinidae/Catostomidae

**Materials:** Weiser I: 1 ceratohyal, 1 opercle, 1 vertebra fragment, 1 expanded dorsal spine, 1 1st or 2nd vertebra, 2 abdominal vertebra

Weiser II: 1 ceratohyal, 1 hyomandibular, 1 opercle, 1 parasphenoid, 1 urohyal, 4 scapula, 2 basioccipital, 20 indeterminate
vertebra, 178 vertebrae fragment, 3 vertebra 1 (atlas), 1 1<sup>st</sup> or 2<sup>nd</sup> vertebra, 4 ultimate vertebra, 82 abdominal vertebra, 47 caudal vertebra
Weiser III: 8 vertebrae fragment, 3 abdominal vertebra, 1 caudal vertebra
Weiser IV: 1 otolith, 1 indeterminate vertebra, 21 vertebrae fragment, 4 abdominal vertebra, 2 caudal vertebra

Remarks: Several cranial elements are morphologically distinctive and can be used to identify cyprinid and catostomid remains to the family level or finer. However, many remains are morphologically similar and thus are difficult to distinguish, especially given the degree of fragmentation in this assemblage. Where possible, remains were assigned to a single family, however a joint cyprinid-catostomid category was used for those that remained indistinguishable. Vertebrae were identified as abdominal or caudal following Wheeler and Jones (1989). Taxonomic assignments for vertebrae follow Butler (2004, 2010), who notes that other than the first and second vertebrae, cyprinid and catostomid vertebrae cannot be distinguished morphologically.

Order Acipenseriformes
Family Acipenseridae- sturgeons
Acipenser sp.- sturgeon

Materials: Weiser II: 2 unidentified elements

Remarks: Two specimens were identified as Acipenser based on morphological similarities to comparative specimens, however the remains were too fragmentary to assign to a specific element. These specimens were assigned to Acipenser based on distinctive surface morphology and texture. Only one species of sturgeon, Acipenser transmontanus, is native to the area of the Hetrick site, thus these specimens are likely from this species.
Order Salmoniformes
Family Salmonidae- Salmons, Trouts, and Whitefish

Materials: Weiser II: 7 vertebra fragment
          Weiser III: 17 vertebra fragment, 2 gillraker
          Weiser IV: 27 vertebra fragment

*Prosopium williamsoni*- Mountain Whitefish
Materials: Weiser II: 1 abdominal vertebra

*Salvelinus sp.-* Bull trout/Dolly varden
Materials: Weiser II: 1 abdominal vertebra

Remarks: As previously discussed, there are five salmonids native to the Snake River: *Prosopium williamsoni* (mountain whitefish), *Salvelinus sp.* (Bull trout/Dolly varden), *Oncorhynchus clarki* (cutthroat trout), *Oncorhynchus tshawytscha* (Chinook salmon), and *Oncorhynchus mykiss* (steelhead/rainbow trout). *O. mykiss* has two very different lifecycles, one that is anadromous (steelhead) and one that spends its entire life in freshwater (rainbow trout). Bull trout (*Salvelinus confluentus*) and Dolly Varden (*Salvelinus malma*) are morphologically very similar and are generally only identifiable by the number of branchiostegal rays (Wydoski and Whitney 2003).

Vertebrae were identified based on distinctive shape and fenestration, and assigned to vertebrae types following Butler (1990). One vertebra type II was assigned to *Prosopium williamsoni* because the centrum does not have the typical *Oncorhynchus* fenestrations, rather it has horizontal struts (following Butler 2004, p. 320). Another was identified as *Salvelinus sp.* based on size and fenestrations. Species identification could not be made based on morphological similarities between Bull trout and Dolly Varden (using Wydoski and Whitney 2003).
Many intact salmonid elements are difficult to assign to a particular species due to morphological similarities, so these fragmentary remains were only identifiable to Salmonidae. Vertebrae fragments were compared with complete vertebrae from salmonids of known body size. Fragment size, and the degree of curvature of centrum edges best match large bodied anadromous fishes like *Oncorhynchus*.

**Recovery and Sample Size**

Presence/absence of taxa in an assemblage, as well as body part representation, can be affected by three factors: human behavior, taphonomy, and recovery. Previous studies show that sample size can influence analysis; rare taxa are often missed in small samples, and the odds of encountering rare taxa increase as sample size increases until one begins to “sample to redundancy” (Lyman 2008, p. 143-151). Further, measures of abundance, such as abundance and diversity indices, are often correlated with sample size. Weiser I/II has a much larger sample size than either Weiser III or Weiser IV, so we would expect Weiser I/II to have a better representation of rare taxa than the other, much smaller samples (Figure 4.1). These differences in sample size can be due to a number of factors; either fish were simply used rarely in the assemblage, or sample size was affected by recovery methods, including screen size and volume excavated.

As previously discussed, screen mesh size can affect representation of taxa in an assemblage: larger taxa are often over-represented in comparison to smaller taxa that are lost through the screens. Smaller mesh sizes (1/8” or smaller) result in inclusion of smaller taxa in an assemblage (Butler and Chatters 1994). If salmonids
were originally present in the assemblage, then their remains should have been
recovered equally or more often than the smaller cyprinids and catostomids. Butler
(1993) notes that the only salmonid remains lost in 1/8” mesh but recovered in
1/16” were neural spines and vertebra fragments. Since the salmonid remains for
this assemblage are primarily vertebra fragments, any larger, more complete
elements should have been recovered, if present. Given that all occupations were
screened with a minimum of 1/8” mesh or finer, recovery methodology should
provide an accurate representation of remains present in the archaeological
deposits at the time of excavation. Indeed, the use of 1/16” mesh was critical for the
recovery of most of the small fish remains analyzed here.

The total number of remains recovered is not correlated with the excavated
volume for each occupation ($r_s=0.5$, $p>.5$), however the number of salmonid remains
recovered is highly correlated with the excavated volume for each occupation,
though not statistically significant ($r_s=-1.0$, $p<.5$; Table 4.1). Most of the remains

Figure 4.1. Sample Size by Occupation

![Bar Chart: Sample Size by Occupation]

<table>
<thead>
<tr>
<th>Occupation</th>
<th>NISP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weiser IV</td>
<td>500</td>
</tr>
<tr>
<td>Weiser III</td>
<td>100</td>
</tr>
<tr>
<td>Weiser I/II</td>
<td>300</td>
</tr>
</tbody>
</table>
Table 4.1. Spearman’s Rankings

<table>
<thead>
<tr>
<th>Volume excavated (m³)</th>
<th>Rank</th>
<th>Fish NISP</th>
<th>Rank</th>
<th>Salmonid NISP</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weiser I/II</td>
<td>9.29</td>
<td>1</td>
<td>470</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>Weiser III</td>
<td>1.02</td>
<td>2</td>
<td>37</td>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>Weiser IV</td>
<td>.04</td>
<td>3</td>
<td>61</td>
<td>2</td>
<td>27</td>
</tr>
</tbody>
</table>

from the Weiser I/II occupation come from Features E, F, and the IIId bone layer (total excavated volume= 9.291 m³), while the remains from Weiser III come from Feature C (total excavated volume= 1.02 m³) and Weiser IV comes from Features A and B (total excavated volume = 0.04 m³). As such, I looked for correlations between sample size and the changes in fish over time.

Comparison of Analyses

Table 4.2 compares the number of specimens from Rudolph (1995) with my results. Rudolph reports a total fish assemblage with a number of specimens (NSP) of 5095 (compared to my NSP of 5,231) and, since the number of unidentified specimens in my analysis and the initial report remains approximately the same, my analysis shows an increase in identifiable specimens (N=595, my analysis; N=484, Rudolph 1995).

