ISLANDS IN THE STREAM: SEARCHING FOR STRUCTURE IN THE ABORIGINAL FISHERY ALONG THE SNAKE RIVER

by

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A thesis

submitted in partial fulfillment

of the requirements for the degree of

Master of Science in Interdisciplinary Studies

Boise State University

May 2010

BOISE STATE UNIVERSITY GRADUATE COLLEGE

DEFENSE COMMITTEE AND FINAL READING APPROVALS

of the thesis submitted by

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Thesis Title: Islands in the Stream: Searching for Structure in the Aboriginal Fishery Along the Snake River

Date of Final Oral Examination: 07 April 2010

The following individuals read and discussed the thesis submitted by student Travis Jay Pitkin, and they evaluated his presentation and response to questions during the final oral examination. They found that the student passed the final oral examination.

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ACKNOWLEDGMENTS

I wish to thank the members of my thesis committee, Dr. Mark Plew, Dr. David Wilkins, and Dr. Ken Reid, for their patience and encouragement throughout this process. Their advice, instruction, and thoughtful conversations are greatly appreciated. I'm grateful to each for their time, efforts, and their willingness to guide me to this point.

Thank you also to Dr. Chris Hill who provided advice and support along the way. Barbara Valdez made timely reviews of the manuscript and offered editorial comments. Although all of their constructive criticisms have greatly improved the quality of this thesis, any errors are mine alone.

I'm most indebted to my wife and sons. They have been buoys when I sank and beacons when I was lost. Thank you Beth, Spencer, and Cameron, for your patient love, gentle nudges, and unwavering support.

ABSTRACT

The ethnographic literature describing indigenous groups that traditionally inhabited the course of the Snake River commonly cites anadromous fish as an integral and seasonal part of their subsistence pursuit. This study maps known fishing sites and associated landscape variables along the Snake River. A Geographic Information System (GIS) is used to analyze known fishing sites within the framework of surrounding physiographic features as they related to fishing strategy, salmon behavior, and decisions regarding fishing site selection. Examining the immediate stretch of adjacent river, relevant physiographic features are identified, inventoried, and their intervals recorded. The locations of Snake River fishing sites are studied as geographically dependant phenomenon in order to quantify associations with background variables, and ultimately predict aboriginal salmon harvest locations. The results indicate that three background variables conditioned aboriginal fishing site selection. Islands, rapids, and falls are associated with fishing site locations to the greatest degree.

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CHAPTER 1: INTRODUCTION

This study maps known fishing sites and associated landscape variables along the Snake River. A Geographic Information System (GIS) is used to store, sort, analyze and visualize known fishing site locations in a framework of surrounding physiographic features. Through an examination of the immediate stretch of river adjacent to a fishing site, certain physiographic features are identified, inventoried, and their intervals recorded. Ultimately, fishing sites locations may be predicted by their degree of association with terrain features as they relate to fishing strategy, salmon behavior, and decisions regarding how the landscape shapes fishing site selection.

When describing aboriginal life along the Snake River corridor, the ethnographic literature commonly cites fishing, and particularly salmon fishing, as an integral and seasonally predominant part of the local subsistence strategy (Fowler 1986; Hewes 1998; Landeen and Pinkham 1999; Liljeblad 1957; Marshall 1977; Murphy and Murphy 1986; Steward 1938; Spinden 1964; Walker 1998). Such literature identifies three major runs (spring, summer and fall) of anadromous fish in the Snake River basin as underwriting large-scale salmon procurement. A hallmark of the historic inhabitants of the Snake River is extended winter encampments along the river (Murphy and Murphy 1986; Steward 1938; Walker 1998). This defining characteristic and common ethnographic observation depended on the caching of surplus anadromous fish for winter use. While such ethnographic and historical descriptions are limited to the early historic period, beginning with observations of the Corps of Discovery in the early 19th century, the fishing techniques and practices represent the end results of adaptation throughout the Holocene (Gard 1992; Hewes 1998; Walker 1967). These techniques and practices, including netting, spearing, and trapping, are assumed here to have been shaped in part by local physiographic variations. For example, turbulent and shallow sections of the river make the use of nets impractical. Instead, these types of locations lend themselves to the efficient use of fish spears, composite harpoons and leisters. Furthermore, narrow areas at lower flows would be suitable for trapping by way of weir construction. Conversely, areas of the river too deep or wide for the use of spears and harpoons or weirs could have been fished with nets. Local physiographic features can also vary seasonally, potentially altering fishing techniques at a particular location. For instance, fishing with nets may have been more effective at high flows during spring migrations, whereas summer and fall migrations during lower flows may have been intercepted more efficiently in certain areas by spearing and trapping. Using a Geographic Information System (GIS) as a tool to store, manipulate, display and analyze geographically dependant phenomenon, this study identifies and evaluates the importance of physiographic setting in fishing site selection by correlating fishing evidence with the presence of, and proximity to, certain physiographic features.

If large-scale salmon procurement were as important as the ethnographic descriptions would have us believe, an archaeological signature or pattern along this river corridor might be expected. However, available archaeological evidence for a heavy reliance on salmon is not commensurate with these descriptions (Gould and Plew 1996; Johnston 1987). The lack of archaeological evidence may be attributable, to a degree, to certain processing techniques as described by Ray (1933), Post (1938) and others, where the separation of bones from meat was a common practice. Scavengers and the organic nature of fish bone and many fishing implements also help to erase their archaeological signature. Further, as noted by Nelson (1969) when fishing during summer and fall migrations at lower flows, much of the initial processing, (i.e., separating bone from meat) may have been completed in areas inundated at higher flows, washing away much of the osteological evidence. Also, Plew (2009:29) points out that data recovery methods, such as dry screening through hardware mesh greater than ⅛ inch, prior to the late 1970's may inadequately represent fish bone among excavated faunal assemblages.

Given the discrepancy between ethnographic descriptions and the archaeological evidence for fishing along the Snake River, one may question the importance of salmon to peoples living along this corridor. However it is neither the aim of this study to argue the intensity of salmon use, nor to define the position of various hunter-gatherer populations along the Forager/Collector continuum (Binford 1980). No previous studies have systematically analyzed existing landscape data to predict possible fishing site locations along the course of the Snake River.

Toward this end, a Geographic Information System (GIS) is used to evaluate relationships along the Snake River between selected physiographic features and archaeological sites that retain traces of the cultural use of anadromous fish. Available archaeological data are assessed in terms of background variables, quantifying topographic and hydrographic features that may condition fishing site selection. Such results provide a basis for modeling where other aboriginal fishing may have taken place. Archaeological evidence for salmon fishing being scarce, predicting fishing locales must begin with known locations. Points of fish harvest, collection, or interception are assumed to be situated nearby but not necessarily to coincide with locations having salmon bone or other evidence of fishing. A critical factor in salmon fishing with the goal of storage for later use was the ability to quickly preserve bulk harvests of fish before they began to spoil (Hewes 1998). Given this factor of time, harvest locations and sites with fishing evidence should be in close proximity to one another. Therefore, a view from a location with known salmon fishing evidence would likely include the targeted point of interception.

Sixty archaeological sites were selected based upon certain evidence criteria: sites containing fish bone and features and artifacts generally associated with salmon fishing. The set spans the study area, divided into three separate sections: the Middle Snake River (17 sites), Hells Canyon (8 sites), and the Lower Snake River (35 sites) (Figure 1). Using GIS the sites are examined in a framework of surrounding physiographic features as they relate to fishing strategy, salmon behavior, and decisions regarding how the landscape shapes fishing site selection. In an examination of the immediate stretch of the adjacent river, certain physiographic features are identified, inventoried, and their intervals recorded. For each physiographic feature type high inventory values and low interval values may indicate a close association between fishing activity and conditions that favor production.

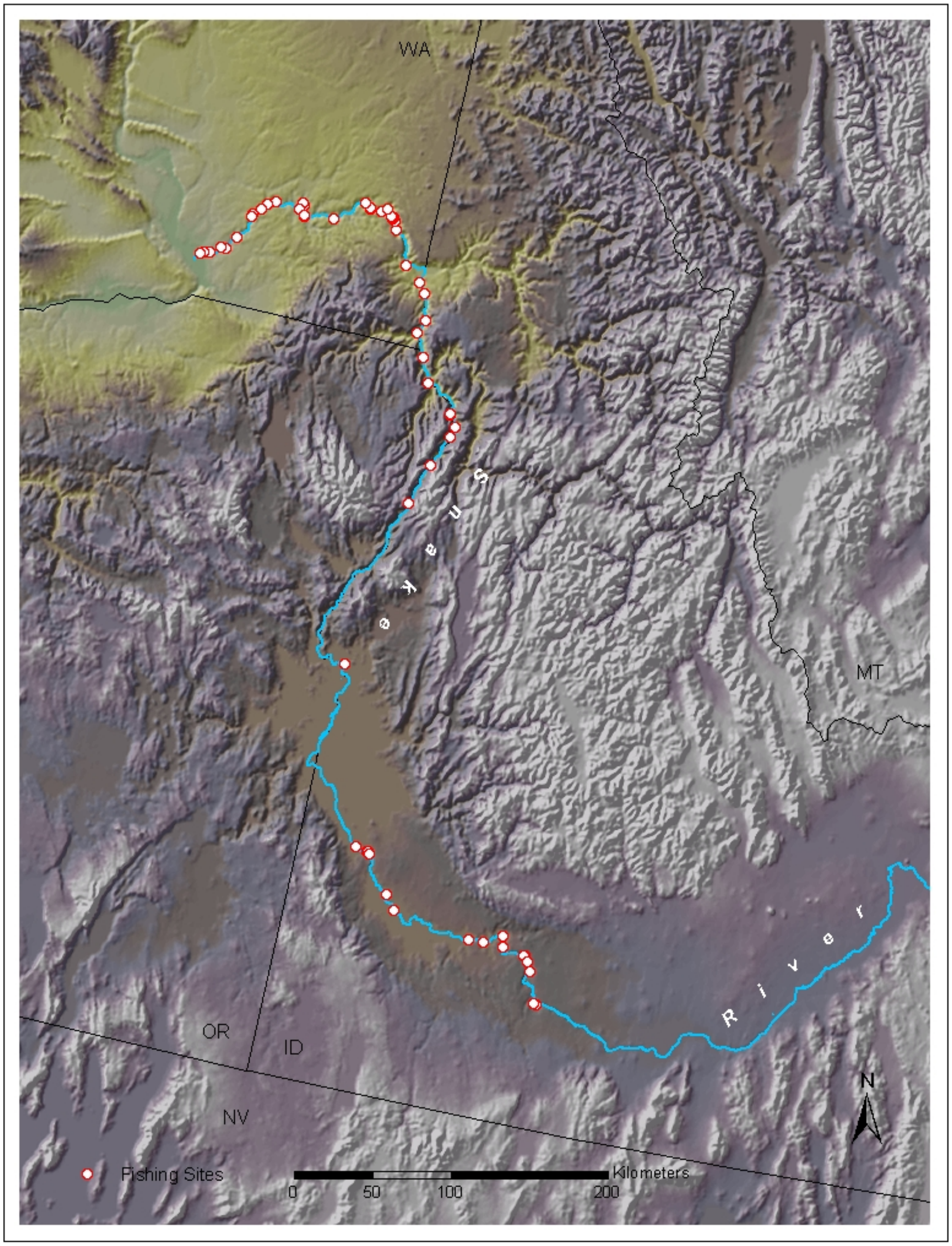

Figure 1 Distribution of Selected Sites

Summary of Chapters

This thesis is comprised of eight chapters beginning with this introduction. Chapter 2 provides a general overview of historic and ethnographic descriptions of populations along the Snake River. Subsistence activities, with and emphasis on salmon fishing, are the focus. Chapter 3 provides environmental and physiographic descriptions of the Snake River Basin in general and defines the study area specifically. A brief geological history provided for each river segment indicates types of geological deposits in which sites may be found. Chapter 4 presents the range of species and anadromous ecology found within the study area, including general lifecycle descriptions and migration timing. Implications of anadromous ecology and migration timing include resource seasonality, availability along specific river segments and locations within the river channel where interception is most successful. A brief overview of the structure of an anadromous fishery is included. Along with a general overview of previous GIS applications in archaeology, Chapter 5 contains a description of methods employed in the current study. A description of the application of GIS in the exploratory analysis of site locations based upon background conditions is included. In Chapter 6 the site variables that define evidence for salmon fishing and associated background variables that condition fishing locations are presented. Chapter 7 provides brief details for each of the archaeological sites within the sample set. For each site, the general location is described, and fish remains along with stone, bone or wood tools pertaining to fishing are identified and quantified. If available, radiocarbon dates that can be associated with fishing evidence are indicated. Each site description also includes inventory results and associated measurements for each of the background variables. Chapter 8 concludes with the results of the study and discussion detailing the implications of those results. Finally, the Appendix will include GIS-generated maps of each site discussed within the text.

CHAPTER 2: ETHNOGRAPHIC ACCOUNTS

This chapter provides a general overview of ethnographic descriptions of populations along the Snake River. Subsistence activities related to salmon fishing are the focus.

The study area encompasses parts of two distinct cultural areas of northwestern North America -- the Great Basin and Plateau areas. Northern Shoshone and Bannock peoples utilized the Middle Snake River, above Hells Canyon. Nez Perce peoples exploited the Hells Canyon reach of the Snake, extending to the Lower Snake where they shared territory with the related Palus peoples.

Middle Snake River

Steward (1938) cites the abundance of anadromous fish in southern Idaho, noting that salmon fishing was the principal subsistence of the Shoshone inhabiting the western Snake River Plain. The Bannocks were originally Northern Paiute-speaking peoples who migrated to the western Snake River Plain where they cooperated with Northern Shoshone populations (Murphy and Murphy 1986). Northern Paiute, however, generally practiced salmon fishing techniques, such as dip netting from platforms or spearing with harpoons from weirs, along tributaries to the Snake and Columbia Rivers, and not on the main channels (Fowler and Liljeblad 1986). The abundance of the seasonal runs as far upstream as Shoshone Falls were reported large enough to facilitate their preservation and storage, although no one resource was abundant and reliable enough to warrant long-term occupation and population densities (Liljeblad 1957). Murphy and Murphy (1986) echo Steward's (1938) assertion that salmon and steelhead trout provided the principal source of subsistence for Shoshone living below Shoshone Falls on the western Snake River Plain. This is further supported by the Northern Shoshone custom of naming local groups after a food type typically eaten in a given area. The Northern Shoshone inhabiting the area below Shoshone Falls were referred to as "Agaideka" or Salmon Eaters (Murphy and Murphy 1986; Steward 1938). The anadromous resources were harvested by detachable headed harpoons from platforms, rock walls, or by wading within the channel. Rock walls for fishing were constructed by piling stone in the river from the bank and angling into the river upstream. Walls provided an artificial eddy in which fish are likely to take rest as well as a platform to spear or dip net from (Landeen and Pinkham, 1999). Weirs built of stone and brush, and occasionally incorporating basketry traps, were also constructed across narrow channel widths to impede upstream migration (Murphy and Murphy 1986). According to Landeen and Pinkham (1999), Liljeblad (1957), Steward (1938), and Walker (1967), fish walls and weirs were common methods of procurement along the entire length of the study area. Walker (1967) asserts that fish walls and weirs or traps were extensive projects and are still discernible in many locations along the Snake River and its tributaries. Fowler (1986) reports fish intended for overwinter use were preserved for long-term storage by air drying on racks in shaded areas and stored in sacks or cached in lined pits.