Table 4.2 Comparison of NISP values from Rudolph (1995) and this analysis

<table>
<thead>
<tr>
<th></th>
<th>Rudolph 1995</th>
<th>This analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salmonidae</td>
<td>146</td>
<td>57</td>
</tr>
<tr>
<td>Acipenseridae</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Cyprinidae</td>
<td>222</td>
<td>34</td>
</tr>
<tr>
<td>Catostomidae</td>
<td>108</td>
<td>92</td>
</tr>
<tr>
<td>Cyprinidae/Catostomida</td>
<td>0</td>
<td>410</td>
</tr>
<tr>
<td>Total Identified</td>
<td>484</td>
<td>595</td>
</tr>
<tr>
<td>Unidentified</td>
<td>4,611</td>
<td>4,636</td>
</tr>
<tr>
<td>Grand Total</td>
<td>5,095</td>
<td>5,231</td>
</tr>
</tbody>
</table>
It is possible that the increase in NSP and NISP is the result of fragmentation that occurred between the timing of the two analyses. While NSP is a count of all remains, including remains that are not identifiable, NISP is a method of quantification that counts the number of elements (both complete and fragmentary) that are identifiable to a taxonomic category (Lyman 2008). Since NISP is only a simple count, fragmentation can inflate the representation of some taxa. If a specimen breaks in such a way that it is still identifiable (e.g., distal and proximal ends of a femur), one runs the risk of counting the same specimen multiple times, thus inflating the representation of that element or taxon in the assemblage (Lyman 2008). However, it is important to note that as the degree of fragmentation increases, it becomes increasingly difficult to identify specimens to skeletal element and taxon. This is particularly noteworthy for this assemblage.

I found very few specimens that could be attributed to salmonid or *Acipenser*; in comparison, Rudolph's (1995) analysis has almost three times the number of salmonids and four times the number of *Acipenser*. Rudolph also has a much larger portion of the assemblage identified as cyprinid than is seen in my results. Perhaps fragmentation resulted in the increase in NSP by 174 from the previous analysis, which may have made it so that specimens previously identified as salmonid, cyprinid, or *Acipenser* are no longer identifiable. However, my analysis shows an increase in total NISP, suggesting that if fragmentation occurred it did not reduce identifiability as much.
It is possible that previously identifiable specimens may have broken but remained identifiable, but it is not likely that any fragmentation seen here would result in the same bones being identified to different taxa. Instead, the differences in the counts for each taxon are likely due to interanalyst variation, where two analysts may not have the same criteria for what makes a specimen identifiable (Lyman 2008). It is plausible that taxonomic abundance differs between the two analyses because my criteria for recognizing salmonid bones differ from the original analyst. This demonstrates the necessity of explicitly reporting analytic rules for taxonomic identification for comparison with future analyses (Driver 1992). Given the careful evaluation of the specimens in this analysis by myself and Dr. Virginia Butler, I argue that my identifications are as accurate as is possible given the state of the assemblage.

One way to counteract the problems associated with using NISP is by calculating the minimum number of elements (MNE). In order to calculate MNE, I noted the presence/absence of landmarks on each element. These landmarks are identifiable markings that can occur only once per element (eg. an articular surface). In order to ensure that each element is only counted once, only elements with landmarks present were included in analyses using MNE. For vertebrae, the presence of 50% or more of the centrum was used as a landmark (eg. Butler 1993, 1996). Given the fragmentary state of most of the salmonid remains, MNE calculations were primarily used for cyprinids and catostomids. MNE can be used to examine element survivorship and the degree of fragmentation, among other things, however its use for the salmonids in this assemblage is limited. Thus, NISP values do
still have some merit and both values are used throughout this analysis in order to include salmonid remains and to see if the two quantitative measures provide different results. Table 4.3 provides NISP and MNE values for the assemblage as an aggregate.

**Change Over Time**

A $\chi^2$ analysis for this data set shows a statistically significant difference in the distributions of specimens for each family through time (Figure 4.2, Table 4.4). The Weiser I/II occupation has significantly fewer salmonids than were expected, while the Weiser III and IV occupations had significantly more salmonids and fewer resident freshwater species represented than were expected ($\chi^2=197.63,
p<.05$). Abundance indices (AI) show a change in taxonomic abundance over time. Index values closer to 1 show a higher proportion of that taxon in the archaeological record, which suggests a higher rate of exploitation. Figure 4.3 shows an increase in AI values from Weiser I/II (AI=0.02) to Weiser III (AI=0.51), with a slightly lower value for Weiser IV (AI=0.47). The Shannon diversity index shows a similar pattern. In this index, high values indicate that the distribution of NISP between taxa is highly even; low index values indicate that most of the NISP is in one taxon.

Similar to the abundance indices, Weiser I/II has very low diversity values ($H=.098$), while Weiser III and IV have higher values ($H=.6929$ and $H=.6859$, respectively). Could these changes over time reflect different strategies of fish use
by the human occupants at the site, or are they a result of sampling, recovery, or
taphonomy?

Table 4.3 Salmonid and Non-Salmonid NISP and MNE values (entire assemblage)

<table>
<thead>
<tr>
<th>Element</th>
<th>Salmonid NISP</th>
<th>Salmonid MNE</th>
<th>Non-Salmonid NISP</th>
<th>Non-Salmonid MNE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angular</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Basioccipital</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Ceratohyal</td>
<td>0</td>
<td>0</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>Dentary</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Epiphyal</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Gillraker</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hyomandibular</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Maxilla</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Opercle</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Otolith</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Palatine</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Paraphynoid</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Quadrates</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Urohyal</td>
<td>0</td>
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<td>0</td>
</tr>
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<td>Vomer</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Cleithrum</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Scapula</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Basipterygium</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Indeterminate vertebra</td>
<td>0</td>
<td>0</td>
<td>21</td>
<td>2</td>
</tr>
<tr>
<td>Vertebra fragment</td>
<td>51</td>
<td>0</td>
<td>208</td>
<td>0</td>
</tr>
<tr>
<td>Pharyngeal</td>
<td>0</td>
<td>0</td>
<td>33</td>
<td>0</td>
</tr>
<tr>
<td>Premaxilla</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Expanded dorsal spine</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Tooth</td>
<td>0</td>
<td>0</td>
<td>28</td>
<td>0</td>
</tr>
<tr>
<td>Vert 1 (atlas)</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Vert 2</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Vert 1 or 2 (unclear)</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Ultimate vertebra</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Abdominal vertebra</td>
<td>2</td>
<td>2</td>
<td>91</td>
<td>89</td>
</tr>
<tr>
<td>Caudal vertebra</td>
<td>0</td>
<td>0</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>55</strong></td>
<td><strong>2</strong></td>
<td><strong>514</strong></td>
<td><strong>212</strong></td>
</tr>
</tbody>
</table>
Spearman's rank order correlation coefficient shows that there is a correlation between sample size and the measures of diversity calculated here \((r_s=-1.0, p<.5)\), however there is no correlation between sample size and salmonid NISP in each occupation \((r_s=-0.5, p>.5)\). This is particularly interesting since the Weiser I/II occupation has the fewest salmonid remains, yet its large sample size should increase the likelihood of finding rare taxa (Lyman 2008). Thus, if salmonids were present, even if rare, we would expect to find them in larger quantities in the largest sample. This suggests that salmonid remains were very rare in the record for Weiser I/II, while they were found nearly equal to non-salmonid in later occupations. Despite small sample size, the presence of more salmonids in later occupations may indicate that salmonids were deposited in the record more frequently than in earlier time periods, however taphonomic factors must still be considered.
Table 4.4. Fish Family Representation (NISP) by Occupation

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Radiocarbon date</th>
<th>NISP salmonid</th>
<th>NISP cyprinid</th>
<th>NISP catostomid</th>
<th>NISP cyprinid/catostomid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weiser I/II</td>
<td>9835 ±30, 9830 ±30</td>
<td>9</td>
<td>31</td>
<td>77</td>
<td>354</td>
</tr>
<tr>
<td>Weiser III</td>
<td>Ca. 6000 BP</td>
<td>19</td>
<td>0</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Weiser IV</td>
<td>110 ± 20</td>
<td>27</td>
<td>2</td>
<td>86</td>
<td>395</td>
</tr>
</tbody>
</table>

Figure 4.3. Salmonid Abundance and Diversity Index Values for Each Occupation

Taphonomy and Body Part Representation

Taphonomic processes, both natural and cultural, can affect the representation of remains in an assemblage. In naturally deposited assemblages, bone density is strongly correlated with survivorship, though human activity can lower this correlation (Butler 1993, 1996; Butler and Chatters 1994). In general, bones with higher density are more likely to survive than less dense bones from the same individual. For example, it has been shown that salmonid cranial elements are more susceptible to destruction than postcranial elements due to their flatter, thinner shapes and lower density (Butler 1996; Butler and Chatters 1994). It has
also been suggested that differences in bone density result in differential preservation of certain genera, with salmonid remains more likely to deteriorate than those of cyprinids or catostomids (Butler and Chatters 1994; Chatters et al. 1995).