Some 577 river miles from the Snake's confluence with the Columbia and nearly one thousand river miles from the Pacific Ocean, Deur (2004) documents (collections of) journal and diary entries of Oregon Trail emigrants describing aboriginal subsistence pursuits of anadromous fish at Bell Rapids and the Upper and Lower Salmon Falls on the Snake River. A primary and well-traveled route of the Oregon Trail passed by the south bank of the Snake River along the Salmon Falls stretch and became an important stop for emigrants to replenish supplies by bartering for salmon (Deur 2004). Photographs of the Bell Rapids and Salmon Falls reaches of the Middle Snake River, prior to inundation by the Lower Salmon Falls Dam, depict the falls as long diagonal chutes during high flow periods and as shallow vertical falls during low flows. Among the methods of procurement described as being used along the Salmon Falls stretch were harpooning or spearing from steep banks or salient points within the stream, trapping by means of weirs, and creating artificial channels through rock walls or fish dams (Deur 2004).

Hells Canyon and Lower Snake River

While salmon and steelhead trout were exploited to varying degrees by Northern Shoshone and Bannock populations along the Middle Snake River, the importance of the resource was reportedly greater to Nez Perce and Palus downstream along the Lower Snake River. It has been estimated that anadromous fish comprised up to 50% of the Late Prehistoric diet of the Nez Perce and the aboriginal populations of the Plateau cultural area in general (Marshall 1977; Walker 1967). Many estimates of aboriginal fish consumption on the Plateau have been considered. Hewes (1998) offers an averaged estimate of 400 to 450 pounds of fish per person per year for aboriginal fish consumption on the Plateau. Walker's (1967) research indicates that Nez Perce fishing techniques were typical of the Plateau.

Among the Nez Perce, salmon and steelhead trout were commonly speared, hooked, netted or trapped, although hooks were most likely intended for steelhead since salmon will not take bait during spawning migration (Hewes 1998; Spinden 1964; Walker 1967, 1998). Fish walls, as described by Walker (1967) were built at various elevations on the shore and extended into the channel to accommodate for fluctuations in seasonal water depth. Spears, harpoons, leisters and nets were employed at fish walls. The construction of large fish walls and weirs implied intense use and were generally built by communal effort near an established village (Marshall 1977; Walker 1998). Canoes were also employed as platforms for dip netting and spearing where the depth of water precluded the construction of fish walls or weirs (Walker 1967, 1998). Nez Perce salmon fishing was most intensive during spring migrations, when winter caches had been depleted, and again during the fall when people would gather in the canyons to replenish winter stores (Hewes 1998; Marshall 1977; Walker 1998). The harvests were sun-dried or smoked and stored in lined caches for delayed consumption (Walker 1998).

CHAPTER 3: PHYSIOGRAPY

This chapter provides environmental and physiographic descriptions of the Snake River Basin in general, and defines the study area specifically. A brief geological history is provided for each river segment and indicates the types of geological deposits in which sites may be found.

Snake River Basin

The study area is contained within the Snake River Basin of the Columbia Plateau, a subprovince of the greater Intermontane Plateaus Physiographic Province of western North America (Baker et al. 1991). The Columbia Plateau is bordered on the east and north by the Northern and Middle Rocky Mountains provinces, on the south by the Basin and Range province, and on the west by the Cascade Mountains. Structurally, the Columbia Plateau is characterized by vast horizontal lava flows. Those parts of the province covering central and southeastern Washington, and northern Oregon consist of Miocene to Pliocene aged flood basalts, with most of the eruptions dating between 17.5 and 14.5 million years ago (Baker et al. 1991). These same flows also spill into the western edge of Idaho and abut the Northern Rocky Mountain Physiographic Province. Much of the Columbia Plateau covering central and southeastern Oregon consists of undifferentiated Middle to Late Tertiary-aged lavas that extend into the Basin and Range Province (Camp, Hooper, Swanson and Wright 1982). The portion of the Columbia

Plateau that extends across the Snake River Plain is characterized by Late Tertiary and Quaternary-aged lava flows consisting mainly of basalt lavas on the Western Snake River Plain, and rhyolitic volcanic rocks overlain by basaltic flows on the Eastern Snake River Plain (Malde 1991).

The physiographic nature of the Snake River basin is highly variable and diverse. Thomas, Broom, and Cummans (1963) divide the basin into seven separate physiographic regions: the Upper Snake River Mountains, the Upper (eastern) and Lower (western) Snake River Plains, the Southern Highlands, the Central Mountains, the Northern Mountains, and the Northern Hills.

The Upper Snake River Mountains contain the source of the Snake River at the basin's eastern rim. This steep and rugged terrain, with a mean elevation of 2316 m (7598 ft), provides substantial runoff to the Snake River (Thomas et al. 1963: 4). The Upper and Lower Snake River Plains -- the eastern and western portions of the Snake River Plain respectively -- exhibit minimal relief with the exception of occasional buttes on the eastern plain and canyons, on the western plain, where the river channel has downcut through volcanic rock. Here the Snake River flows generally northwest, following an enormous arching swath across southern Idaho. The elevation across these plains ranges from 1829 m (6000 ft) at salient points on the Eastern Plain to 610 m (2001 ft) on the Western Plain (Thomas et al. 1963: 4-5). The Southern Highlands bound the southern portion of the Snake River Basin, physically delineating the larger physiographic regions of the Columbia Plateau from the Great Basin. Stretching the combined length of the eastern and western Snake River Plain, the Southern Highlands region introduces multiple north draining tributary basins at roughly consistent intervals (32 km). Within this region the broad valleys range in elevation from 1220 m to 1542 m (4002-5059 ft), while the separating ridges range between 1829 m and 3353 m (6000-11000 ft) (Thomas et al. 1963: 5-6).

The Central Mountains border the Eastern and Western Plains to the north. This steep and rugged terrain also introduces tributary basins draining to the south. However, only surface stream channels west of the Malad River reach the Snake, while those within the Eastern Plain are readily absorbed as a result of high soil permeability on the arid plain (Thomas et al. 1963: 6). The Snake River bisects the Northern Mountains on its northern course through Hells Canyon. Here the river channel gradient increases, compared to that over the Upper and Lower Plains, dropping 427 m in 322 river kilometers (1400 ft in 200 river miles) (Thomas et al. 1963: 6-7). The Northern Hills comprise the northernmost region within the Snake River basin and are almost entirely below 1219 m in elevation (4000 ft.). In the Northern Hills region the Snake flows westerly through the loess-filled Palouse Hills and Channeled Scablands to its confluence with the Columbia River. In all, the Snake River basin comprises the largest tributary of the Columbia River drainage, covering an area of 116,000 square miles at a mean elevation of 1554 m (5098 ft) (Thomas et al. 1963: 7). Major tributaries to the Snake within these physiographic regions include the Palouse, Tucannon, Clearwater, Grande Ronde, Imnaha, Powder, Salmon, Weiser, Payette, Boise, Malheur, Owyhee, Bruneau, Big Wood, Big Lost, Portneuf, Henry’s Fork, Teton, Buffalo Fork, Gros Ventre, Hoback, Greys, and Salt Rivers.

Physiographically, the eastern and western portions of the Snake River Plain are linked to the Columbia Plateau region, though both are distinct, structurally and chemically, from the larger Columbia Plateau region and from each other (Mabey 1982; Malde 1991).

Study Area

For the purposes of this study, the course of the Snake River is divided into three fundamental sections that shape its general path:

1. The *Middle Snake River* segment (above Hells Canyon) from Shoshone Falls downstream to the confluence of the Burnt and Snake Rivers;
2. The *Hells Canyon* segment from the confluence of the Burnt and Snake Rivers downstream to the confluence of the Snake and Grande Ronde Rivers; and
3. The *Lower Snake River* segment (below Hells Canyon) from the confluence of the Snake and Grande Ronde Rivers to the confluence of the Snake and Columbia Rivers.

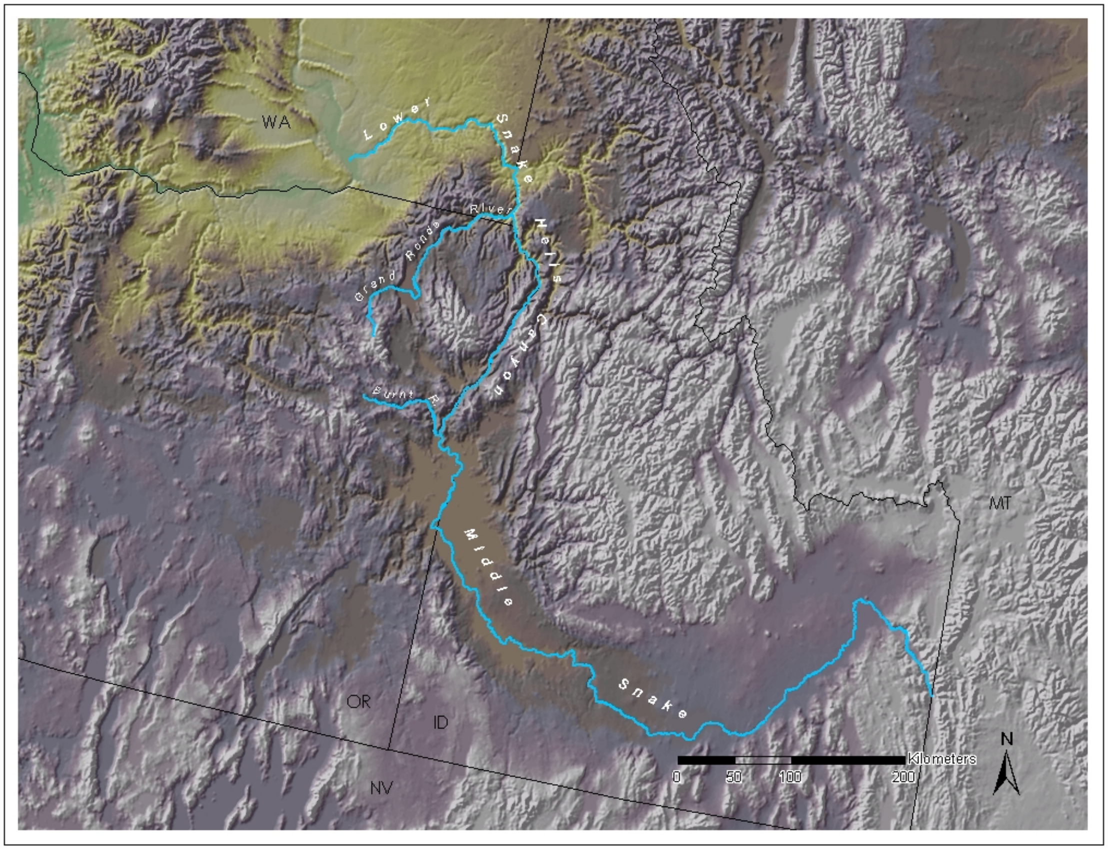

Figure 2 Segments of the Study Area.

The study area (Figure 2), stretching from Shoshone Falls in Idaho downstream to the confluence with the Columbia River in Washington State, begins on the western edge of the eastern Snake River Plain. Malde (1991) describes the eastern Snake River Plain as a belt of volcanic terrain comprised of rhyolitic ash-flow tuffs greater than 3 km in depth, and overlain by thinner (1 km) flows of basalt. The rhyolitic deposits are the product of eruptions of an active mantle hot spot. The North American plate drifted across this hot spot in a generally southwestern direction. Eruptions from this migration began 17.5 million years ago on the Owyhee Plateau in the region of what now comprises southeastern Oregon, northern Nevada and southwestern Idaho and can be traced across the wide, arcing swath of south central and southeastern Idaho. The rhyolitic deposits were capped by basaltic flows in areas along the path of the migration shortly after passing over the hot spot. The hot spot currently rests under the Yellowstone Plateau where the youngest of these rhyolitic eruptions dates to 600,000 years ago, though basalt eruptions further west on the eastern plain are as recent as 2,000 B.P. (Malde 1991).

The course of the Snake began to take shape at the beginning of the Pleistocene. With markedly increased precipitation during the Pleistocene, runoff from the Upper Snake River Mountains, the Central Mountains, and the Southern Highlands began contributing greater amounts of sediment along the length of the Snake River Plain. Comparatively, greater amounts of sediment were transported from the Central Mountains than from the Southern Highlands, resulting in a gradual trend to the southern margin of the Snake River Plain (Malde 1991). Downcutting and incising of the river created ancestral canyons along the western portion of the eastern plain. Periodically, canyon-filling basalts displaced the river channel further to the south with each eruptive episode, and new channels were downcut until entrenched in the current alignment (Malde 1991). The eastern and western portions of the Snake River Plain abut along the segment of the Snake River between Shoshone Falls and King Hill, roughly between 115º and 114º west longitude.

Middle Snake River

The western Snake River Plain as described by Malde (1991) is a fault-bounded basin filled with alluvial and lacustrine sedimentary deposits locally interbedded with layers of basalt, all underlain by with a thick slab of basalt. A group of Miocene to early

Quaternary-aged sedimentary deposits is collectively known as the Idaho Group. These include the Poison Creek, Chalk Hills, and Glenns Ferry Formations (Malde 1991).

Ancestral drainages also contributed to the sediment deposits of the western Snake River Plain. Evidence of a high energy drainage system on the western Snake River Plain can be inferred by way of the Tuana Gravels -- indicating northward drainage of the Southern Highlands -- and the Tenmile Gravels -- indicating drainage of the Central Mountains to the south and west onto the western Snake River Plain (Malde 1991). The interbedded layers of basalt and Tertiary and Quaternary-aged sediment deposits of the western Snake River Plain are the result of episodic lava flows that dammed ancestral canyons and river channels of the Snake, periodically impounding runoff. Uplift of the Ochoco-Blue Mountains during the Cenozoic may have also contributed to repeated ponding of the Snake on its western plain adding to the sedimentary deposits that measure as much as 1.7 km in some areas (Malde 1991).

The most recent lava flows on the western Snake River Plain belong to the Bruneau Formation and Snake River Group, the youngest of which are less than a million years old (Malde 1991). These flows, pouring from the northern canyon rims of the previously incised channel, repeatedly forced the Snake toward the southern margin of the western plain and ultimately into its present course where it is entrenched in steep basalt canyons up to 300 m in depth and downcut through sediments in broad, terraced valleys (Malde 1991). The episodic impoundment of runoff on the western Snake River Plain is collectively referred to as "Lake Idaho" (Malde 1991; Vallier 1967, 1998). The Snake River originally drained the western plain by way of southeastern Oregon, northwestern Nevada, and northern California until deformation and volcanic activity blocked the river's former course. The resulting Lake Idaho eventually spilled over at the Oxbow, into an early tributary of the Salmon River, draining the Lake Idaho as early as 2 million years ago (Malde 1991; Vallier 1967, 1998).

Hells Canyon

Late Pliocene and early Pleistocene runoff from Idaho Lake helped to form the deeply incised Snake River through Hells Canyon. The Hells Canyon stretch of the Snake River is defined for this study as the river segment between the confluence with the Burnt River and the confluence with the Grande Ronde River. Hells Canyon of the Snake River is characterized as a steep-walled V-shaped canyon lacking flood plains and scattered with terraces and alluvial fans. Vallier (1998) also describes the foundations of Hells Canyon as *exotic terrane*. Much of the oldest bedrock exposed throughout Hells Canyon belongs to the Blue Mountains province, covering portions of eastern Oregon, western Idaho, and southeastern Washington. These pre-Cenozoic-aged rocks began forming the Blue Mountains Island Arc in the ancient Pacific Ocean as early as 250 Ma, were transported via tectonic plate action, and become part of the North American continent by 120 Ma (Vallier 1998). The Columbia River Basalt Group (described below) overlaying these Blue Mountains Island Arc is particularly evident on the Oregon side of Hells Canyon. Tectonic uplift along the Hells Canyon region has promoted further downcutting by the Snake River and has caused the formation of the rugged mountainous terrain found along the eastern and western margins of the canyon (Vallier 1998).