In addition to bone density, human use can affect body part representation because human activity, such as butchery and processing for storage, can result in differential transport and deposition of body parts (Butler 1993; Butler and Chatters 1994). Thus, different sites will have different expectations for body part representation depending on the activities that occurred there. For example, processing sites are expected to have assemblages with abundant cranial elements and few vertebrae, while those with many vertebrae and few cranial elements are thought to be evidence for the use of storage. These interpretations are based on assumptions regarding the use of fish heads, which are thought to have been more difficult to store, given high oil content, and were thus used immediately and/or discarded at processing sites. This is further supported by ethnographic observations in the Pacific Northwest, where fish heads were processed and stored independently of the rest of the trunk (Butler 1993).

Further, human processing can result in the destruction of bones of certain parts of the body more than others. Butler (1993) notes that for fish, the head and trunk differ in the location and number of bones, and yield different amounts of meat. The trunk has fewer bones and more meat that can be removed without disturbing the vertebrae, whereas the head has less flesh that requires damaging, if not destroying, the many cranial elements to access. She argues that it was often
more efficient for heads to be cooked whole and that, since cooking can damage the organic components of bone, making them increasingly fragile, this can further result in the loss of cranial elements over time.

Given this, if the assemblage is the result of an immediate use strategy (where a person catches, processes, and eats the fish all in one location) then most, if not all, of the remains from the fish should be deposited into the assemblage. Taphonomic factors, such as cooking and density mediated attrition, can affect the remains, but the densest remains should be recovered. If there is a difference in body part representation, such that even the densest cranial elements (eg, otoliths) are not recovered, then this can be indicative of human processing for storage.

The following arguments assume that the samples from each occupation represent similar behavioral patterns such that deposition of faunal material into the archaeological record was consistent through time. I do not distinguish between human behaviors that affect site formation processes, such as primary or secondary deposition (sensu Schiffer 1972).

In order to determine if there is variability in body part representation related to either taphonomic factors or butchery patterns at the site, elements were assigned to one of three categories based on their anatomical position: head, paired fins, and trunk. Morphological similarities made it difficult to distinguish vertebrae to the family level, so a joint Cyprinid-Catostomid category was used. Since head elements were typically identifiable to a particular family, assignment to Cyprinidae, Catostomidae, or the Cyprinid-Catostomid category was entirely dependent upon anatomical position (trunk elements in the Cyprinid-Catostomid category, heads in
Cyprinidae or Catostomidae). As such, I combined all remains identified to Cyprinidae, Catostomidae and Cyprinid-Catostomid to form a “local species” category to examine if body part representation differs for local and anadromous species.

This analysis shows that, for the total assemblage, there is a statistically significant relationship between taxon and body part representation, with salmonids having fewer head and more trunk elements than are expected ($\chi^2=11.676$, $p<.05$; Table 4.5). However, when the different occupations are compared, there is not a statistically significant difference in body part representation for local and anadromous species for Weiser I/II ($\chi^2=2.516$, $p<.5$) and Weiser III ($\chi^2=3.123$, $p<.5$), though there is for Weiser IV ($\chi^2=5.284$, $p<.05$). Weiser IV shows fewer than expected salmonid cranial elements, but more “local species” cranial elements than expected.

<table>
<thead>
<tr>
<th>Table 4.5. Body Part Representation (NISP) for Salmonids and Non-salmonids in the Total Assemblage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taxon</td>
</tr>
<tr>
<td>--------------------</td>
</tr>
<tr>
<td>Salmonid</td>
</tr>
<tr>
<td>Non-salmonid</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Was this pattern due to human behavior, or density? The site is interpreted as a foraging base camp occupied during spring or late summer, which we would expect to fit the expectations for immediate use rather than storage. The presence of cranial elements for local species (22% of Cypriniform remains) meets this expectation, however most of the salmonid remains present are vertebrae or vertebrae fragments (96%), with only 2 cranial specimens (both gillrakers) present.
Salmonid vertebrae have greater density values than most elements and are thus more likely to survive taphonomic processes, but they are still susceptible to destruction. Table 4.6 presents density information for the cyprinid cranial elements identified in this assemblage. These data are compared with salmonid density values for the same elements in order to illustrate that even the most robust salmonid elements (other than the otolith) are less dense than most Cyprinid elements.

In order to determine if there is a correlation between density and the recovered remains, I calculated element survivorship (%MAU) for each occupation, following Butler (1996) (Table 4.7-4.9, Figure 4.4). First, I calculated the minimum animal unit (MAU) using the MNE values I generated earlier. MAU is an MNE value divided by the number of times that element occurs in the skeleton. For example, each individual has two ceratohyals, and an MNE value of 17 results in an MAU of 8.5 for the Weiser I/II assemblage (Table 4.7). I used this value to calculate the

Table 4.6. Density comparison of Cyprinid and Salmonid elements for entire assemblage

<table>
<thead>
<tr>
<th>Element</th>
<th>Cyprinid (Gila bicolor) bone density (g/cc)</th>
<th>NISP</th>
<th>MNE</th>
<th>Salmon (Onchorhynchus tschawytscha) bone density (g/cc)</th>
<th>NISP</th>
<th>MNE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angular/Articular</td>
<td>.881</td>
<td>4</td>
<td>4</td>
<td>.20</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dentary</td>
<td>.831</td>
<td>2</td>
<td>2</td>
<td>.19</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1st vertebra</td>
<td>.821</td>
<td>10</td>
<td>2</td>
<td>.27</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Maxilla</td>
<td>.809</td>
<td>1</td>
<td>1</td>
<td>.20</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Vertebrae</td>
<td>.714</td>
<td>374</td>
<td>91</td>
<td>.34-.30</td>
<td>53</td>
<td>2</td>
</tr>
<tr>
<td>Basipterygium</td>
<td>.577</td>
<td>3</td>
<td>3</td>
<td>.11</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pharyngeal</td>
<td>.520</td>
<td>32</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Scapula</td>
<td>.509</td>
<td>4</td>
<td>3</td>
<td>-</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Coracoid</td>
<td>.460</td>
<td>0</td>
<td>0</td>
<td>.07</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Exoccipital</td>
<td>.458</td>
<td>0</td>
<td>0</td>
<td>.11</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Opercle</td>
<td>.444</td>
<td>2</td>
<td>2</td>
<td>.07</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Cyprinid data from Butler 1996, salmonid data from Butler and Chatters 1994. NISP and MNE values from all occupations included in this analysis.
%MAU by dividing the number of elements observed by the number of elements expected, based on the largest MAU value. For example, each individual has 2 cleithrums and, with an MAU of 8.5, we would expect to see 17 cleithrums in the entire assemblage. Since I only have an MNE of 2 cleithrums, the %MAU is 2/17,