Lower Snake River

The Lower Snake River begins at the confluence with the Grand Ronde River. From this point the canyon becomes less rugged and shallower as the river flows through the Palouse Hills and Channeled Scablands to the confluence with the Columbia River. This third fundamental geological section of the river's course is characterized by enormous Tertiary-aged basalt floods covering much of southeastern Washington, eastern Oregon, and the western edge of central Idaho. These expansive basalt flows are collectively recognized as the Columbia River Basalt Group. The Columbia River Basalt Group consists of the Imnaha Basalt (17.5 Ma), Grande Ronde Basalt (16.5 Ma), Wanapum Basalt (13.5 Ma) and Saddle Mountains Basalt (6 Ma) (Hooper and Swanson 1990). The flows that make up this group were intermittent and therefore interbedded with developed soils (Baker et al. 1991; Vallier 1998). The basalt rocks resulting from these early molten floods are distinct, both temporally and chemically, from the volcanic flows that created both the Upper and Lower Snake River Plains (Malde 1965). The Columbia River Basalts are overlain by a thick deposit of loess in large portions of eastern Washington and northern Idaho. This fine-grained, Pleistocene-aged, eolian deposit reaches 75 m depth in places (Baker et al. 1991). The Snake River enters this portion of the study area entrenched in a basalt canyon roughly 600 m in depth. On its westward path, the Snake River canyon that incised into the Columbia River Basalts decreases in depth until it flows along a broad, open valley at the confluence with the Columbia River.

Major Flood Events

Many features along the course of the Snake River result from the catastrophic Bonneville and Missoula flood events. Lake Bonneville, covering approximately 50,000 km² of northern Utah, breached the divide separating the Great Basin and the Snake River Basin at Red Rocks Pass in eastern Idaho near the end of the Pleistocene. O'Conner (1990; 1993) estimates nearly 5,000 km³ of water was discharged through Red Rock Pass, Idaho, in a single flood event that may have lasted tens of weeks. This volume of water is estimated to have produced peak discharges between one million m³ per second at Red Rocks Pass and 600,000 m³ per second 1,100 km downstream at Lewiston, Idaho (Vallier 1998). The catastrophic torrent scoured the narrow Snake River canyon walls approximately 14,500 years ago, filling canyons to the brim, gorging deep holes and moving sediment loads as large as basaltic boulders 10 m in diameter (O'Conner 1990). Broader expanses downstream from the canyons of the western Snake River Plain allowed for ponding and the settling of sediment loads, creating enormous gravel bars of well-rounded and worn basalt boulders known as melon gravel (Malde 1965). Bonneville flood alluvial bars and melon gravels are found as far downstream as Hells Canyon where flood levels reached depths greater than 100 m and nearly 200 m at Pittsburg Landing (Vallier 1998). Similar floods, though of greater magnitude (50 times the volume of water of the Bonneville Flood), repeatedly back-flooded the lower Snake River canyons as glacial Lake Missoula discharged catastrophic torrents from northwestern Montana between 15,300 and 12,700 B. P. (Thomas et al. 1963). Reid (1991) indicates that many of the caves utilized by prehistoric man within the canyons of the Snake River were created by these flood events.

Bonneville Flood alluvial bars and melon gravels adjacent to the Snake River have proven to be stable landscape features for nearly 15,000 years. Osterkamp (1998) and Osterkamp, Johnson, and Dixon (2001) present evidence that indicate the river channel and islands along a portion of the Middle Snake River are unusually stable and have remained largely unchanged since the Bonneville Flood event. These studies looked at the section between Swan Falls and Farewell Bend, defining and differentiating between regime and relict islands. Regime islands are formed primarily of tributary sediments and are irregularly shaped. Such islands, generally comprised of finer grain sediments and flood plain deposits, are more susceptible to erosional forces and do not share the same antiquity as relict islands .

Relict islands were formed as a result of the deposition of coarse detritus and mass movements of sediment created by the Bonneville Flood. Rising above nearly immobile Bonneville Flood debris, relict islands along this stretch have proven to be more resistant to erosional forces and have remained relatively unchanged since that event. Relict islands tend to be elongated -- with their upper surfaces rising above the local flood plain -- and support both riparian and upland vegetation. Regime islands, by contrast, support only riparian vegetation, exhibit braiding and channel meandering, and share the same elevation as the modern flood plain. Osterkamp (1998: 538) contends the streambed of much of this stretch of river has been stable both vertically and horizontally due to a very low channel gradient and coarse bed sizes armoring the stream channel, minimizing erosional forces. Additionally, limited post-flood inputs of tributary sediments above the Owyhee River have been insufficient to alter the course of the Middle Snake.

This evidence is not cited to suggest that the fluvial environment of the Snake River is static and unchanging. In fact, Swanson and Muto (1975) have shown that three major cycles of climate fluctuation over the last 8,000 years can be inferred from depositional periods of rockshelter roof fall. Changes in sediment size and distribution within radiometrically dated geological stratum from Hogup Cave, in northern Utah, indicate freeze-thaw cycles and variations in precipitation. These cycles, which began as arid, increase in moisture and cooling, followed with moisture and warming, and then return to arid conditions, correspond with similar evidence from other rockshelters in the region and thus represent a regional pattern in climate fluctuations (Swanson 1972; Swanson and Muto 1975; Swanson and Sneed 1966; Ranere 1971). During moisture-laden periods, Swanson (1974) reports rapid and violent flooding and development of alluvial fans and mud and rock slides, all of which would aid in the creation and elimination of both island and rapids.

Flood events are not limited to periods of higher levels of precipitation however. Recent and comprehensive studies addressing fire history show that warming climate and drought may have increased the magnitude and severity of past forest fires (Pierce et al. 2004). These authors describe how severely burned slopes increase surface runoff while decreasing slope stability, leading to flooding, debris flow and slope failure. By dating organic material within alluvial fans along the South Fork Payette River, Pierce et al. (2004:42-43) have shown that these massive sediment flows and flooding events were coincidental with severe fires during the Medieval Climactic Anomaly between 750-1,050 calendar years B.P.

Flood events, long-term erosion, and sediment deposition can all act to eliminate islands from one location and cause their formation in another. Similar factors act upon the creation or elimination of rapids within a fluvial environment as well. The dynamic nature of the chosen study area is understood, and it is conceded that change in these variables cannot be controlled for over long periods of time. While Osterkamp's description of Middle Snake River relict islands cannot be extrapolated along the entire length of the study area, there is evidence at least between Swan Falls and Farewell Bend that fluvial islands may have remained stable for as long as the area has been exploited by humans.

CHAPTER 4: ECOLOGY OF ANADROMOUS FISH AND RANGE OF SPECIES

This chapter presents the range of species and anadromous ecology found within the study area, including general lifecycle descriptions and migration timing. Implications of anadromous ecology and migration timing include resource seasonality and availability along specific river segments and configurations of the river channel where their interception is most successful. A brief overview of the structure of an anadromous fishery is included.

Anadromous salmonids are widely distributed throughout the North Pacific Ocean region. They spawn and rear in from the smallest of creeks to the largest rivers and lakes across diverse climatic zones of the Pacific Rim. The native ranges of anadromous Pacific salmon and trout include the North Pacific Ocean and coastal areas of both North America and Asia from approximately 35° north latitude to the Arctic Ocean and extending inland to interior rivers and lakes (Quinn 2005). While the antiquity of the family of salmonids in the North Pacific Ocean is on the order of millions of years, their distribution within the waters of northwestern North America is limited to approximately the last 10,000 years, when deglaciation at the end of the Pleistocene opened new habitat (Quinn 2005). This chapter presents the ecological requirements and life cycle of Pacific salmon, conditioners that affect fishery productivity, and the distribution and range of the species within the study area.

Anadromous Ecology

Anadromy is an adaptive strategy in which certain species are spawned and reared within inland fresh waters and migrate to sea where they grow to their final size and sexual maturity. The end of the life cycle culminates in another migration inland for spawning. Most Pacific salmon species die once they have spawned (semelparity), though some stocks of trout, such as the steelhead trout, can survive the spawning process (Quinn 2005; Reiser 1998). The downstream migration to the sea is an adaptation that increases breeding success at the end of the life cycle. At sea, anadromous fishes have a much greater growth opportunity based on available food sources. Greater growth potential in turn increases fertility in males and greater egg production in females (Quinn 2005). Upstream migration culminates in reproductive activities. Thompson (1972) suggests that upstream migration for salmon and trout requires a minimum water depth of 0.4 to 0.8 ft flowing at a maximum velocity of 4.0 to 8.0 ft/second (Reiser 1998). Upon arriving at the natal stream, females select, prepare and defend from other females the incubation locations, or "redds." Spawning habitat must include silt-free, well-oxygenated water flowing through interstitial spaces in the streambed substrate. This habitat is generally located in channels where the water is 30-60 cm deep, flowing with a velocity of no more than a meter per second and no fewer than 30 cm per second. The streambed should include coarse sands and gravels ranging in size from 2-10mm (Quinn 2005). Larger cobbles also allow for the water flow in the space between rocks necessary for the deposition of eggs and for the fry after hatching. There is little room for variation in water temperature.

Ideally, the spawning water temperature is between 16 degrees Celsius and 3 degrees Celsius. Water temperatures of 20 degrees Celsius are survivable but only for very short durations.

Conditions Impacting Productivity

Schalk (1977) examined anadromous fisheries in the North Pacific Ocean and provides observations on ecological and geographic structures and cultural exploitation of such resources. Anadromous fish are those that begin life in inland fresh water, spend a portion of their lives at sea, and migrate back to fresh water to spawn. This migration is an evolutionary response to seasonal temperature variation within riverine environments. Cold winter temperatures increase oxygen concentrations in river environments which benefits fish reproduction. Lower overall temperatures in streams and rivers that support anadromy also tend to be food-scarce for portions of the annual cycle, unable to support large populations of salmon year round. Marine environments are more productive in terms of food sources and experience far fewer temperature fluctuations at equivalent latitudes. The migrations of anadromous fish take advantage of productive marine environments as well as the reproductive benefits of cool, well oxygenated freshwater inland. The ability and success of anadromous migrations and spawning are determined by the terrestrial environment through which the natal river flows. Discharge -- or runoff -- and water temperature, the most critical variables in determining successful spawning habitat, can be affected by flooding, drought, erosion of stream gravels, over-siltation, freezing, or overheating. Stable riparian environments support anadromous species, and are correlated with the diversity of species.

The variability of riparian environments supporting anadromous species is associated with latitude. Schalk identifies three zones of the North Pacific where latitudinal temperature thresholds of riparian environments limit species distributions. The approximate borders of these latitudinal zones are located below 45° north latitude, between 45° and 60° north latitude, and above 60° north latitude. The intermediate zone contains potential spawning habitat for all the most common Pacific and Atlantic salmon and for other anadromous species such as steelhead trout and white sturgeon. Above and below this broad zone the diversity of anadromous species decreases commensurately with the distance from the intermediate zone. Shorter periods of spawn result from increased seasonality; therefore, runs are compressed temporally at higher latitudes and elongated at lower latitudes, though temperatures beyond survivability prevent anadromy all together at either extreme.

Human exploitation of anadromous fish can be viewed as the result of either generalist or specialist adaptations. Whereas generalists exploit resources in proportion to their abundance in environments of low stability, low productivity and high seasonality, specialists tend to focus on specific resources in stable environments with high productivity and low seasonality. Schalk offers, for example, one measure of specialization as the degree of dependence on food storage, a mechanism for not exploiting resources in proportion to their abundance in the environment. The major variables that influence degrees of specialization on anadromous fish include seasonality, year-to-year stability of abundance, and productivity (abundance) itself.

Schalk's (1977) latitudinal continuum of the Northern Hemisphere provides a basis for describing how hunter-gatherers may be expected to interact with an anadromous fish resource. Fish runs below 45° north latitude are generally long in duration due to the lower seasonality and generally coincide with lower terrestrial productivity. Exploitation and dependence upon the resource by low-density foragers in this zone are not dependent on storage, due to decreased seasonality. Given the temporal availability of the resource in this zone, the need for storage is reduced as is the need for capturing and processing large amounts of fish in a short time span. Fish runs between 45° and 60° north latitude have greater seasonality here than runs below 45° north latitude. This latter zone has the highest potential for high species diversity and low variation in year-to-year productivity. Due to increased seasonality, specialized dependence on anadromous fish is expected to be limited when storage is absent and is determined by run duration. Because the duration of runs tend to decrease northward in the zone, with distance upstream, and as river size decreases, generalized adaptations are expected to increase as distance upstream increases. Fish runs above 60° north latitude demonstrate acute seasonality and are very brief. Variation in year-to-year productivity is considerable and species diversity is minimal. The expectation for reliance on anadromous fish, even with a generalist adaptation, is low.

Range of Species

Salmonidae are a family of fish that include salmon, trout, chars, freshwater whitefishes and graylings. Non-anadromous salmonids native to the Columbia River Basin include bull trout (*Salvelinus confluentus*), cutthroat trout (*Oncorhynchus clarkii*), rainbow trout (*Oncorhynchus mykiss*), pygmy whitefish (*Prosopium coulterii*), and mountain whitefish (*Prosopium williamsoni*).

Anadromous fish historically inhabiting the greater Columbia River Basin include steelhead trout (*Oncorhynchus mykiss*), chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*Oncorhynchus kisutch*), sockeye salmon (*Oncorhynchus nerka*), chum salmon (*Oncorhynchus keta*), and rarely pink salmon (*Oncorhynchus gorbuscha*) (Fulton 1968, 1970). Species distribution varied historically throughout the Columbia Basin. Steelhead trout were widely dispersed throughout the entire watershed. Coho salmon spawned in smaller streams, mostly in the lower reaches of the Columbia. Sockeye salmon migrated to lakes and their tributaries in the middle of the watershed. Chum salmon spawned in the lower portions of tributaries of the lower Columbia. Like the steelhead, the chinook salmon spawned in the main stem and in nearly every tributary to the Columbia River (Fulton 1968, 1970).

The Snake River, the largest tributary of the Columbia River, historically provided spawning habitat or access to spawning habitat for steelhead trout, chinook salmon and sockeye salmon (Fulton 1968, 1970; Reiser 1998). In the past, coho salmon utilized the lower Snake River as a passageway to spawning habitat in certain drainages of the Salmon, Clearwater, Tucannon and Grande Ronde rivers (Fulton 1968, 1970; Reiser 1998). Table 1 shows the distribution of salmon species within the Snake River Basin.

Oncorhynchus mykiss

Steelhead trout can be divided into two groups on the basis of migration timing. Winter run steelhead historically have arrived at the mouth of the Columbia between November and April. Summer steelhead historically entered the Columbia drainage between May and October (Fulton 1970). Winter steelhead are more reproductively mature when entering the fresh water of the Columbia drainage and spawn shortly thereafter at lower elevations in the tributaries of the lower Columbia River. Summer steelhead migrate further inland, generally overwintering in the larger channels before migrating further upstream to spawn in the spring (Reiser 1998; Quinn 2005). Steelhead trout spawn in streams of all sizes and were historically widespread throughout the Columbia drainage. Within the study area, steelhead spawning habitat was historically found in the main stem Snake and its tributaries, including the Palouse, Tucannon, and Clearwater Rivers; Asotin Creek; the Grande Ronde, Salmon and Imnaha Rivers; Pine, Indian and Wildhorse Creeks; the Powder, Burnt, Weiser, Payette, Malheur, Boise, Owyhee and Bruneau Rivers; Canyon Creek; the Malad River; and Salmon Falls and Rock Creeks (Fulton 1970).

Oncorhynchus tshawytscha

Chinook salmon historically have been the largest and most abundant of the anadromous fish migrating within the Columbia Basin (Fulton 1968). Bevan et al. (1994) estimated the total annual production at the end of the 19^{th} century for the Snake River drainage to exceed 1.5 million chinook salmon (Reiser 1998). As with the steelhead trout, the chinook salmon are grouped according to migration timing. Within the Columbia River drainage these distinct temporal divisions include the spring, summer, and fall runs and are designated according to the arrival of adults in freshwater at the beginning of the upstream migration.