Table 4.7. NISP, MNE, MAU, and %MAU values for Weiser I/II

<table>
<thead>
<tr>
<th>Element</th>
<th>Non-Salmonid NISP</th>
<th>Non-Salmonid MNE</th>
<th>MAU</th>
<th>%MAU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angular</td>
<td>3</td>
<td>3</td>
<td>1.5</td>
<td>17.6</td>
</tr>
<tr>
<td>Basioccipital</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>5.9</td>
</tr>
<tr>
<td>Ceratohyal</td>
<td>17</td>
<td>17</td>
<td>8.5</td>
<td>100.0</td>
</tr>
<tr>
<td>Dentary</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>11.8</td>
</tr>
<tr>
<td>Epibryal</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>5.9</td>
</tr>
<tr>
<td>Hyomandibular</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>23.5</td>
</tr>
<tr>
<td>Maxilla</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>5.9</td>
</tr>
<tr>
<td>Opercle</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>11.8</td>
</tr>
<tr>
<td>Palatine</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>5.9</td>
</tr>
<tr>
<td>Parasphenoid</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Quadratoles</td>
<td>8</td>
<td>7</td>
<td>3.5</td>
<td>41.2</td>
</tr>
<tr>
<td>Urohyal</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Vomer</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>5.9</td>
</tr>
<tr>
<td>Pharyngeal</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Expanded dorsal spine</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>11.8</td>
</tr>
<tr>
<td>Tooth</td>
<td>28</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cleithrum</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>11.8</td>
</tr>
<tr>
<td>Scapula</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>23.5</td>
</tr>
<tr>
<td>Basipterygium</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>11.8</td>
</tr>
<tr>
<td>Vertebrae fragment</td>
<td>178</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Vertebrae (atlas)</td>
<td>7</td>
<td>3</td>
<td>1.5</td>
<td>17.6</td>
</tr>
<tr>
<td>Vertebrae (unclear)</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>23.5</td>
</tr>
<tr>
<td>Ultimate vertebra</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>47.1</td>
</tr>
<tr>
<td>Other vertebra</td>
<td>152</td>
<td>132</td>
<td>3.43</td>
<td>40.3</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>462</strong></td>
<td><strong>193</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.8. NISP, MNE, MAU, and %MAU values for Weiser III

<table>
<thead>
<tr>
<th>Element</th>
<th>Non-Salmonid NISP</th>
<th>Non-Salmonid MNE</th>
<th>MAU</th>
<th>%MAU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angular</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>50.0</td>
</tr>
<tr>
<td>Basioccipital</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>100.0</td>
</tr>
<tr>
<td>Hyomandibular</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>50.0</td>
</tr>
<tr>
<td>Basipterygium</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>50.0</td>
</tr>
<tr>
<td>Vertebrae fragments</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pharyngeal</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Premaxilla</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>50.0</td>
</tr>
<tr>
<td>Other vertebrae</td>
<td>4</td>
<td>3</td>
<td>0.08</td>
<td>7.8</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>18</strong></td>
<td><strong>8</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4.9. NISP, MNE, MAU, and %MAU values for Weiser IV

<table>
<thead>
<tr>
<th>Element</th>
<th>Non-Salmonid NISP</th>
<th>Non-Salmonid MNE</th>
<th>MAU</th>
<th>%MAU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ceratohyal</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>50.0</td>
</tr>
<tr>
<td>Otolith</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>50.0</td>
</tr>
<tr>
<td>Vertebrae fragments</td>
<td>21</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pharyngeal</td>
<td>2</td>
<td>0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Hyomandibular</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>50.0</td>
</tr>
<tr>
<td>Basipterygium</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>50.0</td>
</tr>
<tr>
<td>Premaxilla</td>
<td>1</td>
<td>1</td>
<td>0.5</td>
<td>50.0</td>
</tr>
<tr>
<td>Other vertebrae</td>
<td>7</td>
<td>6</td>
<td>0.16</td>
<td>15.6</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>35</strong></td>
<td><strong>12</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

or 11.8%. Using the %MAU values from Tables 4.7-4.9 and the density values for the elements in Table 4.6, there is no correlation between density and survivorship for Weiser I/II ($r_s$=.464, $p>.1$). Small sample size precludes this analysis for Weiser III and IV.

While a correlation between density and %MAU could not be run for salmonids due to low MNE values (see Table 4.3), it stands to reason that if non-salmonid survivorship has no correlation with density, it is likely that salmonid survivorship would not be correlated as well. However, cyprinid and catostomid remains are denser and thus more likely to survive than salmonid remains, so density cannot be completely be ruled out as a contributing factor for salmonid survivorship (Butler and Chatters 1994; Butler 2004). Density could explain why there are fewer salmonid cranial elements in the Weiser IV assemblage, given the correlation between density and Cypriniform element survivorship during that occupation.

Further consideration for the role density played in structuring the
assemblage comes from the nature of the deposits from the Weiser II occupation. Rudolph (1995) notes that this assemblage predominately comes from a freshwater shell deposit. Shell typically is beneficial for bone preservation, thus one may question the degree to which the recovery of few salmonid remains from the Weiser II occupation stems from destruction due to taphonomic processes.

If taphonomy and recovery did not affect the number of salmonid elements, then human behavior is a probable cause. As previously discussed, human behavior can result in different elements being represented in an assemblage. Differing degrees of fragmentation can be indicative of different levels of processing for certain body parts, which can reflect processing techniques. Chi-square analysis using data for all fish shows that the level of fragmentation is dependant upon anatomical position for all occupations (Weiser I/II: $\chi^2=11.59$, p<.05, Weiser III:
\( \chi^2 = 11.013, p < .05, \) Weiser IV: \( \chi^2 = 12.271, p < .05 \). Weiser I/II has more fin elements intact than expected, while there are more cranial elements intact than expected in Weiser III and IV. Thus, it does not appear that certain body parts were discarded during processing for storage. Further, the degree of fragmentation appears to be consistent for all occupations.

Butler (1993, 1996) notes that human cooking can affect preservation by decreasing the organic components of bone. To see if this is a contributing factor, I compared patterns of burning between occupations and genera. Most of the remains recovered are unburned (Weiser I/II: 96%, Weiser III: 97%, Weiser IV: 93%). There is no difference in the degree of burning (calcined, burned black, not burned) between occupations (\( \chi^2 = 3.978, p = .409 \)), or between local and anadromous species (\( \chi^2 = 0.792, p = .673 \)). Similarly, there is no difference in the degree of burning by body part (head, trunk, paired fins) over time (Weiser I/II: \( \chi^2 = 6.066, p = .194 \), Weiser III: \( \chi^2 = 0.284, p = .868 \), Weiser IV: \( \chi^2 = 1.11, p = .292 \)). Given the patterns of fragmentation and burning, human processing does not appear to have changed between genera, body part, or over time. It is possible that most burned remains did not preserve, however if cooking processes affected density and thus preservation, we would expect already fragile cranial elements to be lost more frequently than denser vertebrae. Given the number of cranial elements recovered, it is unlikely that cooking methods resulted in the loss of elements.
Body Size

Casteel (1972, 1976) showed that there is a correlation between body size (length and weight) and vertebrae width. Given this, I used the cyprinid/catostomid regression equations presented in Casteel (1972) (Table 4.10) to reconstruct body length of ancient fish using width measurements of intact vertebrae (Figure 4.5). Vertebral width was measured to the nearest 0.01 mm three times using digital calipers, and the average of those measurements was entered into the equations.

Most of the vertebrae used for this analysis were cyprinid/catostomids from Weiser I/II (N=56). Only two vertebrae from Weiser IV (both cyprinid/catostomids) and one salmonid vertebra (from Weiser I/II) were complete enough to measure. While these are very small sample sizes, they provide a basis for study of change over time.

Overall, body size reconstruction shows that most fish were very small, ranging from 250 to 319 mm, with many specimens falling into the 280-289 mm range. While the sample size is very small for the Weiser IV occupation, it appears that cyprinid/catostomid body size did not change significantly as the specimens fall into the same size range as those from Weiser I/II. Based on the expectations from OFT discussed in Ch. 3, these body size estimates show no evidence for

<table>
<thead>
<tr>
<th>Taxon</th>
<th>Vertebra type</th>
<th>Regression equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyprinidae/Catostomidae</td>
<td>Abdominal</td>
<td>$Y = 2.6699x + 0.7883$</td>
</tr>
<tr>
<td></td>
<td>Caudal</td>
<td>$Y = 2.5668x + 0.8757$</td>
</tr>
<tr>
<td>Prosopium williamsoni</td>
<td>Abdominal</td>
<td>$Y = 2.9377x + 0.8718$</td>
</tr>
</tbody>
</table>
overharvesting or resource depression that would lead to body size decreasing over time. Similarly, the lone salmonid specimen is from a *Prosopium williamsoni*, a small bodied freshwater salmonid similar in size to resident cyprinids and catostomids. Comparison of fragmentary vertebrae with specimens of known body size suggests that the fragmentary vertebrae came from members of the genus *Oncorhynchus*. If so, this further contradicts OFT models, which predict that larger resources will be used far more frequently than smaller ones. This analysis shows that small fish were primarily being used at this site over larger, anadromous salmonids.

**Previous Analysis of the Hetrick Site Faunal Assemblage**

Rudolph (1995) describes the Hetrick faunal assemblage as primarily consisting of fragmentary mammalian remains. Using bone weight as a measure to estimate meat weight, large mammals were determined to be the primary focus of subsistence activities for all occupations, though dietary contribution from small
mammals increases in the Weiser III and Weiser IV occupations (Table 4.11). As previously mentioned, NISP values were only provided for features, not for individual strata. As such, my interpretations use data from the report for each feature.

The majority of the faunal remains are described as fragmentary, with many remains listed as “unidentifiable”. Other than Feature A, fewer than 5% of the remains from each occupation were identifiable to the family level. Many mammalian remains were identified only to size-class, predominately small and medium mammals. Most remains were unburned, and less than ten percent of the remains from each feature were subject to rodent gnawing (with the exception of the IIId bone layer, at 10.1%).

### Table 4.11. Comparison of Percent of Dietary Contribution

<table>
<thead>
<tr>
<th></th>
<th>Fish</th>
<th>Bird</th>
<th>Small Mammal</th>
<th>Large Mammal</th>
<th>Total</th>
<th>Fish</th>
<th>Bird</th>
<th>Small Mammal</th>
<th>Medium Mammal</th>
<th>Large Mammal</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weiser IV</td>
<td>2</td>
<td>4</td>
<td>29</td>
<td>65</td>
<td>100</td>
<td>71</td>
<td>3</td>
<td>19</td>
<td>7</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Weiser III</td>
<td>6</td>
<td>12</td>
<td>35</td>
<td>47</td>
<td>100</td>
<td>40</td>
<td>17</td>
<td>32</td>
<td>10</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>Weiser II</td>
<td>4</td>
<td>12</td>
<td>19</td>
<td>65</td>
<td>100</td>
<td>35</td>
<td>0</td>
<td>52</td>
<td>4</td>
<td>9</td>
<td>100</td>
</tr>
<tr>
<td>Weiser I</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>94</td>
<td>100</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Most of my arguments based on my analysis rely on the percentage of dietary contribution as represented by NISP (see Figure 4.6). This method operates under the assumption that presence in an archaeological assemblage accurately indicates the level of use by site inhabitants. As such, faunal categories with the most remains present are thought to have had greater economic value than categories with fewer
remains present. My calculations of dietary contribution differ greatly from those presented by Rudolph (1995) (Table 4.11). This is largely due to the quantitative methods used in both analyses, which can result in very different interpretations of resource use.

As previously discussed, NISP is subject to problems of fragmentation resulting in over-representation. Further, Lyman (2008) notes that NISP can overestimate the number of individuals represented by a faunal assemblage due to differences between taxa, including bone frequencies and differential preservation (e.g., different bone densities). These problems can result in inflated representation of certain taxa, which can skew any interpretations using these data. Lyman (2008) also states that a single bone from one taxon can represent a larger contribution of meat than the same bone from another taxon, or even a lower utility part from

![Figure 4.6. Contribution of Faunal Categories to Assemblages (Using NISP)](image-url)
the same individual. This can cause problems for interpretation, because a few
bones from one taxa or one part of the body may contribute more to the diet than
many bones from another taxa or body part. Because of these shortcomings, other
analytical methods have been developed in an attempt to calculate accurate
representations of abundance and diversity, such as the use of bone weight to
estimate meat weight used by Rudolph (1995).

While bone weight does not have the same challenges as NISP, there are still
problems that can arise from using bone weight to estimate meat weight
contribution to the diet. Lyman (2008) notes that there are various calculations for
converting bone weight into meat weight which must take many variables into
account, including the amount of usable meat for each species depending upon an
individual’s age and sex and the butchery practices used. Other variables must also
be considered, such as differential preservation and what percentage of an
organism’s live weight is represented by dry bone weight recovered
archaeologically. There are numerous methods for calculating each of these
variables, and each calculation results in a different bone-weight-to-meat-weight
conversion. Lyman argues that due to the degree of inter- and intraspecies variation
that must be considered, there is no set way to determine the best conversion factor
for this type of analysis.

Given the fragmentary nature of this assemblage, it is possible that species
representation can be affected by the problems inherent to NISP. In order to control
for this, unidentifiable remains were omitted from calculations for Figure 4.6,
though mammalian size-class data were included. Given the size of many medium
and large mammals, there is a greater chance that their remains would be identifiable to size class, even when fragmentary. As such, the prevalence of smaller taxa in dietary contribution using NISP suggest that problems with NISP are of less concern than using bone and meat weight estimates.

**Summary**

There is a significant difference in the distributions of specimens for each family through time. Despite its large sample size, the Weiser I/II occupation has far fewer salmonids than would be expected, and the two later occupations have far more salmonids relative to local taxa than would be expected. This pattern does not appear to be due to sample size or recovery methodology. While density may be a factor in preservation, there is no correlation between density and element survivorship, so it is not likely to be the root cause. Body size regression shows that cyprinid/catostomid body size does not appear to change over time, and that small fish species were being exploited during the Weiser I/II and IV occupations.
Chapter 5. Discussion

The Debate Over Fish Use

There is a debate over the degree and nature of fish use in archaeological research in the Snake River Canyon (Gould and Plew 2001; Plew and Plager 1999). One side of the debate argues that the increased use and storage of salmon was the basis for the emergence of the WVP, while the opposing hypothesis argues that there was year-round fishing that focused on the short-term procurement of a number of taxa, including, but not limited to, salmon. If found to be true, the latter hypothesis could be used to support arguments that small populations could be sedentary without the use of storage seen in ethnographic times (eg., Chatters 1995). Proponents for the latter hypothesis argue that salmon were not a favorable resource, given the amount of time and labor it takes to process enough salmon to last throughout the winter. These scholars argue that many alternative resources give similar returns but do not have the temporal restrictions on acquisition and processing that salmon harvest and storage would entail (Gould and Plew 1996).

Settling this debate has been problematic due to various limitations with the archaeological record of the Snake River and because there is a lack of systematic analysis of faunal remains, particularly from fish. Of the sites that have been studied, few sites show evidence of fishing, either fish remains or fishing gear, and those that do are mostly from occupations within the past 1,500 years (Plew 2009; Plew and Plager 1999). This is illustrated in the Appendix, which combines data from a number of published studies of fish use over the last 8,000 years.
The Hetrick site shows fish use throughout the Holocene, and can be used to address this debate. Figure 4.6 shows that fish use was common at the site over the entire Holocene. However, fish increased from 40% to 70% in the most recent occupation, Weiser IV. Within these assemblages, there is change over time in the species representation in each assemblage, as discussed in Chapter 4. Schalk (1977) notes that explanations for subsistence system compositions must be concerned not only with the extent to which various resources are exploited, but also with why certain resources are used, and why others are not. This is particularly of interest given the large time gaps between occupations at this site.

Davis (2007) argues that issues with preservation make it unlikely that a representative picture of salmonid use can be attained using NISP. He states that human behaviors, such as off-site disposal of filleted carcasses, on-site feeding of salmon parts to dogs, and secondary processing of skeletal elements through cooking would result in the destruction of salmonid remains (Davis 2007:254). As such, salmonids would be under-represented and any arguments for evidence of salmonid use are biased. However, this analysis shows that, though they likely affected representation to some degree, issues of taphonomy did not structure this assemblage.

Low density values for salmonid cranial elements may have resulted in few of these elements being recovered, however the small sample of denser vertebrae (similar in density to cyprinid/catostomid remains that were recovered) suggests that salmonids may not have been used as frequently. As such, I feel that NISP is a
more valid measure than meat weight given current analytic techniques and the shortcomings of the bone- and meat-weight methods previously used.