Spring and Summer Chinook

Spring chinook historically arrived at the mouth of the Columbia River between February and May and in the Snake between April and mid-June. The spring chinook spawn generally began in late July, lasting through late September (Fulton 1968; Reiser 1998). Summer chinook historically arrived at the mouth of the Columbia River between June and mid-August and in the Snake between mid-June and late August. The summer chinook spawn generally began in mid-August, lasting through mid-November (Fulton 1968; Reiser 1998). The distribution of spring and summer chinook was widespread within the Columbia River Basin and the Snake River drainage. The spring chinook spawned predominately in Columbia's smaller tributaries and in the upper reaches of its principal tributaries. The summer chinook spawned predominately in the main stem of the Columbia and in its medium to large tributaries. Within the study area, spring and summer chinook spawning habitat was historically found in the Snake's primary and secondary tributaries, including the Tucannon, Clearwater, Grande Ronde, Salmon and Imnaha Rivers; Pine and Indian Creeks; the Powder, Burnt, Weiser, Payette, Malheur, Boise, Owyhee and Bruneau Rivers; and Salmon Falls and Rock Creeks (Fulton 1968).

Fall Chinook

Fall chinook historically arrived at the mouth of the Columbia between mid-August and late October and in the Snake between September and the end of November. The fall chinook spawn generally began in late September through early December (Fulton 1968; Reiser 1998). Spawning habitat was not as extensive as that of the spring and summer chinook and was limited to the tributaries of the lower Columbia, sections of the lower and middle main stem Columbia, and all of the main stem Snake to at least Auger Falls (Fulton 1968; Reiser 1998).

Oncorhynchus nerka

Sockeye salmon have the most limited distribution of the anadromous fish species within the study area. Sockeye upstream migration extends May through August and ends at high mountain lakes by September. Sockeye spawn generally began in mid-September, peaking in mid-October (Fulton 1970). Spawning habitat for sockeye salmon is limited to lake inlet or outlet tributaries or to shoreline areas within lakes (Reiser 1998). Within the Columbia Basin, sockeye spawning habitat included the Arrow Lakes, the Okanogan Lakes, the Yakima Lakes, Wenatchee Lake, Payette Lake, Wallowa Lake, the Stanley Basin Lakes, and Suttle Lake (Fulton 1970). Spawning destinations within the study area include Wallowa Lake, Payette Lake, and Redfish, Alturas, Pettit, Stanley and Yellow Belly Lakes of the Stanley Basin (Fulton 1970; Reiser 1998). The main stem Snake provided passageway for sockeye to the Salmon, Grande Ronde and Payette Rivers.

Table 1 Salmon Distribution in the Snake River Basin.

Stream	Steelhead Trout		Chinook Salmon			Sockeye Salmon
	Winter	Summer	Spring	Summer	Fall	
Main Stem Snake R.		X			X	X
Palouse R.						
Tucannon R.		X	X	X		
Clearwater R.		X	X	X		
Asotin Ck.		X				
Grande Ronde R.		X	X	X		X
Salmon R.		X	X	X		X
Imnaha R.		X	X	X		
Pine Ck.		X	X	X		
Indian Ck.		X	X	X		
Wildhorse Ck.		X				
Powder R.		X	X	X		
Burnt R.		X	X	X		
Weiser R.		X	X	X		
Payette R.		X	X	X		X
Malheur R.		X	X	X		
Boise R.		X	X	X		
Owyhee R.		X	X	X		
Bruneau R.		X	X	X		
Canyon Ck.		X				
Malad R.		X				
Salmon Falls Ck.		X	X	X		
Rock Ck.		X	X	X		

CHAPTER 5: METHODS

This chapter contains a general overview of GIS applications in archaeology, as well as a description of methods employed for the current study. The features of GIS enable exploratory analysis of site locations based upon background conditions.

Theoretical Perspectives

Analysis through mapping and plotting distributions is fundamental in archaeology. There is a fundamental spatial reference within archaeology in as much as artifacts are distributed within sites and sites are distributed across regions (Kvamme 1989). With Geographic Information Systems (GIS), vast amounts of spatially referenced data can be digitized, stored, sorted, visualized, manipulated, queried, generated and extensively analyzed. GIS makes possible comparisons of any number of variables, such as environmental, geologic, economic, or social for the same physical location. The scale at which GIS can be employed ranges from global to continental to regional to local, or even to the microscopic.

Two fundamental types of data are employed within a GIS -- raster and vector. In the most basic terms, vector data represents discrete features that have explicit (x, y) locations, while raster data represents phenomena that vary continuously over a landscape. Vector data are object-based, examples of which include points, lines and polygons. Points may represent location features such as archaeological sites or isolated projectile points. Lines may represent features like roads, trails or rivers. Polygons are series of line segments that enclose an area, defining perimeters or boundaries that could represent the footprint of a building, the borders of a district, or the extent of a study area. Raster data are not as accurate in terms of exact (x, y) location but rather represent the differences a phenomenon may exhibit over a continuous space. Elevation, precipitation, and temperature are examples of phenomena that exist between discrete points. Raster data is expressed as a grid where each cell in the grid is assigned a numeric value represented by different colors, shades and tones to show what is present in that space and how it varies over a spatial extent. The result is a mosaic or impressionistic reproduction of what is observable in the field. Vector data is most effective when location accuracy is required because of its ability to pinpoint x, y, and z values. Raster data is less precise for location accuracy but better able to convey variation across a space. The detail, or resolution, of raster data is determined by the size of each cell within the grid. A grid with small cells, i.e., 1m x 1m, will have a much greater resolution and much more detail than a grid with 10m x 10m cells. The two data models also have a direct effect upon data storage space and processing time. Vector data takes up much less computer memory storage space and "re-draws" much more quickly than does raster data as layers are added or removed. Raster data, and the amount of memory storage space it requires, is further accentuated by grid cell size; the smaller the cell, the higher the resolution and therefore the more information stored.

Kvamme (1999) provides a comprehensive review of current uses of GIS in archaeology, including regional and intra-site databases, locational analysis, locational modeling, remote sensing, and viewshed analysis.

Regional databases, such as those maintained for the management of cultural resources by State and Federal agencies, are a common use of GIS. Databases such as these, when linked with GIS, can be searched and queried according to specific attributes and the spatial distribution of sites displayed in relation to other features of the region, such as water sources, or elevation and temperature gradients. Limp and Gisiger (1992), Wheatley (1995), and others illustrate how regional databases linked to a GIS environment allow for the integration of spatially referenced text and numerical data, easing access to diverse and varied information sources, reducing administrative loads, and facilitating management decisions in planning where archaeological or environmental factors are a concern. Spatial data exploratory analysis is possible with immense regional databases through the simultaneous display of various types of regional data, revealing relationships and associations not visible on smaller scales (Kvamme 1992a). Exploring distributions and associations on an intra-site basis are possible as well. Locations of features such as middens, house floors, or post holes can be portrayed in a vector format and classified according to feature type, cultural affiliation or time period. Raster data make density surfaces possible, depicting artifact or bone gradient distribution for intra-site analysis (Kvamme 1999). Middleton (1998), for example, compared previous analysis of Head-Smashed-In Buffalo Jump with a GIS-aided intra-site investigation that incorporated existing faunal and lithic data from previous excavations to identify discrete cultural events within the complex bone beds.

Data derived from remote sensors are raster in nature and therefore suited for application in GIS. Remote sensing can be divided into two basic categories, active and passive. Active remote sensors generate their own energy and record the reflection of such energy from a surface. Most geophysical prospection techniques -- such as magnetometry, electrical resistivity, ground penetrating radar, or electromagnetic conductivity -- are examples of active remote sensing. Passive remote sensors record energy -- such as electromagnetic energy -- as it is either reflected or emitted from the earth's surface. Passive remote sensors aboard aircraft or satellites can detect spectral signatures of objects revealing properties of materials and suggesting patterns of moisture, vegetation coverage and thermal energy on the earth's surface (Campbell 2002). Remotely sensed data is conducive for use on an intra-site or regional level and are effective in identifying patterns of ecological change, human land use, and settlement patterns by rectifying this geophysical data with aerial photographs, regional site distributions, site plan maps, artifact density surfaces, topographic maps, or digital elevation models (Kvamme 1999).

The analytical capabilities of GIS are most apparent in regional level research designs that look at site location, catchments and cost surfaces, predictive modeling, viewshed analysis, or simulations (Kvamme 1999). Site location analyses generally aim to determine what background environmental conditions influence site placement across a regional distribution of sites. Regional locational analyses have centered on an ecological approach, namely how humans interact with their environments (cultural ecology) as "mobile, observant, communicative animals adapting to and instigating environmental change" (Wise 2000; 141). Examples of specific studies have focused on site location based on climate variables (Allen 1996), settlement patterns based on altitude, slope, aspect and solid geology (Perkins 2000), environmental catchment of sites with evidence for horticulture based on soil types (Hunt 1992), and the spatial and temporal distributions of sites according to geomorphic landform associations (Bauer, Nicoll, Park, and Matney 2004; Lashlee, Briuer, Murphy, and McDonald 2002).

By merging what is known about the locations of past settlements, sites, or activities from locational analysis, descriptions of multivariate environmental and spatial patterning of sites can be made leading to predictive statements about where undiscovered settlements, sites, or activity locations may be found (Kvamme 1999). Predictive modeling has been driven, in large part, by cultural resource management issues faced by governmental land managing agencies of the western United States where vast tracts of land remain unsurveyed (Judge and Sebastian 1988). The ability of a GIS to make measurements and calculations on enormous sets of data quickly and accurately is one of the fundamental reasons predictive modeling is possible on a large scale. Measuring by hand the environmental predictors required for even the simplest model over a limited space is prohibitive due to time consumption and inevitable error introduced. Continuous variables such as slope, aspect, viewshed and distance to water can be calculated from elevation models and hydrology layers for large tracts of land -- to name only a few -- and stored in a GIS, creating easily accessible background environmental data (Kvamme 1988, 1992b). Correlations between background environmental variables and known site locations can indicate likely site locations in unsurveyed areas (Judge and Sebastian 1988; Kvamme 1988, 1992a).

Movement over space, such as settlement patterns, trade routes, and catchment analyses, are upgraded with the use of GIS as a way of integrating cost surface analysis. Kvamme (1999) describes cost surface analysis as a move beyond a flat, unchanging plain when investigating movements. Cost surface analysis assigns weights of impedance to surfaces at individual locations based on landscape characteristics such as terrain, land cover, and natural barriers. As slope increases, vegetation becomes thicker or rivers become impassable, costs for travel over such terrain raise higher according to the continuum weight assigned to specific features. Limp (1991) applies cost surface analysis to the concept of catchment analysis. The combination of catchment and cost surface analyses help to illustrate that costs associated with accessing and exploiting resources within the landscape surrounding a site define the extent and boundaries of a catchment.

GIS Applications in the Current Study

A sample set of sixty archaeological sites was selected based upon certain evidence criteria: sites containing fish bone and features and artifacts generally associated with salmon fishing. The sample set was compiled through review of archaeological literature resulting from survey and excavation along the Snake River. The resulting list of fishing sites constituted the data available at the outset of this project. Undoubtedly, additional sites meeting the evidence criteria have gone unreported and others may have been identified prior to the completion of the project.

Within a GIS, sites are examined in a framework of surrounding physiographic features as they relate to fishing strategy, salmon behavior, and decisions regarding how the landscape shapes fishing site selection. Through an examination of the immediate stretch of river adjacent to a fishing site, certain physiographic features are identified, inventoried, and their intervals recorded. For each physiographic feature type, high inventory values and low interval values may indicate a connection between fishing activity and conditions that favor production.

The set spans three separate sections of the study area: the Middle Snake River, Hells Canyon, and the Lower Snake River (see Figure 2). The Middle Snake River, stretching from Shoshone Falls downstream to the confluence of the Burnt and Snake Rivers, contains 17 sites. The Hells Canyon segment, running from the confluence of the Burnt and Snake Rivers down to the confluence of the Snake and Grande Ronde Rivers, accounts for 8 sites. The remaining 35 sites are situated along the Lower Snake River between its confluences with the Grande Ronde and the Columbia River. The study area is a vast stretch of river corridor over 600 river miles in length. The magnitude of the study area required the ability to store and manipulate enormous amounts of digital data in the form of digital raster graphics representing topographic maps and digital elevation models simulating topography.

Site Vicinity Analysis

Each of the 60 sites in the population were mapped on USGS 7.5 minute topographic maps within the study area. The landscape and hydrographic features -- or background variables -- and the river channel were digitized in the GIS using the topographic maps and Corps of Engineers river charts showing the river configuration and island and rapids locations prior to the placement of dams and reservoir impoundments.

Points of fish harvest, collection, or interception are assumed to be situated near but not necessarily coinciding with locations with salmon bone or other evidence of fishing. A critical factor in prehistoric salmon fishing productivity was the ability to process and prepare for preservation large quantities of fish before excess could spoil

(Hewes 1998). Accounting for this critical factor, it is assumed that harvest locations and processing locations would be in close proximity to one another. In order to evaluate how local landscape and hydrographic features affected the spatial distribution of these sites, a buffer -- or site vicinity as it relates to the course of the river -- is defined.

The vicinity of each site is defined as that area covering a distance of 5 kilometers of river channel in both upstream and downstream directions (Figure 3). The spatial definition of the site vicinity is an arbitrary distance but is based on the assumption that the movements of harvested fish to processing locations were constrained by transport over varied terrain, the volume of haul to be moved, and time constraints associated with spoilage. In terms of site vicinity, a 5 km distance is assumed to be the outer limits of travel from the site location (where fish bone or fishing artifacts are found) to a preferred fishing location. Transporting harvested fish farther would require additional expenditures of time and energy in pursuit of an already expensive resource. Labor forces and time required to prepare and position for harvest, and to process and prepare fish for preservation would have been substantial (see Plew 1990). Accounting for the additional costs of transporting fish from one location to another, the areas of the site vicinity at a distance greater than 2 km from a site are considered the “general vicinity.” Distances of 2 km or less from a site are considered the “immediate vicinity.” The area within the first kilometer ring is termed “adjacent”. The adjacent area is a subset of the immediate vicinity.

The factor of time between harvest and processing for preservation, as it relates to spoilage, will be most critical during the late spring through early fall when bacteria-friendly temperatures are common. Temperatures above 41 degrees Fahrenheit are known to promote the growth of bacteria which causes food borne illness (U.S. Department of Health and Human Services Public Health Services, Food and Drug Administration 2005).