That the relative salmonid abundance increases in the Weiser III assemblage from Weiser I/II suggests salmon use has increased during this occupation, though not dominating the assemblage. It is important to note that, due to small sample size, my conclusions for Weiser III are tentative. For this study, I operate under the above assumption in order to use these data to address the debate over fish use on the Snake River. Here, I compare Hetrick records that show increase in salmon use in Weiser III (ca. 6000 BP) and IV (3000-300 BP) with the timing of regional demographic change, technological change, and paleoclimatic change.

**Demography & Technology**

Chatters (1995) develops a chronology that describes subsistence strategies and mobility patterns for the Southern Columbia Plateau over the course of the Holocene. His Late Cascade phase (6800-4400 BP) consists of only residential sites and locations with faunal assemblages dominated by seasonally specific resources and little evidence of storage. He argues that this indicates the inhabitants were small groups of highly mobile foragers. Population numbers remain low throughout this phase, but begin to increase at the beginning of Pithouse I.

The Pithouse I phase (4400-3900 BP) has evidence for semi-subterranean dwellings located only in optimal areas that would provide year-round resource availability (Chatters 1995). These sites have even assemblages, which Chatters argues is evidence of an encounter, rather than a pursuit strategy of resource
acquisition, and many of these assemblages show evidence of reliance on smaller, non-salmonid fish and mammal species. At the end of this phase population numbers decrease, which Chatters attributes to a lack of storage technology that would allow for adaptation to an increasingly seasonal environment. In contrast, the Pithouse II phase (3500-2200 BP) shows evidence of a complex pursuit-based logistical strategy focusing on large ungulate, salmonids, river mussels, and roots (Chatters 1995). Site types expand to include seasonal base camps, field camps, and locations, and population numbers peak at the end of the phase.

Chatters (1995) notes that the ethnographic pattern, focusing on the exploitation of salmonids for winter storage, appears to have begun ca. 2,200 BP. This coincides temporally with Plew’s (2009) analysis of diet breadth on the Snake River Plain. Plew argues that fish, and salmonids in particular, were rarely used during the Early (8,000-5,000 BP) and Middle Archaic (5,000-2,000 BP), but are ubiquitous in assemblages from the Late Archaic (2,000-150 BP). While these two studies differ on the nature of fish use prior to 2,000 BP, they agree that after 2,000 BP fish use increased drastically.

Rudolph (1995) dates the Weiser IV occupation to 3,000-300 years BP on the basis of both radiocarbon dates and the presence of diagnostic tool types. Given the drastic increase in fish use during this occupation (Figure 4.6), as well as the increase in salmonids, this assemblage seems to fit an increase in fish use during the Late Archaic, though it also shows fish being used frequently in previous occupations.
My analysis shows an increase in salmonid use during the Weiser III occupation (Figure 4.2, Table 4.3), which Rudolph (1995) dated to ca. 6,000 BP using a Cascade point. Figure 5.1 shows the radiocarbon date ranges for the occupations at the site, along with the timing of sedentism in the Southern Plateau. This shows that salmon use at the Hetrick increased during Chatters’ (1995) Late Cascade phase and in subsequent occupations. It is important to note that while there was an increase in use at this time, salmonids do not dominate the fish assemblage during any occupation - a pattern contrary to predictions if intensified salmonid use led to increased sedentism. Further, if there was a correlation between increased salmonid use and sedentism, either increased salmonid use leading to sedentary lifestyle, or vice versa, we would expect to see evidence appearing closely together in time. Using this chronology as a basis, there is no clear correlation between the increased use of salmonids at this site and the regional implementation of storage, sedentary dwellings, or increasing population.

Notably, since I was unable to attain a radiocarbon date from the sample submitted for Weiser III, this interpretation is based solely on the dating of this occupation using a diagnostic projectile point in Rudolph (1995). Cascade points typically appear in assemblages ranging from 8,500-4,500 BP. If one were to use the very latest date for the Cascade point to date Weiser III, then there would appear to be similar timing between the increase in salmonids and the very earliest evidence of sedentism on the Southern Plateau (Ames 2000, see dashed line in Figure 5.1). However, even if there was a correlation between the timing of these two events, the lack of storage at sites showing early evidence of semi-sedentism does not
match arguments for increasing use of salmon leading to the WVP. Even with the very latest date for the Cascade point, the Weiser III occupation predates the earliest evidence of storage by 1,000 years.

Figure 5.1. Hetrick Site Mean Radiocarbon Ages Arrayed Against Regional Culture Units¹

¹Radiocarbon date ranges from this analysis are overlaid by Chatters’ (1995) Pithouse chronology. Dashed line indicates earliest possible evidence for semi-sedentism in the region (based on Ames 2000).

While it is important to note that Columbia Plateau groups do not fall strictly at one end or the other of Binford’s (1980) spectrum, if increased use and storage of salmonids led to sedentism and the WVP, we should see a closer temporal
relationship between these developments than that which is seen here. As such, the Hetrick assemblages do not directly support arguments for increasing salmonid use leading to the development of the ethnographic Winter Village Pattern.

**Paleoclimate and Optimal Foraging Theory**

As previously discussed, paleoclimate can drastically affect salmonid populations. Poor climatic conditions can result in decreased abundance of salmonid populations, which in turn may result in decreased use by prehistoric human populations. Given the suggestion that climatic conditions during the Holocene would have been challenging for salmonids (see Table 2.1), it is plausible that salmonids were used infrequently during the earliest occupations of the Hetrick site (Weiser I and II) because of low abundance. Even though some of the climatic models come from the Columbia River region, they are relevant to this discussion because if paleoclimate results in a poor year for salmonids on downstream rivers, the effect on upstream rivers will likely be the same, if not worse (Schalk 1977). However, decreased abundance due to inhospitable climate may not be the only reason why salmonids were not used in the past.

Foraging models predict that large-bodied salmonids should have higher rank relative to smaller-bodied local salmonids, however low abundance can increase pursuit costs. If encounter rates with high-ranked prey decrease, foragers will either move, travel farther to procure high-ranked resources, or expand diet breadth. This site suggests a broad-scale diet, given the prevalence of cyprinids and catostomids in the early assemblages. It is probable that mass capture of smaller
bodied local species would increase their rank and result in frequent use, relative to salmon, as suggested by the Weiser I/II assemblage.

Another factor that could elevate the rank of resident freshwater fish relative to salmonids relates to declining caloric and nutritive value of salmonids with inland migration. Many scholars believe salmon was not as important on inland tributaries, such as the Snake River, as it was on the Columbia because these tributaries are a great distance inland (Gould and Plew 1996; Plew 1983; Schalk 1977). Since salmon do not eat once they have begun spawning, they rely entirely on stored energy and fat deposits to fuel their inland migration (Love 1970; Gould and Plew 1996; Plew 1983; Schalk 1977). Love (1970) notes that spawning salmon deplete up to 99% of their stored lipids and up to 72% of their protein content, at the same time increasing the water content of their tissues. For anadromous runs on inland rivers, such as the Snake, increased distance travelled to spawn would result in decreased nutrients available to inland human populations. Thus, Plew (1983) suggests “ethnohistoric accounts may more correctly reflect the abundance of the resource than its quality” (63), suggesting that ethnohistoric subsistence focused on salmonids because they were abundant, not because they provided the best caloric returns.

Along with aspects of poor nutrition, Snake River salmon runs had a tendency to fail, even during ethnographic periods of apparent abundance. Steward (1938) notes:

The Snake River is unique in having salmon, but their quantity and quality were somewhat less than nearer the coast. When running, the fish were sufficiently abundant to supply all who could take them. The
main limitation on them was their occasional failure to run and the restricted number of convenient fishing places... (238).