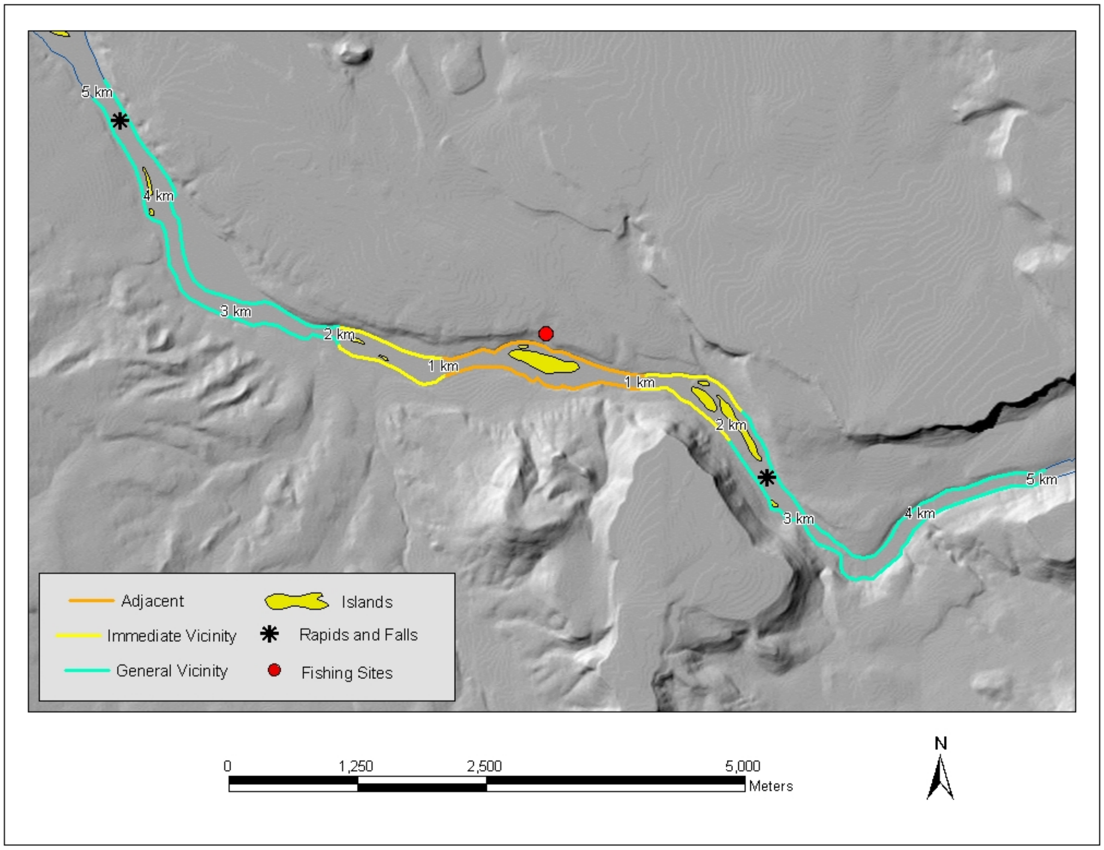

Figure 3 A Site Vicinity is Defined by a 5 km Stretch of River in Each Direction. The Area of River Channel Between 2 km and 5 km from a site is the General Vicinity. The Area up to 2 km from a Site is the Immediate Vicinity. The Distance of 1 km from a Site is the Adjacent Stretch of River Channel.

Several inventories and measurements of background variables (see Chapter 6 for a discussion of background variables) are taken for each site's vicinity. The total numbers of islands and rapids within each site vicinity are inventoried. The presence of islands and rapids are noted within each kilometer segment surrounding the site. High inventory values and low interval values for islands and rapids may indicate a connection between fishing activity and conditions that favor production. Channel width measurements -- or Minimum Channel Width (MCW) -- are made from one river bank to the opposite side at the narrowest point within each kilometer increment of the site vicinity. The proximity of the site to the narrowest measurement is recorded to reveal patterns in the distribution of channel constrictions. An average of the MCW measurements (AMCW) for each site indicates the overall width of the immediate stretch of the adjacent river. Each AMCW is made up of 10 measurements for each site, one for each kilometer increment in both upstream and downstream directions. Finally, perennial streams and streams supporting salmon spawning habitat are considered. The discharges from perennial and spawning streams are inventoried when occurring within each site vicinity. Background variables occurring within the immediate vicinity of a site are considered to exhibit a close association between fishing sites and the physiographic features that condition their location.

CHAPTER 6: SITE VARIABLES

This chapter offers two basic sets of site variables associated with the study. The first set of site variables define the evidence for prehistoric salmon fishing along the Snake River. The second, the physiographic features, or background variables, associated with the site that condition fishing site selection.

Fishing Evidence

Salmonidae are the family of fish that include salmon, trout, chars, freshwater whitefishes and graylings. Among the non-anadromous salmonids native to the Columbia River Basin are bull trout (*Salvelinus confluentus*), cutthroat trout (*Oncorhynchus clarkii*), rainbow trout (*Oncorhynchus mykiss*), pygmy whitefish (*Prosopium coulterii*), and mountain whitefish (*Prosopium williamsoni*). Anadromous fish historically inhabiting the greater Columbia River Basin include steelhead trout (*Oncorhynchus mykiss*), chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*Oncorhynchus kisutch*), sockeye salmon (*Oncorhynchus nerka*), chum salmon (*Oncorhynchus keta*), and rarely pink salmon (*Oncorhynchus gorbuscha*).

The archaeological literature reviewed for this study identified fish remains to varying degrees and it should be noted that some difficulty exists in the osteological distinction of salmon and trout. Frequently fish bone was identified to family level, Salmonidae, which could include the non-anadromous trout and whitefish. However, vertebrae and otoliths, preserved in an archaeological context and identified to genus level (*Oncorynchus*) form the strongest evidence suggesting the cultural use of anadromous fish.

Other features or implements commonly, though not exclusively, associated with salmon fishing among Plateau culture groups will be included here as well. These fishing implements comprise stone net weights, fish spears, harpoons and leisters and fishing features, include fishwalls or weir remains (Table 2).

Stone net weights, occasionally notched, grooved or perforated, were used to anchor seine or gill nets in deep or swift moving water (Johnston 1987:15-22). This technique was ideally suited to collecting the greatest number of fish from a temporally finite resource for the least amount of expended energy, and suggests a strategy for storage.

Table 2 Fishing Evidence.

Fishing Evidence Variables	
Type	**Representative Evidence**
Osteological	• vertebrae • ribs • skull parts • otoliths
Fishing Artifacts	• stone anchor weights (associated with net capture) • fish spear/harpoon bone points • fish spear/harpoon wood main shafts/fore shafts • bone leister barbs (individual capture with hand held tools)
Fishing Features	• stone fish walls • stone weir base

A basic fish spear consists of a bone projection, occasionally barbed and fastened to a main shaft. Harpoons were designed with detachable heads and were secured by cord for easy retrieval of a struggling fish without damaging the fore or main shaft. Leisters held secure wriggling fish with inverted barbs. Fishing techniques with spear, leister or harpoon allowed salmon fishing in more shallow areas -- where nets could not be used -- often in conjunction with weirs, or at rapids or falls (Johnston 1987: 24-25; Walker 1993: 218-231). This method was common along the Middle Snake River (Murphy and Murphy 1986; Steward 1938) and suited to both anadromous and native species of fish. Extensive utilization of this technique for acquiring salmon can be seen both ethnographically (Deur 2004) and archaeologically at Schellbach Cave No. 1 (10OE240). Among the items collected at Schellbach Cave are the remains of chinook salmon (*Onchorynchus tshawytscha*) and ancient fishing gear, including fish spear fore shafts, harpoon shafts, fishing line, net sinkers and a fishhook (Pavesic, Follet, and Statham 1987; Schellbach 1967).

Fishwall features are long, low stone walls extending at varying angles from the shore, into the stream channel, providing a calm resting place for migrating salmon as well as a platform from which to spear or dip net from (Johnston 1987:103; Walker 1993: 231). Fishwalls recorded in the Lewiston Basin were first described by the Corps of Discovery (Thwaites 1959: [7]170) and reportedly were still in use into the twentieth century (Nelson and Rice 1969: 90). The Corps of Discovery also reported a fish weir in use for the collection of salmon in the Lemhi Valley in August of 1805 (Thwaites 1959: [3]6-7). Fence-like structures, often secured with piled stone bases, weirs were used in areas of shallow water to prevent the upstream progress of salmon. Accumulating in bunches against the weir, salmon were collected with dip nets, speared, or directed into various types of traps.

The fishing artifacts found in Hells Canyon, bone harpoon points from the Squaw Creek Shelter (10AM76) and the Tin Shed site, and bone barbs and leisters from Bernard Creek Shelter (10IH483) and the Tryon Creek site (35WA288) are all associated with salmon bone. The close association between both rapids and islands within a turbulent and steep side-walled canyon may point to a strategy where resting salmon were taken by spear thrust from pools and eddies from steep canyon wall or island positioning opportunities.

Along the Middle Snake River stone weir foundations at 10GG312, 10GG332, and 10EL216 are all directly associated with islands in an apparent attempt to augment the natural configuration created by the island channel. Stone net weights are associated with salmon fishing along side Lower Salmon Falls (10GG191) and with islands as is the case at Schellbach Cave (10OE240) and (10AA188). Artifacts and features from the Middle Snake River, ranging from net weights, to weir bases, to harpoon points suggests a variety of different fishing strategies with most fishing sites closely aligned with islands.

While composite harpoon points are not uncommon along the Lower Snake River, net weights are present at nearly every fishing site along this segment. Out of 35 fishing sites on the Lower Snake only two sites (10NP10 and 45AS17) -- where fish walls are located -- have not yielded net weights. Over 90% of the Lower Snake fishing sites were involved in harvesting by net. While the majority of fishing along this segment appears to be by net, evidence for spear and composite harpoon techniques seems to suggest a strategy similar to that found in Hells Canyon. All but one of the eight sites where bone harpoon points are found are directly associated with a rapid.

Evidence, then, for the prehistoric procurement of salmon along the Snake River includes -- either individually or in combination -- osteological fish remains in an archaeological context, along with stone, wood, or bone artifacts representing various fishing techniques, and stone features representing fishwalls and weir bases.

Background Variables

With evidence criteria identified for defining a fishing site, the factors or background variables that condition fishing locations are required. The migration of anadromous fish to inland waterways is greatly influenced by local landscape and hydrographic features (Hewes 1998; Schalk 1986; Quinn 2005).

Table 3 Background Variables.

Background Variables
Physiographic features conditioning fishing site selection
• **Rapids or Falls** – stretches of rough, turbulent and swift water; vertical or near vertical drops passable by fish
• **Islands** – segments of exposed land within and dividing the river into two or more channels
• **Channel Width** – narrow channel restrictions
• **Tributaries** – additional discharge and potential spawning habitat

The background variables are obstacles, obstructions, and points of natural constriction that influence the spawning migration of salmon and help to concentrate the volume of fish in these areas, creating situations favorable to their harvest or capture (Table 3).

Rapids and falls, obvious impediments to fish passage, are often noted as productive fishing locales. Rather than serving as obstacles or obstructions, islands configure the river channel in a way that may facilitate the interception of upstream migration. Depending on configuration, an island may be conducive to fish harvesting that involves nets in deeper pools or spears along shallows. The constriction around an island may also be amplified by the construction of rock walls or weirs. Migrating salmon, when not resting, invariably swim into the swiftest downstream current (Bovee 1978). Selecting the swift side of an island increases opportunities for harvest.

Along stretches of river channel narrowing, the area available for fish navigation also decreases. It is expected that areas exhibiting narrow channel widths will include canyon settings (where the channel is formed by bedrock and colluvium) or along stretches where islands have formed. Lastly, major and minor tributaries are included among background variables as providers of the additional discharge essential to healthy spawning habitat and routes of known migration.

The presence of these background variables will be shown to impact and influence decision-making processes regarding salmon procurement along the Snake River. Aided by GIS the analysis of fishing site locations against the proximity to topographic and hydrographic features will model likely interception points of anadromous fish by aboriginal populations along the Snake River.

CHAPTER 7: SITE DATA

This chapter provides brief details for each of the archaeological sites within the sample set. For each site, the general location is described, fish remains and stone, bone or wood tools pertaining to fishing are identified and quantified. Site location along the river corridor is expressed in river miles (RM), from USGS topographic maps, beginning with the confluence of the Columbia River at RM 0 and progressing upstream to the end of the study area at roughly RM 615. Site vicinity measurements and inventories are also included. Distance measurements are made in kilometers (km), or meters (m) when appropriate. Minimum Channel Width measurements are abbreviated as MCW and the Averaged Minimum Channel Width measurements are abbreviated as AMCW. If available, radiocarbon dates that can be associated with fishing evidence are indicated. Radiocarbon dates are expressed as radiocarbon years before present (B.P.) unless otherwise noted. Each site description also includes inventory results and associated measurements for each of the background variables. Table 4 is a composite matrix listing fishing evidence associated with sites and divided by river segment.

Table 4 Fishing Sites and Representative Fishing Evidence.

Fishing Evidence Matrix				
Site #	**Salmon Bone**	**Other Fish Bone**	**Artifacts**	**Features**
Middle Snake River Segment				
10GG278	*Salmo*	*Cyprinidae*		
10GG312				weir base
10GG191	*Salmonidae*		net weights	
10GG332				weir base
10GG1	*O. tshawytscha*			
10TF352	*Salmonidae*	*Cyprinidae, Catostomidae*		
10EL216				weir bases
10EL22	*Salmonidae*	unidentified		
10EL294	*O. tshawytscha*	*Catostomidae, Acipenseridae*		
10EL1367	*Salmonidae*			
10EL392	*Salmonidae*	unidentified		
10OE269	*O. tshawytscha*			
10OE277				fish wall
10AA188	*Salmonidae*	*Catostomidae Cyprinidae*	net weight	
10OE240	*O. tshawytscha*		net weights, bone harpoon points, wooden spear fore shafts	
10CN1	*Salmonidae*	*Cyprinidae*		
10WN469	*Oncorynchus*	*Acipenseridae, Cyprinidae, Catostomidae*		
Hells Canyon Segment				
10AM76	*Salmonidae*	*Catostomidae*	bone harpoon point	
10IH483	*Salmonidae, Salmo, Oncorynchus*	*Cyprinidae, Catostomidae*	bone barbs and leisters	
10IH699	*O. tshawytscha*	*Cyprinidae, Catostomidae*		
Tin Shed	*Oncorynchus*	*Acipenseridae, Catostomidae*	bone harpoon point	
35WA286	*Salmonidae*			
35WA288	*Oncorynchus, Salmonidae*		bone leister barb	
35WA767	*Salmonidae*	*Catostomidae*		
10NP464	*O. tshawytscha* or *O. keta*			

Fishing Evidence Matrix, continued				
Site #	**Salmon Bone**	**Other Fish Bone**	**Artifacts**	**Features**
Lower Snake River Segment				
45AS47			net weight	
10NP10				fish walls
45AS17				fish wall
10NP151	*Oncorynchus*	unidentified	net weights	
45AS78	*Salmonidae*	unidentified	net weights	
45AS82	*Salmonidae, Oncorynchus*	unidentified	net weights	
45WT41	*Salmonidae*	unidentified	net weights	
45WT39	*Salmonidae*	unidentified	net weights, bone harpoon point	
45WT36			net weights	
45WT49			net weights	
45GA61	*Salmonidae*	unidentified	net weights, bone harpoon point	
45WT35			net weights	
45GA26		unidentified	net weights	
45WT48			net weights	
45WT31		unidentified	net weights	
45WT30			net weights	
45GA17	*Oncorynchus*	unidentified	net weights	
45CO11		unidentified	net weights, bone harpoon point	
45CO1		unidentified	net weights, bone harpoon point	
45WT134	*Salmonidae, Oncorynchus*	*Cyprinidae, Catostomidae,* unidentified	net weights	
45FR50	*Oncorynchus*	*Cyprinidae, Catostomidae,* unidentified	net weight	
45FR201		unidentified	net weights	
45WT2		unidentified	net weights, bone harpoon point	
45WW25			net weight, harpoon valves, antler harpoon points	
45FR39		unidentified	net weights, harpoon valve	
45FR40	*Salmonidae*	unidentified	net weights, bone gorges	
45WW61	*Oncorynchus?*	unidentified	net weight?, bone harpoon point?	
45FR46			net weights	
45FR272			net weights	
45FR32			net weights	
45FR34			net weights	
45FR42			net weights, bone harpoon point	
45FR7			net weights	
45FR283			net weights	
45FR5	*Oncorynchus*	*Catostomidae*	net weights	

10GG278, Kanaka Rapids, Middle Snake River

Site 10GG278 is located upon the first river terrace at approximately RM 592. The site is situated on the north bank of this east-to-west segment of the Middle Snake River, above the head of Kanaka Rapids. Test excavations at 10GG278 were conducted in 1983 (Butler and Murphey 1983). The evidence suggesting salmon procurement at 10GG278 proved to be minimal. The excavations yielded no fish procurement tools and the remains of only three individual fish, all of different genera (Butler and Murphey 1983: 12). The recovered fish bone proved to be that of a trout (Salmo sp.) and minnow or chub (Cyprinidae). The site is estimated to fall within the Late Period (500-1300 A.D.) based upon the association and relative dating of four Rose Spring side-notched points (Butler and Murphey 1983: 24).