Fish runs were much smaller on major rivers, such as the Columbia and the Snake River, from 8000-6000 BP, and individual fish may have been smaller (Chatters et al. 1995; Neitzel et al. 1991; Plew and Plager 1999). Schalk (1977) argues that exploitation of upstream runs may be disadvantageous. Not only are upstream runs less productive, he notes that downstream groups are exploiting runs, potentially decreasing the number of individuals available to successfully reach upstream spawning habitats and fishing locations. Further, if conditions are poor on rivers downstream, this effect is likely for rivers upstream as well.

Further, one must consider processing and handling times for salmonids and other available resources. Temporal and spatial aggregation of salmonids means that processing must occur concurrently with harvest, lest spoilage occur (Plew 1990; Schalk 1977). Plew (1990) argues that there are alternative subsistence strategies that have equal, or greater, nutritional value while having lower acquisition and processing costs. He notes that harvesting and processing Snake River salmon may require 40-45 days, and that nearly twice as much salmon may be required to survive a winter than on the Columbia Plateau. He bases this argument on nutritional deficiencies, expected loss of stored resources (due to scavengers or physical conditions), and the usable percentage of each carcass. In comparison, other resources, such as camas, have longer collection time, minimal preparation, simple storage, and a larger percentage of the resource is usable.
Even without use of storage, these arguments all suggest that salmon would have had very low rank during the earliest occupations at the Hetrick site. It is highly improbable that foragers would focus on the pursuit of an unpredictable resource with low abundance and low nutritional value when other resources were available. Thus, the low contribution of salmonids to the earliest Hetrick assemblages makes sense. Instead, we expect that the pursuit of smaller-bodied local species with more stable populations using mass capture techniques would result in higher return rates per energy expended (Madsen and Schmitt 1998; Ugan 2005). It is possible that the presence of a few salmonid remains in the Weiser I/II assemblage is the result of opportunistic capture while in pursuit of other resources.

While there are many explanations for why salmonids were rarely used in the earliest occupations, it is more difficult to explain why salmonid use increased in the Weiser III occupation. Nutritional depletion is a factor dependent upon salmonid behavior and the distance travelled upstream. Assuming that salmonid behavior regarding feeding while spawning remains the same, and given that distance travelled should not have changed significantly, the level of depletion should remain the same throughout all occupations and is thus not likely a deciding factor.

Stability of runs, while also partially dependent upon the distance travelled upstream, is also susceptible to changes in climate. Similarly, salmonid abundance is also related to climatic conditions. It is possible that increased abundance and decreased risk of run failures may increase the rank of salmonids and thus their use and presence in the archaeological record. Given this, we can expect that improvements in paleoclimatic conditions will result in increased salmonid use.
However, if environmental factors alone determine which subsistence strategies will be used, any changes in resource use should immediately follow changes in climatic conditions (Chatters 1995).

Climatic patterns were highly variable throughout the Holocene, which can strongly affect salmonid abundance. This assemblage shows increased fish use at ca. 6,000 BP, during a period of warm and dry climatic conditions that would not be conducive to salmonid survival. This time period is not consistent with regards to climatic conditions; Chatters and Hoover (1992) note a cooler, moister period 7800-6500 BP, and Chatters (1995) notes that conditions were cool and moist with delayed and prolonged freshets beginning ca. 5500 BP. Other sources note trends toward cooler, moister conditions beginning around the time of the Weiser III occupation (Walker and Pellatt 2008). Cannon (1996:30) notes “long term gradual improvement in environmental conditions could lead to relatively rapid increase in fish abundance once some critical threshold was achieved”. As such, it is possible that these ameliorating climatic conditions may have been enough to increase salmonid abundance to the point where they became more profitable to exploit.

However, resource abundance does not strictly result in resource use. It is possible that within this time period, changing conditions may have created a more favorable environment for exploiting salmonids. Hicks (2004) notes that in warmer conditions, there are fewer salmon available but those that are present are in the rivers for a longer period of time. In contrast, cooler conditions result in abundant salmonids with a more predictable annual cycle, however they are available for a more restricted period of time. If, during this period of transition around 6000 BP,
salmonid abundance increased but runs lasted longer than during periods of more seasonal climate, it is feasible that exploitation could be more favorable than it was in the past, simply due to availability and increased encounters. Butler and Schalk (1986) suggest that if salmon were available throughout the year, human groups should be able to consume salmon as they were caught, which may have made salmon a more attractive resource.

Plew (2009) argues for another possible explanation related to paleoclimate and its role in the timing of increased salmon use at Snake River sites. As seen in Table 2.1, paleoclimatic conditions prior to 6000 BP were poor for artiodactyl populations as well, as increased aridity decreased the amount of available forage. Plew argues that this would result in an aggregation of artiodactyls near water, and that strategies focusing on exploiting these large mammals could provide an opportunity to add aquatic resources to the diet. Similarly, Hicks (2004) notes that seasonal restrictions would have kept large mammals at lower elevations, near residential bases along rivers and streams. This may have allowed groups to stay in one place longer, delaying the need to move on to the next resource.

This shift in habitat could offset the costs associated with changing subsistence practices. If large mammals lured groups to focus on riverine habitats, aquatic resources could be added to the diet as diet breadth expanded, and they may have become a more important resource through time. As conditions improved and salmon became more abundant, people already focusing on that resource patch could procure them more frequently. Hicks (2004) notes
If forager diet had become somewhat dependent on fish, adaptations that could include high volume harvest and storage to maintain the relative amount of fish in the annual diet can be hypothesized as part of a transition to a collector strategy (417).

Altogether, these hypotheses suggest that groups could be semi-sedentary without the need for storage, until it became necessary with the advent of climatic conditions with increasing seasonality. As climate changed, these groups may have developed storage (as in Pithouse II) and begun to exploit increasingly abundant salmonids along with other fish, though Hetrick suggests salmonids were still not a primary focus of the diet.

**Hetrick and Other Early Sites on the Snake River**

As previously noted, past studies suggest that a semi-sedentary mobility pattern may have been developed by inhabitants using a foraging subsistence strategy (Chatters 1995; Lohse and Sammons-Lohse 1986; Prentiss and Chatters 2003). Archaeological evidence suggests that fishing was not a primary subsistence focus before ca. 2000 BP; most sites show evidence for subsistence strategies focusing on the exploitation of large mammals. After 2000 BP, climatic conditions were similar to today and salmon runs became more like historic runs (Butler and Schalk 1986; Plew 2009; Plew and Plager 1999). Evidence for fishing also increases, with many sites from after 2000 BP found in riverine habitats and salmonid remains much more frequent in regional archaeological assemblages (Plew 2009; Plew and Plager 1999; Figure 5.2).

To evaluate some of these claims against Hetrick and other Snake River sites, I compiled fish faunal records from twenty-six published sites located along the
Snake River, including Hetrick, that had fish remains present (Appendix; Figure 5.2, 5.3). Fish remains are grouped by family as salmonids, cyprinids, catostomids, cyprinid/catostomids, *Acipenser* and generic categories such as “non-salmonids” and “unidentified fish”. NISP values are provided for many sites, though only presence/absence is noted for some. When mentioned, screen size was recorded for comparison of different recovery strategies. Radiocarbon dates were also listed when given, otherwise common dates (eg., post-AD 1000) listed in sources were used. To compare fish representation over time, sites were divided into 1,000 year increments based on mean radiocarbon ages or mean age range (Figure 5.3). For sites with multiple occupations, NISP values were assigned to individual occupations using information provided in the original reports so that values were not counted multiple times (eg., Kirkwood Bar-Occupation I, Marmes- Rockshelter Stratum I in the Appendix). For sites with one occupation over a long time period NISP values were assigned to thousand year increment containing the averaged date (eg. 2000-150 BP, average date is in the 1000-2000 BP increment).

While comparing these records is problematic due to different recovery and reporting methods for each site, as well as the number of sites for each age, a general trend shows few salmonids in records for sites from the Early Holocene, with salmonids dominating NISP values after 2000 BP. This is very similar to the patterns seen in the Early Holocene assemblage at Hetrick. One possible reason for the dramatic change in fish use seen in Figure 5.3 is changes in site use across the region, as well as within sites with multiple occupations throughout the course of the Holocene. It is possible that changing site use could result in the use of different
species, as well as different behaviors leading to site formation (e.g., different disposal behaviors at different sites).

Perhaps what is most interesting about the Hetrick site is in the Early Holocene assemblage. As seen in Figure 5.3, Early Holocene sites in the region show evidence of small-bodied, local fish exploitation prior to 6,000 BP. While not providing specific NISP values, Lohse and Sammons-Lohse (1986) note that suckers and minnows were twice as abundant as salmonid remains at a pithouse site dating to ca. 5200 BP. There are few Early Holocene sites in the region with evidence of fish use, however four sites show patterns very similar to those seen at Hetrick: Marmes Rockshelter (Butler 2004; Hicks 2004), Kirkwood Bar (Reid and Chatters 1997), and Bernard Creek Rockshelter (Randolph and Dahlstrom 1977) (Figures 5.2-5.5).

Kirkwood Bar has three occupations at 6890, 6850, and 6740 BP that show fish were the primary resource used at this site, though there is variation in which taxa dominate the assemblages depending upon which analytic method is used (Reid and Chatters 1997). Using NISP, Cypriniformes dominate all three occupations (97.4%, 94.3%, and 80%, respectively), though salmonid NISP increases slightly in Occupation 3 (6890 BP). Using MNI, Cypriniformes dominate the assemblage in Occupation 1 (85%), but their representation decreases in Occupation 2 (62%) and Occupation 3 (45%).

This pattern is attributed to taphonomic factors and differences in salmonid, cyprinid, and catostomid bone density (Reid and Chatters 1997). The authors point out that salmonid bones are less dense and are thus likely under-represented by NISP. However, MNI values were calculated using salmonid otoliths,
Figure 5.2. Map Showing Locations of Snake River Sites With Recorded Fish Remains

1=Hetrick, 2=35ML1328, 3=35ML1379, 4=Marmes Rockshelter (both localities), 5=Bernard Creek Rockshelter, 6=Kirkwood Bar, 7=Bachman Cave, 8=Dry Creek Rockshelter, 9=10CN1, 10=10CN5, 11=10CN6, 12=10CN9, 13=Midden Site (10AA306), 14=Schellbach Cave (10OE240), 15=Swan Falls (10AA17), 16=10EL3031, 17=Bonus Cove Ranch (10OE269), 18=10EL392, 19=Kanaka, 20=10TF352, 21=10GG1-81, 22=10EL1577, 23=10EL294, 24=10EL22, 25=10GG191, 26=Nahas Cave
Figure 5.3. Fish Representation (NISP) in Regional Assemblages (Based on Data Compiled in Appendix)
which are very dense (1.41 g/cc) and thus more likely to survive than even the
densest cyprinid or catostomid remains, which are thus likely under-represented
using MNI. The authors argue that the “proportionate representation of salmonid
and non-salmonid fishes in the original assemblage lay somewhere between the
values we have for MNI and NISP” (Reid and Chatters 1997: 4.17).

In addition to NISP or MNI, Reid and Chatters (1997) estimate live body
weights for salmon, suckers, and minnows. These estimates suggest that salmon
should have been the most important fish at Kirkwood Bar based on contribution to
the diet. While the exact representation of each taxon is unclear, I use the NISP
values provided by the authors so that comparisons can be made with other regional sites (Figure 5.5).

In contrast to Kirkwood Bar, Bernard Creek Rockshelter (7250 BP) shows a subsistence strategy focusing on large mammals, predominately deer and mountain sheep (Randolph and Dahlstrom 1977). It is difficult to estimate the use of fish and mammals in the diet given non-comparable volumes, however the site contained abundant fish remains. Of 1828 remains recovered, only 498 were identified. Of these, 220 were salmonid, while 278 were non-salmonid (local suckers and minnows). Only remains from Block 1 were analyzed, as such change over time could not be determined for this site. Despite this, the proportion of salmonid and non-salmonid remains shows nearly equal representation in the Middle Holocene, a trend that is similar to that seen in the small Weiser III sample at Hetrick.

Marmes Rockshelter consists of two localities: the rockshelter (earliest date at 11,230 BP) and the floodplain (earliest date at 10,570 BP). The faunal assemblage for both localities shows evidence of a foraging strategy exploiting large and medium mammals, fish, and shellfish during the early occupations (Hicks 2004). Later occupations have fewer remains of large and medium mammals and shellfish, with the assemblage primarily consisting of fish and small mammals. While Marmes had very different recovery methods from Hetrick (e.g., use of ¼” mesh in the rockshelter locality, <1/8” mesh in the floodplain), the similarities between these fish assemblages are noteworthy.

Butler (2004) notes that small, freshwater fish dominate fish remains from the earliest occupations of the Marmes floodplain. Body size reconstruction shows
that mean cyprinid/catostomid vertebrae width was 6.1 mm for early Rockshelter deposits, and 1.91 mm for floodplain deposits. This is very similar to the mean vertebrae size from Hetrick, which was 2.04 mm for vertebrae from Feature E (n=57). Rockshelter deposits at Marmes show salmon remains increasing relative to
freshwater fish 2 to 1 around 6000 BP, though the sample size is small. This is particularly interesting given the similar timing of salmon increase seen at Hetrick, although Hetrick deposits beginning at 6000 BP have an equal representation of salmonid and non-salmonid remains. Non-salmonids then increase in the most recent assemblage, dominating the recovered fish remains. While these two assemblages differ in the degree of fish use over time, it is noteworthy that fish use changed around the same time. Hicks (2004) notes that this pattern disagrees with regional trends that suggest climatic and environmental change led to changes in subsistence strategies due to resource stress, also similar to the patterns seen here for the Hetrick assemblage.
Chapter 6. Conclusions

Re-examination of the Hetrick site fish assemblage suggests a different pattern of subsistence over the course of the Holocene than is presented in the original report by Rudolph (1995). Using NISP values, fish appear to have contributed significantly to the diet in all occupations except for the Weiser I/II occupation in the Early Holocene. The Weiser I/II occupation, also from the Early Holocene, consists primarily of small bodied, freshwater fish, with little to no salmonids. A number of factors may have contributed to infrequent salmon use during this occupation, such as low abundance due to poor paleoclimatic conditions. Despite small sample size, salmonid use appears to have increased during the Weiser III occupation (ca. 6000 BP) with no apparent correlation between changes in paleoclimate, settlement patterns, or technology.

Perhaps what is most interesting about this site is that it is very similar to other sites from the Early and Middle Holocene in the Middle Snake River in terms of the exploitation of small, resident fish species. The only other contemporary sites from the region with evidence of fish use also have evidence for many small, resident fish being exploited before 6000 BP. Even more interesting, one of these sites, Marmes Rockshelter, shows increased salmonid use at the same time as Hetrick. The timing of this increase is curious since it occurs before optimal climatic conditions for salmonids are established ca. 4000 BP.

Few other sites in the Middle Snake River region show evidence of fish use before the Late Archaic, ca. 2000 BP. Further research is needed to ascertain the nature of fish use in the Early and Middle Holocene. Zooarchaeological analyses of
fish remains need to be reported consistently, with raw data (e.g., NISP, descriptive summaries) included for use in future analyses. Of upmost importance, consistent use of 1/8” screen mesh and smaller is essential to the recovery of extremely small remains that accurately represent fish assemblages. Without the bulk samples and fine screen processing used at Hetrick, the evidence for the use of small fish seen here would have been lost.

Additional analyses can also benefit from more systematic analyses and discussions of fish use on a regional scale. For example, when discussing the presence of small-bodied fish at Marmes Rockshelter, Butler (2004) notes few studies present body size estimates that allow for comparisons. This information can be invaluable for discussions of resource depression, mass capture methods targeting specific body sizes, and other topics. Body part representation data is also important when considering issues from taphonomy to butchering patterns. Finally, more radiocarbon dates from sites on a regional scale are needed to refine when changes in fish use occurred, as well as when changes in settlement occurred in order to address larger regional questions.
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### Appendix. Snake River Sites with Fish Present

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<th>Cat</th>
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<th>Acip</th>
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