The site vicinity of 10GG278 has an Average Minimum Channel Width (AMCW) of 65 m. The Minimum Channel Width (MCW) is 15 m and is located 3 km upstream of the site. The nearest perennial stream is Mud Creek, just over a km downstream, while the nearest tributary exhibiting salmon spawning habitat is Salmon Falls Creek, over 7 km downstream. Six major islands and numerous smaller islands occur within the site vicinity. The nearest islands to the site occur nearly 4 km upstream and over 2 km downstream. Four hydrographic features occur within the site vicinity. The head of Kanaka Rapids is little more than 1 km downstream, and a smaller rapid is located less than .5 km upstream.

10GG312, Middle Snake River

Site 10GG312 is located on an island within the Middle Snake River at approximately RM 590. 10GG312 is an open site exhibiting a variety of stone tools, including several Desert Side Notched points, pot sherds, simple ground stone and exposed fish bones. Murphey (1985) estimates a relative date for the Late Archaic site at approximately 100 BP based upon the presence of Desert Side-notched points and Shoshoni Plainware. The most notable feature associated with site 10GG312 is an exceptionally well-preserved v-shaped, stone fish weir located at the south end of the island and extending west into the river channel (Murphey 1985). Butler and Murphey reference the proximity of 10GG312 to the Kanaka Rapids, speculating that early historic references to a major fishery at Kanaka Rapids were mistaken and most likely referred to the Briggs Creek locality (1983: 4-5). This speculation is "directly related to the ease of establishing artificial adjuncts to fishing in the stretch of river immediately below Kanaka Rapids than at the rapids themselves" (1983: 5).

The site vicinity of 10GG312 has an AMCW of 46 m. The MCW is 15 m and is located 5 km upstream of the site. The nearest perennial stream is Briggs Creek, adjacent eastward of the site, while the nearest tributary exhibiting salmon spawning habitat is Salmon Falls Creek, over just over 5 km downstream. Three major islands and numerous smaller islands occur within the site vicinity. The site occurs on, and adjacent to, an island. Three hydrographic features occur within the site vicinity. The nearest rapid, Kanaka Rapids, is approximately two km upstream.

10GG191, Crutchfield Site, Middle Snake River

The Crutchfield site (10GG191) is located on the north bank of Billingsley Creek, less than 1 km from the Snake River near RM 573. Test excavations revealed sporadic occupation throughout the Archaic, ranging from 7,350 to 620 BP. (Murphey and Crutchfield 1985). The youngest occupation yielded evidence for salmon fishing in Assemblage No. 1. This assemblage included numerous occupational features, including a conical hut house floor (Feature C1), a formal hearth (Feature C2), a cache pit (Feature C3), work area (Feature C4) and post molds (Feature C5). Feature C3 was described as a small cache pit, lined with talus slabs and a flat cobbled floor, containing shell and fish bones (Murphey and Crutchfield 1985: 76). A radiocarbon date of 620 ± 80 B.P. was obtained for Assemblage No. 1 from burned shell associated with Feature C3 (Murphey and Crutchfield 1985: 74). It is assumed that the fish bones associated with Feature C3 are the three Salmonidae vertebra from Assemblage No. 1 (Murphey and Crutchfield 1985: 146). In addition to the Salmonidae bone, Assemblage No. 1 yielded notched (n = 15) and perforated (n = 3) net weights (Murphey and Crutchfield 1985: 59-60).

The site vicinity of 10GG191 has an AMCW of 81 m. The MCW is 32 m and is located 4 km downstream of the site. The nearest perennial stream is Billingsley Creek, adjacent south of the site, whereas the nearest tributary exhibiting salmon spawning habitat is the Malad River, 3 km downstream. No islands occur within the site vicinity of 10GG191. The nearest hydrographic feature is Lower Salmon Falls (now inundated by Lower Salmon Falls Dam), less than one km downstream. No hydrographic features occur upstream within the site vicinity, although Bell Rapids (now submerged) were situated just over 6 km upstream.

10GG332, Middle Snake River

10GG332 is described as a linear cobble alignment across the north end of a cobble bar island in the Middle Snake River located near RM 569. The site is perpendicular to the long axis of the island and the flow of the river. Miss and Campbell (1988) indicate that the orientation of the alignment across the island -- perpendicular to the river's flow -- suggests it was used to trap fish, adding that it may have been the base for a wooden weir or a backwater trap (p 40). The alignment is constructed of rounded unmodified river cobbles (10-40 cm in length) and measures 1.5 to 2 m in width, 50 cm in height and just over 13 m in length (Campbell and Randolph 1988).

The site vicinity of 10GG332 has an AMCW of 44 m. The MCW is 29 m and is located 3 km downstream of the site. The nearest perennial stream and nearest tributary exhibiting salmon spawning habitat is the Malad River, nearly 4 km upstream. A single major island and three smaller islands, as well as three hydrographic features, occur within the site vicinity. Site 10GG332 is situated directly on a smaller island and between small sets of rapids fewer than 3 km, in both upstream and downstream directions.

10GG1, The Bliss Site, Middle Snake River

10GG1 is situated on a large terrace on the north bank of the Middle Snake River near RM 566 and directly across from site 10TF352. Test excavations at 10GG1 yielded 528 fish remains (499 salmonids, 22 non-salmonid, 8 unidentifiable fragments) (Huelsbeck in Plew 1981: 273). Plew and Gould (2001: 12) assert the fish remains indicate approximately 250 individuals. Plew indicates that 10GG1 provided evidence of four components ranging from the Late Archaic through the Early Historic period with a radiocarbon date associated with *Oncorhynchus* sp. bone of 250 ± 110 B.P. (RL-1501) (Plew 1981: 157; 1983: 60) Another radiocarbon date of 290 ± 50 B.P. (TX7464) was obtained from Feature 5, a rock-lined hearth associated with a pestle, an edge-battered cobble and articulated salmon vertebrae (n=10) (Plew and Gould 2001: 5).

The site vicinity of 10GG1 has an AMCW of 40 m. The MCW is 29 m and is located 2 km upstream of the site. The nearest perennial stream and nearest tributary exhibiting salmon spawning habitat is Malad River, 8 km upstream. A single major island and two smaller islands occur within the site vicinity. The nearest island is immediately adjacent to the site. The nearest and only hydrographic feature within the site vicinity is an unnamed rapids located 2 km upstream from the site.

10TF352, Middle Snake River

10TF352 is located on the south bank of the Middle Snake River, near RM 566. Site 10TF352 is bisected by a road separating two cultural components, an upper terrace A, and a lower terrace B. The Area A component dates to roughly 4,000 – 700 B.C. based upon Humbolt point typology, while the younger Area B component dates to roughly A.D.600 – 1,200, based upon Eastgate and Rose Spring point typologies (Plew 1981: 72-73). Site 10TF352 yielded 75 fish bones, including 19 salmonid and four unidentified fragments from Area A, and 47 salmonid and five unidentified from Area B (Huelsbeck in Plew 1981: 275).

Located directly across the river from the Bliss Site, the site vicinity of 10TF352 is identical to 10GG1. The site vicinity of 10TF352 has an AMCW of 40 m. The MCW is 29 m and located 2 km upstream of the site. The nearest perennial stream and nearest tributary exhibiting salmon spawning habitat is Malad River, 8 km upstream. A single major island and two smaller islands occur within the site vicinity. The nearest island is immediately adjacent to the site. The nearest and only hydrographic feature within the site vicinity is an unnamed rapid located 2 km upstream from the site.

10EL216, Middle Snake River

A large open site near RM 553, site 10EL216 is located on the first river terrace along the west bank of the Middle Snake River. Butler and Murphey (1982) describe the site as a well preserved housepit depression, a petroglyph panel, and a series of weirs. Test excavations revealed a single living surface only a few centimeters in depth with no evidence of a hearth feature. Recovered artifacts include a fragment of Great Salt Lake greyware pottery, a fragment of an Eastgate point, a small number (35) of flakes of various sizes, and a minimal amount of minute, unidentifiable bone fragments (Butler and Murphey 1982: 11). The presumed housepit depression is likely an historic feature, however, although no salmon remains were recovered, the associated stacked rock features (n=3) extending from the south bank of the Snake River to the adjacent gravel bar island may indicate the use of weirs or traps for fishing.

The site vicinity of 10EL216 has an AMCW of 33 m. The MCW is 15 m, located adjacent to the site, a product of the nearest island and the location of the weir bases or fish trap features. The nearest perennial stream is Clover Creek, entering the Snake over 5 km downstream of the site, while the nearest tributary exhibiting salmon spawning habitat is the Malad River, over 22 km upstream. Two islands occur in the vicinity of

10EL216, the nearest located 145 m upstream. Two hydrographic features occur within the vicinity, the nearest located 95 m upstream.

10EL22, Clover Creek Site, Middle Snake River

The Clover Creek site (10EL22) is situated on the north bank of the Middle Snake River at approximately RM 548. The site was initially described by Gruhn (1961) as having been extensively disturbed by looters and collectors. One collector reported to Gruhn having found thick, coarse pottery up to 18 inches below the surface, and thin, brown pottery at two to 2 ½ feet below surface level, along with fish bone. Archaeological test investigations were undertaken over two field seasons in 1978 and 1979 (Delisio 1981). Noted were few unidentified fish bone, and the absence of sinker weights or fish hooks (Delisio 1981: 9). Projectile points recovered from the occupational level during 1988 excavations yielded hydration dates between 1013 A.D. ± 36 and 1187 A. D. ± 31 (Plew and Gould 1990: 3, 9). Salmonid bones (n=29) were recovered during the 1988 excavations (Plew 2009).

The site vicinity of 10EL22 has an AMCW of 58 m. The MCW is 25 m and located within 3 km upstream of the site. The nearest perennial stream is Clover Creek, entering the Snake 315 m downstream of the site, while the nearest tributary exhibiting salmon spawning habitat is the Malad River, nearly 27 km upstream. Two islands occur in the vicinity of 10EL22, the nearest located over 3 km downstream. No notable hydrographic features occur within the vicinity of the Clover Creek site.

10EL294, Three Island Crossing Site, Middle Snake River

Three Island Crossing (10EL294) is situated on the north bank of the Middle Snake River at approximately RM 538. Excavations at Three Island Crossing have yielded significant quantities of fish bone (n=19,000+) (Gould and Plew 2001: 74). The majority of the fish remains are salmon or trout, though sucker, squawfish, and sturgeon are represented as well. The recovered fish bones were vertebrae, fin rays and head parts with the vast majority being ribs. Given the fragmented state of rib bone, the total number of fish remains may have been inflated. A calculation for the minimum number of individuals (MNI) indicates the remains represent approximately 300 fish (Gould and Plew 2001: 75). The site has two discernible occupation areas, Area A and Area B. Fish remains are associated with two Area B hearths, Features 1 and 4 (Gould and Plew 2001: 23-25). Feature 5 was located in Area A. Feature 5 is described as a shallow dish shaped circular depression 25-30 cm in depth, exhibiting four post holes and identified as a pole and thatch wikiup (Gould and Plew 2001: 25, 39). Feature 5 also yielded the largest sample of fish remains from the site and a radiocarbon date of 970 ± 330 B.P. (Gould and Plew 2001: 39, 75).

The site vicinity of 10EL294 has an AMCW of 125 m. The 90 m MCW is located within 4 km downstream of the site. The nearest perennial stream is Little Canyon Creek, entering the Snake just over 2 km downstream of the site, while the nearest tributary exhibiting salmon spawning habitat is the Malad River, over 35 km upstream. Over ten major islands occur in the vicinity of 10EL294, the nearest located 720 m downstream. No notable hydrographic features occur within the vicinity of the Three Island Crossing site.

10EL1367, The Medbury Site, Middle Snake River

The Medbury site (10EL1367) is located on the first terrace above the north bank of the Middle Snake River at approximately RM 530. The site is recorded as lithic and ceramic scatter with shell, bone, and thermally altered rock. Given the presence of Shoshonean Plainware, the site can be relatively dated to the Late Archaic (Sayer 1995). Plew and Willson (2005: 109) also indicate the presence of 22 salmon (*Onchorynchus* tshawytscha) and a single catostomid vertebra are associated with the site.

The site vicinity of 10EL1367 has an AMCW of 112 m. Located within 5 km upstream of the site, The MCW is 67 m. The nearest perennial stream is Cold Springs Creek, entering the Snake just over 1 km upstream of the site, while the nearest tributary exhibiting salmon spawning habitat is Canyon Creek, over 42 km downstream. Numerous major islands occur in the vicinity of 10EL1367; the nearest, Schoffs Island, is located less than 700 m upstream. No notable hydrographic features occur within the vicinity of the Medbury Site.

10EL392, Trueblood Wildlife Area Site, Middle Snake River

The Trueblood Wildlife Area Site (10EL392), is located on the east bank of the Middle Snake River upon the first largely deflated terrace at approximately RM 485. Excavations at 10EL392 have yielded a modest artifactual assemblage, distributed over two separate loci (A and B). Vertebrae, ribs, and otoliths made up the 101 fish remains recovered, all from Loci A (Plew and Sayer 1998: 27, Appendix). Plew (2009) indicates 17 salmonid bones were present in the faunal assemblage.

The presence of Desert Side-notched points, Rose Spring points, and ceramics suggests a Late Archaic occupation (Plew and Sayer 1998:23).

The site vicinity of 10EL392 has an AMCW of 136 m. The MCW is 100 m and is located within 3 km upstream of the site. The nearest perennial stream is Castle Creek, entering the Snake nearly 14 km downstream of the site, while the nearest tributary exhibiting salmon spawning habitat is the Bruneau River, nearly 14 km upstream.
Four major islands occur in the vicinity of 10EL392; the nearest one located less than 3 km downstream. No notable hydrographic features occur within the vicinity of the 10EL392.

10OE269, Bonus Cove Ranch Site, Middle Snake River

The Bonus Cove Ranch site (10OE269) is situated on the west bank and upon the first terrace above the Middle Snake River at approximately RM 475. Yohe and Neitzel noted and mapped five features consisting of five clusters of fire-cracked and spalled cobble representing deflated and scattered hearths (Yohe and Neitzel 1998: 3). Feature 2 yielded burned fish bone (Yohe and Neitzel 1998: 5). Among the fish bone recovered from feature 2 were 5 otoliths identified as Chinook salmon (Yohe and Neitzel 1998: 7). Radiocarbon dates from mussel shell returned a calendric calibrated range between 1,765 and 2,175 B.C. Given the often erroneous dates derived from freshwater mollusks coupled with the exclusive presence of Bliss points associated elsewhere in southern Idaho with Late Period sites, Yohe and Neitzel (1998: 8) estimate the documented occupation of 10OE269 to fall within the last 1,000 years.

The site vicinity of 10OE269 has an AMCW of 98 m. The MCW located within 1 km upstream of the site, is 32 m. The nearest perennial stream is Rabbit Creek, entering the Snake nearly 14 km downstream of the site, while the nearest tributary exhibiting salmon spawning habitat is the Bruneau River, 250 m downstream. Seven islands occur in the vicinity of 10OE269. The site is situated between two of the nearest islands, both located fewer than 200 m in each direction. No notable hydrographic features occur within the vicinity of the 10EL392.

10OE277, Middle Snake River

Site 10OE277 is located on the first river terrace above the west bank of the Middle Snake River at approximately RM 455. Murphey (1977) describes the site as a lithic scatter with mussel shell, cobbles, cobble tools and small Side-notched points. Murphy also notes a set of rapids adjacent to the site and a possible fish wall in the river course measuring 20m x 1m x 1m.

The site vicinity of 10OE277 has an AMCW of 77 m. The MCW is 50 m and located within 4 km upstream of the site. The nearest perennial stream is Sinker Creek, entering the Snake nearly 11 km upstream of the site, while the nearest tributary exhibiting salmon spawning habitat is the Bruneau River, nearly 52 km upstream. Five major islands occur in the vicinity of 10OE277, the nearest located less than 1.5 km upstream. Two hydrographic features occur within the vicinity of the 10OE277. The site is situated adjacent to a rapid and fewer than 5 km downstream from the submerged Swan Falls.

10AA188, Middle Snake River

Site 10AA188 is situated on the north bank of the Middle Snake River at approximately RM 454. The site is located on the slope of the first small terrace above the river, in a small basalt rock shelter with a southern exposure (Sayer, Plager, and Plew 1996). Test excavations yielded a possible net sinker and twenty identifiable fish remains including Catostomidae (n=6), Cyprinidae (n=3) and Salmonidae (n=5) (Sayer et al. 1996: 36, 47). Humbolt-like points suggest an early archaic occupation of 10AA188; however, due to evidence for recent human disturbance, the points cannot be directly associated with the salmon bone.

The site vicinity of 10AA188 has an AMCW of 66 m. The MCW is 50 m and located within 2 km upstream of the site. The nearest perennial stream is Sinker Creek, entering the Snake fewer than 13 km upstream of the site, while the nearest tributary exhibiting salmon spawning habitat is the Bruneau River, 54 km upstream. Four islands occur in the vicinity of 10AA188, two within 1 km and the nearest located adjacent to the site. A single hydrographic feature occurs just over 2 km upstream from 10AA188.

10OE240, Schellbach Cave No. 1, Middle Snake River

Schellbach Cave is located on the south side of the Middle Snake River near RM 453. The cave is situated approximately 150 feet above the Snake River flood plain. Among the items collected at Schellbach Cave are fish bone and fishing gear, including fish spear fore shafts, harpoon shafts, fishing line, net weights, and a composite fishhook (Pavesic et al. 1987; Schellbach 1967). W.I. Follett of the California Academy of Sciences identified the majority fish remains as chinook salmon (*Onchorynchus* *tshawytscha*), while the remainder were identified as salmonid (Pavesic et al. 1987). A "twisted twig bundle" (artifact # 16-6817) provided a radiocarbon date of 2660 ± 60 BP (Beta-126534).

The site vicinity of 10OE240 has an AMCW of 83 m. The MCW is 55 m and located within 1 km downstream of the site. The nearest perennial stream is Sinker Creek, entering the Snake fewer than 13 km upstream of the site, while the nearest tributary exhibiting salmon spawning habitat is the Bruneau River, less than 55 km upstream. Four islands occur in the vicinity of 10OE240, two within 1 km and the nearest located approximately 615 m upstream from the site. A single hydrographic feature occurs just over 3 km upstream from 10OE240

10CN1, Middle Snake River

Site 10CN1 is located near RM 447 on the Middle Snake River and situated on the north bank upon the first very small terrace above the water course. 10CN1, an open campsite, exhibited five features, likely to be hearths, bearing charcoal and or ash and associated with bone, shell, debitage and fire-cracked rock (Sayer, Plew, and Plager 1997: 13). Excavation at 10CN1 yielded Salmonidae and Cyprinidae fish bone representing 22% of the faunal assemblage (Sayer et al. 1997: 35-36), with 166 classified as salmonid (Plew 2009). It should be noted that Sayer et al. (1997: 41) question if the salmonid bone recovered at 10CN1 can be attributed to Pacific salmon species. Based on size comparisons, the recovered salmonid bone resembles trout or whitefish, though no evidence can rule out the presence of salmon at 10CN1. The presence of Desert Side-notched, Cottonwood Triangular, and Rose Spring projectile points indicates a Late

Archaic (post 1,000 B.P.) occupation of the site, though the Elko points would suggest a Middle Archaic component stretching back to 5,000 B.P. (Sayer et al. 1997: 39).

The site vicinity of 10CN1 has an AMCW of 104 m. The MCW is 45 m and located within 1 km upstream of the site. The nearest perennial stream is Reynolds Creek, entering the Snake over 11 km downstream of the site, while the nearest tributary exhibiting salmon spawning habitat is the Bruneau River, over 61 km upstream.
Three major and seven lesser islands occur in the vicinity of 10CN1, two within 1 km and adjacent to the site. No notable hydrographic features occur within the vicinity of 10CN1.

10WN469, Hetrick Site, Middle Snake River

The Hetrick site is situated on the east bank of Monroe Creek and near the confluence of the Weiser and Snake Rivers in southwestern Idaho. Geomorphic analysis of the soils and analysis of the cultural stratigraphy reveal deeply stratified and relatively undisturbed deposits containing four separate occupations. The earliest occupations, Weiser I and II, are dated at 9,730 ± 60 B.P. and 9,850 ± 110 B.P. Theses dates are derived from bone collagen retrieved from lower soil stratum (IIIc and IIId) and are corroborated with diagnostic projectile points (Windust) when calibrated to calendar years from roughly 10,500 B.P to 11,500 B.P. (Rudolph 1995).

Stratum IIIc contained two features, E and F, which yielded significant evidence for the earliest use of salmon along the Snake River. Feature E, a large concentration of mussel shell and small, medium and large mammal bone, as well as a small number of salmonid bone, also contained evidence of cultural modification to bone, including burned bone and butcher marks. Feature F, located adjacent to Feature E, consisted of a similar makeup and distribution of bone, with a higher percentage of salmonid bone. The vast majority of these osteological remains consist of only vertebrae and rib bone, with a near total lack of skull or head fragments (Rudolph 1995). This distribution suggests the trunk portion of the fish were deposited at the site after procurement and initial butchering or processing occurred at a separate location (Butler 1990; Rudolph 1995).

The site vicinity of 10WN469 has an AMCW of 94 m. The MCW is 26 m at a locale within 5 km downstream of the site. The site is situated immediately adjacent to the nearest perennial stream, Monroe Creek. The nearest tributary exhibiting salmon spawning habitat is the Weiser River, less than 1 km to the south. Six major and numerous lesser islands occur in the vicinity of 10WN469, the nearest occurring fewer than 32 km downstream from the site. No notable hydrographic features occur within the vicinity of 10WN469.

10AM76, Squaw Creek Rockshelter, Hells Canyon of Snake River

The Squaw Creek Rockshelter lies at approximately RM 253, on the east bank opposite the confluence of Squaw Creek with the Snake River. The rockshelter is located at the base of a high cliff roughly 125 ft above the river. Four different stratigraphic units are identified and cultural materials recovered throughout to nearly 50cm in depth (Warren, Sims, and Pavesic 1968). Salmonidae vertebrae were recovered from the two lowest stratigraphic units (Warren et al. 1968: 19; Johnston 1987: 54, 146). Fishing tools reported by Warren et al. (1968: 18) include a single fish gorge from the lower stratigraphic units, although Johnston (1987:142) reports both fish catching (gorge) and bone spear or leister recovered from 10AM76. Based on relative dating, Warren et al.

propose a tentative chronology for Hells Canyon phases with the lower stratigraphic units at 10AM76 falling into the Squaw Creek II phase and dating between 1500 to 500 B.C. (1968:13-14).

The site vicinity of 10AM76 has an AMCW of 158 m. The MCW is 40 m at its location within 1 km downstream of the site. The site is situated immediately across from the nearest perennial stream, Squaw Creek. The nearest tributary exhibiting salmon spawning habitat is Pine Creek, approximately 24.5 km downstream. Two islands occur in the vicinity of 10AM76; the nearest is less than 1 km downstream from the site. Four sets of rapids occurred historically within the site vicinity, all now submerged by Hells Canyon Reservoir. The nearest rapid was located fewer than 3 km upstream from 10AM76.

10IH483, Bernard Creek Rockshelter, Hells Canyon of Snake River

The Bernard Creek Rockshelter (10IH483) is located on the east bank at approximately RM 235 in the Hells Canyon reach of the Snake River. Randolph (1975) described the rockshelter as mostly disturbed by pothunting activities, measuring 60-feet wide, and 10-feet deep with a 10-foot ceiling. Randolph and Dahlstrom (1977) tested the site in 1976 to determine the remaining potential and extent of disturbance to the site. Three excavation blocks show the site has been utilized for over 7,000 years. The excavations revealed two extensively utilized occupational areas, a storage pit, a hearth, and a lithic work area. The base of the storage pit (Feature 1) was lined with river cobble, below which fish remains were concentrated (Randolph and Dahlstrom 1977: 42). Feature 2 proved to be an occupational layer, which, present in both excavation blocks 1 and 3, was characterized by an increase in cobble tools, concentrations of mussel shell, and a hearth. A radiocarbon date from this hearth places the occupation at 7250 ± 80 B.P. (WSU-1675). Feature 3 was also a Block 1 hearth, extending from 265cm to 290cm and associated with mammal bone and cobble tools. Feature 4, also encountered in Block 1, is described as a lithic workshop where clusters of worked cobble were found in association with a large boulder (Randolph and Dahlstrom 1977: 42).

Fish remains were abundant, identifiable, and well preserved with the vast majority recovered from Block 1, limited amounts from Block 3 and none from Block 2. Only fish remains from Block 1 were identified. Identifiable fish included Pacific salmon (*Oncorhynchus sp.*), trout, suckers, peamouth, northern squawfish, chub and chiselmouth (Randolph and Dahlstrom 1977: 15). Salmon bone was most prevalent between 200 cm and 370 cm in Block 1, corresponding with a second radiocarbon date of 7190±135 B.P. (WSU-1676) (Randolph and Dahlstrom 1977: 15-16, 38, 96). Recovered fishing tools included bone barbs and leisters (Randolph and Dahlstrom 1977: 74, 77; Johnston 1987).

The site vicinity of 10IH483 has an AMCW of 49 m. The MCW is 30 m and located within 2 km downstream of the site. The nearest perennial stream is Bernard Creek, entering the Snake less than 200 m downstream of the site, while the nearest tributary exhibiting salmon spawning habitat is Big Canyon Creek, less than 32 km downstream. A single island occurs in the vicinity of 10IH483, located less than 500 m upstream from the site. Seven sets of rapids occur within the site vicinity, the nearest located less than 300 m downstream from 10IH483.

10IH699, Kirkwood Bar Site, Hells Canyon of Snake River

The Kirkwood Bar site (10IH699) sits upon the third terrace above the confluence of Kirkwood Creek and the Snake River, on the east bank of the Snake near RM 221. Excavations at the Kirkwood Bar Site yielded three occupational surfaces associated with 14 features, all hearths (Reid and Chatters 1997). Dates from the hearths indicate the three occupational surfaces are contemporaneous in radiocarbon years (Reid and Chatters 1997: 2.15). The prehistoric living surfaces were open sites within an exposed boulder field. Fish represented the bulk of faunal remains, including sucker, squawfish, peamouth, and chiselmouth recovered from each of the occupational surfaces. Chinook salmon were ubiquitous as well with a MNI of 22 recovered at Occupation 1, a MNI of 35 at Occupation 2, and a MNI of 15 at Occupation 3 (Reid and Chatters 1997: 3.6-3.17). Two hearths were noted at Occupation 1 (features 15 and 16). A radiocarbon date of 6740 ± 50 B.P. (Beta 80170) was sampled from Feature 16 (Reid and Chatters 1997: 3.6). At least five hearths were associated with Occupation 2 (features 7, 8, 11, 13, and 14). Feature 14 yielded radiocarbon dates of 7100 ± 60 B.P. (Beta 61101) and 6850 ± 50 B.P. (Beta 68175) (Reid and Chatters 1997: 3.11). Occupation 3 contained seven hearths (Features 1, 2, 3, 4, 5, 6, and 10). Feature 2 yielded a radiocarbon date of 6890 ± 90 B.P. (Beta 80171) (Reid and Chatters 1997: 3.17).

The site vicinity of 10IH699 has an AMCW of 52 m. The MCW is 44 m and is located within 1 km upstream of the site. The Kirkwood Bar site is situated adjacent to Kirkwood Creek, the nearest perennial stream, while the nearest tributary exhibiting salmon spawning habitat is Big Canyon Creek, located over 12 km downstream. A single island occurs in the vicinity of 10IH699, located over 3 km upstream from the site. Six sets of rapids occur within the site vicinity. The nearest, Slaughter Gulch Rapids, is located less than 1 km upstream from 10IH699.

Tin Shed Site, Hells Canyon of Snake River

The Tin Shed site is located along the southern portion of Pittsburg Bar, on the west bank of the Snake River at approximately RM 215. The remaining buried cultural deposit, contained within aeolian or alluvial sand, was lagging from the cutbank and threatened by further erosion. Test excavations revealed four analytical units of cultural stratigraphy (AU1-AU4) (Root, Chatters, Ferguson, and Reid 1998:6, 14, 25). Working from the surface down, AU1 contained artifacts recently redeposited as a result of historic slope wash. The second analytical unit (AU2) yielded a glass bead suggesting a Numipu Phase occupation, as well as corner-notched points indicating a slightly earlier occupation, perhaps a Late Harder phase (Root et al. 1998:43). The third analytical unit (AU3) produced basal-notched, Snake River series points, placing it in the Harder, Early Subphase (Root et al. 1998:43). The fourth analytical unit (AU4) is undated and yielded no diagnostic points, though Root et al. estimate the unit to predate the Harder phase base on its stratigraphic position below AU3 (Root et al. 1998:44). Only two features were observed during test excavations of the Tin Shed site. Feature One is a diffuse charcoal corresponding to AU1, and Feature Two is described as a large concentration of fire cracked rock associated with AU2. Sucker (*Catastomus)*, salmon (*Oncorhynchus*), sturgeon (*Acipnser*) bone were recovered (Root et al. 1998:52). The salmon bones and two otoliths were recovered from AU3 along with a bone tool suggested to represent part of a composite harpoon or spear (Root et al. 1998:43-44).

The site vicinity of the Tin Shed site has an AMCW of 51 m. The MCW, located within 3 km downstream of the site, is 40 m. The nearest perennial stream is Corral Creek, entering the Snake less than 2 km upstream of the site, while the nearest tributary exhibiting salmon spawning habitat is Big Canyon Creek, fewer than 7 km downstream. A single island occurs in the vicinity of the Tin Shed site, located less than 2 km downstream from the site. Ten sets of rapids occur within the site vicinity. The nearest, Upper Pittsburg Landing Rapids, is located less than 500 m upstream from the Tin Shed site.

35WA286, Camp Creek Site, Hells Canyon of Snake River

The Camp Creek site (35WA286) is located on the west bank of the Snake River near RM 210. The site rests upon two remnant terraces (T1 and T2). A collection of block excavations, trenches, and test units exposed at least five separate features spread across T1 and T2 (Leonhardy and Thompson 1991: 7, 9, 13). The features were described variously as shell lenses, scattered shell, and fire-cracked rock. A single radiocarbon date of 1500 ± 100 B. P. (Beta 35719) was assigned to Feature 6, described as a shallow pit earth oven containing charcoal and fire cracked rock (Leonhardy and Thompson 1991: 13). A single salmon bone was collected (Leonhardy and Thompson 1991:18-19).

The site vicinity of the 35WA286 site has an AMCW of 48 m. The MCW is 33 m and located within 3 km downstream of the site. The nearest perennial stream is Camp Creek, entering the Snake roughly 70 m upstream of the site, while the nearest tributary exhibiting salmon spawning habitat is Big Canyon Creek, less than 2 km upstream. A single island occurs in the vicinity of 35WA286, located fewer than 500 m downstream from the site. Five sets of rapids occur within the site vicinity. The nearest, Somers Creek Rapids, is located less than 500 m upstream from 35WA286.

35WA288, Tryon Creek Site, Hells Canyon of Snake River

The Tryon Creek site (35WA288) is situated on an alluvial fan north of Tryon Creek, some 100 m up the west bank of the Snake River at RM 209. Leonhardy and Thompson describe the site as a concentration of no fewer than nine housepit depressions, with most vandalized but at least two intact (Leonhardy and Thompson 1991: 22). Two excavation units were placed within one of the partially disturbed house pit depressions. These test excavations revealed four distinguishable living surfaces and a central hearth feature extending through each of the house floors (Leonhardy and Thompson 1991: 23-26). At least one bone leister barb and a single salmon vertebra were recovered (Leonhardy and Thompson 1991: 26-31). A charcoal sample from the hearth feature corresponding to that from Floor 2, yielded a radiocarbon date of 1230 ±70 years BP (Beta 35,718) (Leonhardy and Thompson 1991: 31). Later excavations at the Tryon Creek site (Hackenberger and Thompson 1995) yielded an additional 70 salmonid specimens associated with radiocarbon dates ranging from 1640 ± 100 to 1085 ± 50 years BP.

The site vicinity of the Tryon Creek site has an AMCW of 45 m. The MCW is 35 m and is located within 2 km downstream of the site. The nearest perennial stream is Tryon Creek, entering the Snake roughly 80 m upstream of the site, while the nearest tributary exhibiting salmon spawning habitat is Big Canyon Creek, just over 2 km upstream. A single island occurs in the vicinity of the Tryon Creek site, located 225 m upstream from the site. Six sets of rapids occur within the site vicinity. The nearest, Cottonwood Rapids, is located less than 1 km downstream from the Tryon Creek site

35WA767, Knight Creek Site, Hells Canyon of Snake River

The Knight Creek site (35WA767) is situated upon a sequence of terraces above Knight Creek approximately one kilometer up from RM 190 on the Snake River. Knight Creek enters the Snake River from the west bank, roughly splitting the distance between the Imnaha River upstream and the Salmon River downstream. Thirteen house depressions were mapped and twelve were tested (Hackenberger 1993). Radiocarbon ages from the Knight Creek site range between 1040 ± 90 B.P. (Beta 34472) and 2450 ± 120 B.P. (Beta 34473) (Hackenberger 1993; 17). Twenty-two salmonid vertebrae and skull fragments were recovered from the deepest levels of House 1 and associated with radiocarbon dates of 2450 ± 120 years BP (Beta 34473) and 2240 ± 60 years BP (Beta 34474) (Hackenberger 1993: 69, 78).

The site vicinity of the Knight Creek site has an AMCW of 42 m. The MCW is 26 m and located within 2 km downstream of the site. The nearest perennial stream, as well as the nearest tributary exhibiting salmon spawning habitat is the Imnaha River, entering the Snake fewer than 2 km downstream of the site. A single island occurs in the vicinity of the Knight Creek site, at more than 4km downstream from the site. Six sets of rapids occur within the site vicinity. The nearest and unnamed rapids at Eureka Bar are located fewer than 400 m downstream from the Knight Creek site.

10NP464 Cougar Bar Village, Hells Canyon of Snake River

The Cougar Bar Village (10NP464), situated alongside the lower reaches of Cougar Creek, lies upon an alluvial fan above the east bank of the Snake at approximately RM 179 (Neitzel, Reid, Pitkin, Miller, and Uebelacker 2006). This location had previously been suggested by Russell (2003) as the Nez Perce encampment that Sergeant John Ordway and Privates Robert Frazer and Peter Weiser of the Corps of Discovery visited in May of 1806. In June of 2006, magnetic gradiometry, electrical resistance and electromagnetic induction methods were employed to map surface and subsurface features including six housepit perimeters and partitions (Features A-F), subsurface hearths (H1-4), mounded earth middens, and a circular distribution of rock (Feature G) immediately below the surface (Kvamme 2006). Feature A, an elongated house depression, measured 21 m by 9 m, dimensions closely matching those described by Sergeant Ordway. Magnetic gradiometry readings identified four subsurface circular magnetic rock anomalies down the center line of the depression (Kvamme 2006). Testing confirmed the location and identity of two hearths within Feature A, a midden berm (Feature A) and the circular rock Feature G. A radiocarbon date of 100 ± 40 B.P. was obtained from one of the interior hearths of Feature A. This date is calibrated to a calendar age of calAD 1811 ± 99, presumably overlapping with Ordway's visit. A steelhead otolith was recovered from the midden berm (Feature A). An indirect association with the early 19th century date can be considered, assuming the contents of the interior hearths and floor of Feature A were deposited in creating the midden berm.

The site vicinity of 10NP464 has an AMCW of 77 m. The MCW is 38 m and is located within 2 km downstream from the site. The nearest perennial stream is the adjacent Big Cougar Creek. The site is situated nearly equidistant between the nearest salmon spawning tributaries. The Grande Ronde River enters the Snake over 15 km downstream and the Salmon River joins the Snake over 13 km upstream of the site. Eight islands occur in the vicinity of the Cougar Bar Village site, the nearest located less than 1 km downstream from the site. Six sets of rapids occur within the site vicinity. The nearest, Cougar Rapids, are located less than .5 km downstream from 10NP464.

45AS47, Lower Snake River

Sites 45AS47, 10NP10, and 45AS17 were surveyed and tested in 1964 (Nelson and Rice 1969) ahead of a proposed Asotin Dam project. Site 45AS47 is an open site located on the west bank of the Snake downstream from RM 169. A single test unit to a depth of two meters revealed a possible earth oven, a small hearth, and mussel shell. A total of 78 stone and bone artifacts were noted, including stemmed Side-Corner-notched and Columbia Plateau Corner-notched points, suggesting sporadic occupation over at least the past 4,000 years. Four sinkers were recovered, suggesting salmon harvesting (Nelson and Rice 1969: 39-40).

The site vicinity of 45AS47 has an AMCW of 93 m. The MCW is 21 m and located within 2 km upstream of the site. The nearest perennial stream, as well as the nearest tributary exhibiting salmon spawning habitat is the Grande Ronde River, entering the Snake less than .5 km upstream of the site. Two islands occur in the vicinity of the 45AS47, the nearest located just over 1 km upstream from the site. Two sets of rapids occur within the site vicinity. The nearest, Limekiln Rapids, are located roughly 1 km downstream from 45AS47.

10NP10, Lower Snake River

Site 10NP10 is described as a series of fish walls on the east bank of the Snake near RM 162. An estimated ten fish walls are scattered along a 300 m stretch of beach at various elevations of the slope (Nelson and Rice 1969: 58). No testing was conducted at 10NP10, though use of the fish walls for dip netting salmon at this location were noted as late as the twentieth century (Nelson and Rice 1969: 95).

The site vicinity of 10NP10 has an AMCW of 108 m. The MCW is 70 m and located within 2 km upstream of the site. The nearest perennial stream is Captain John Creek, entering the Snake approximately .5 km upstream of the site. The nearest spawning stream is the Grande Ronde located over 9 km upstream. Two islands occur in the vicinity of 10NP10, the nearest fewer than 2 km upstream from the site.

Five sets of rapids occur within the site vicinity. The nearest, Captain John Rapids, are also located fewer than 2 km upstream from 10NP10.

45AS17, Lower Snake River

Site 45AS17 is located on the west bank at Tenmile Bar of the Snake River upstream from RM 150. Thirty stone artifacts were recovered from a single excavation unit. Stemmed Side-Corner-notched and Columbia Plateau Corner-notched points suggest site occupation over the past 4,000 years. A single fish wall along the sloping beach indicates salmon harvest (Nelson and Rice 1969: 14).

The site vicinity of 45AS17 has an AMCW of 173 m. The MCW is 95 m and located within 2 km downstream of the site. The nearest perennial stream is Tenmile Creek, entering the Snake roughly 260 m downstream of the site, while the nearest tributary exhibiting salmon spawning habitat is Asotin Creek, over 7 km downstream. Two islands occur in the vicinity of 45AS17, the nearest located less than 2 km downstream from the site. A single set of rapids, Tenmile Rapids, occurs over 2 km downstream from 45AS17.

10NP151, Hasotino, Lower Snake River

The Hasotino Village site (10NP151) is situated upon a minimally sloped floodplain bar along the east bank of the Snake at RM 145. The site is described as a late prehistoric to early historic winter village containing housepit depressions visible on the surface (Iverson 1975). Five excavation units revealed three separate components or cultural units. Only Component 3, the youngest component, yielded any evidence for salmon procurement. Salmon vertebrae, along with notched sinkers, are associated with Component 3 (Iverson 1975: 35, 45). No radiocarbon dates were obtained as a result of the 1975 testing, although, based upon the presence of historic metal and glass artifacts, Component 3 is suggested to correspond with the Ethnographic Period (Iverson 1975: 58). Subsequent testing by Sappington and Carley (1985) also confirmed the presence of salmon bone among 1800 fish remains recovered from a house floor from within the Hasotino Village.

The site vicinity of 10NP151 has an AMCW of 167 m. The MCW is 148 m and located within 4 km downstream of the site. The nearest perennial stream and salmon spawning habitat tributary is Asotin Creek, entering the Snake roughly 450 m downstream of the site from the opposite bank. No islands occur in the vicinity of 10NP151. Four major sets of rapids were located within the Hasotino site vicinity, although all are now inundated. The Hasotino Village site was situated between the upper and lower Hasotino Rapids, both within 1 km of the site.

45AS78/82, Alpowa Locality, Lower Snake River

Largely inundated behind the Lower Granite Dam, the Alpowa Locality was a village site situated at the confluence of Alpowa Creek with the Snake River at approximately RM 131. Situated on Silcott Bar along the south river bank, excavations at the Alpowa Locality (sites 45AS78, 45AS80, and 45AS82) revealed a 6,000 year winter village occupation (Brauner 1976). Both salmon and unidentified fish bone were recovered from sites 45AS78 and 45AS82. At site 45AS82, four semi-subterranean houses were fully excavated and another four partially excavated, along with 31 intrusive pits (Brauner 1976: 49, 165). Nine salmonid vertebrae, another 49 unidentified fish bones, and seven net weights were recovered from within the houses. Activity areas outside the houses yielded another nine net weights and seven *Oncorhynchus* sp. vertebrae (Brauner 1976: 80-195). No fish bone or fishing equipment was recovered from the 31 intrusive pits. Early testing at 45AS78 yielded four net weights (Brauner 1976: 257-271). Later block excavations of two housepits added a single salmonid bone along with 13 net weights (Brauner 1976: 270-280). Lyman (1976) indicates the number of recovered fish vertebrae were greater at the Alpowa Locality. Lyman indicates 69 salmonid vertebrae and 245 vertebrae from other fish were recovered from 45AS82, accounting for nearly 15% of the Alpowa Locality faunal assemblage (Lyman 1976: 26). The oldest radiocarbon date for the Alpowa Locality, 4060±130 B.P. (WSU1438), is derived from wood charcoal obtained near House 5 at 45AS82 (Brauner 1976: 318). A radiocarbon date of 1410 ± 80 B.P. (WSU-1439) obtained from a structural member of House 2C is associated with the salmonids and other fish vertebrae recovered from the floor of the same house (Brauner 1976: 318)

The AMCW within the Alpowa site vicinity is 196 m. The MCW is 147 m and located within 4 km downstream of the site. The nearest perennial stream is Alpowa Creek, which bisects the sites that make up the Alpowa locality, while the nearest tributary exhibiting salmon spawning habitat is the Clearwater River, 13 km upstream. A single island is located in the vicinity, located 3 km downstream of the Alpowa Locality. Two sets of rapids occur within the site vicinity. The nearest set, Alpowa Rapids, are immediately adjacent to the locality.

45WT41, Granite Point Locality 1, Lower Snake River

The Granite Point Locality 1 site (45WT41) is one of numerous archaeological deposits noted eroding from exposed cutbank near RM 114. Now inundated behind the Lower Granite Dam, 45WT41 was situated on the west bank of the Lower Snake River at the downstream end of a small bar (Leonhardy 1970). Excavations at three areas (A, B and C) revealed extensive occupations based on radiocarbon dates ranging from 5145 ± 200 B.P. (WSU 668) to 955 ± 155 B. P. (WSU 666), and living surfaces defined through each stratum characterized by fire cracked rock, charcoal stains, bone fragments, shell lenses and artifacts (Leonhardy 1970: 22, 27, 40, 67-72). Two earlier components, with no clearly defined living surfaces and no radiocarbon dates, were recorded below a Mazama ash horizon marker (Leonhardy 1970: 72). Associated with Component 2 at Area C were large salmonid bone (no count) (Leonhardy 1970: 118). Unidentified fish bone (no count) and notched net weights (one each component) were associated with Components 4 and 5 (Leonhardy 1970:159, 168, 183, 186).

The site vicinity of 45WT41 has an AMCW of 218 m. The MCW is 164 m and located within 1 km downstream of the site. The nearest perennial stream is Kluge Canyon Creek, entering the Snake less than 2k m downstream of the site, while the nearest tributary exhibiting salmon spawning habitat is the Clearwater River, over 31 km upstream. No islands occur in the vicinity of 45WT41. Two sets of rapids occur within the site vicinity. The nearest, Granite Point Rapids, are located just over 1 km upstream from 45WT41.

45WT39, Wawawai, Lower Snake River

Now inundated behind the Lower Granite Dam, the Wawawai Site was situated on Wawawai Bar near the mouth of Wawawai Creek. The site was located on the northeast bank of the Lower Snake River near RM 110. Excavations at Wawawai were conducted in 1968 at Area A and in 1971 at Area B. Excavations at Area A yielded five cultural features, including two houses, two living surfaces and a single hearth. Another four houses were described at Area B (Yent 1976: 17, 23). Fish bone was recovered from both Area A and Area B. No further provenience information is available. Forty-two unidentified fish bone fragments were recovered from Area A and another 10 from Area B. Ten Salmonidae fragments from Area A and two from Area B were also recovered (Yent 1976: 154). Five composite harpoon parts added to the fishing evidence at Wawawai, in addition to five net weights from Area B (Yent 1976: 38, 43, 53).

Two radiocarbon dates from House 3, Area B were associated with two of the net weights (Yent 1976: 23, 38). The radiocarbon dates were returned from two separate samples of charcoal from a burnt structural post and are aged 1030 ± 90 B.P. (WSU-1620) and 910 ± 90 B.P. (WSU-1621) (Yent 1976: 13).

The site vicinity of 45WT39 has an AMCW of 160 m. The MCW is 20 m and located within 3 km downstream of the site. The nearest perennial stream is Wawawai Canyon Creek, entering the Snake less than 1 km downstream of the site, while the nearest tributary exhibiting salmon spawning habitat is the Clearwater River, over 36 km upstream. A single major island occurs in the vicinity of 45WT39. Log Cabin Island is located less than 3 km downstream of the site. Two sets of rapids occur within the site vicinity. The nearest, Ofields Rapids, are located just over 3 km downstream from 45WT39.

45WT36, Thorn Thicket Site, Lower Snake River

Presently inundated behind the Lower Granite Dam, the Thorn Thicket site (45WT36) was located on the north bank of the Lower Snake River. The site is situated upon the alluvial fan of the intermittent Thorn Thicket Creek at approximately RM 109. Exposed during construction of the Camas Prairie Railroad, the Thorn Thicket site yielded deep cultural deposits reaching five meters in depth (Sprague and Combes 1966: 8). No features or house floors were noted by Sprague and Combes (1966) but an early radiocarbon date of 7710 ± 180 B.P. (WSU-409; Bense, 1972) and the recovery of historic trade items (glass beads) suggest intermittent use of the site for a period of 6,000 years. Evidence for fishing at 45WT36 is supported by the recovery of fourteen net weights. The notched sinkers were all recovered within 60 cm of the surface and were associated with trade goods, presumably glass beads (Sprague and Combes 1966: 10).

The site vicinity of 45WT36 has an AMCW of 179 m. The MCW is 20 m and located within 1 km downstream of the site. The nearest perennial stream is Wawawai Canyon Creek, entering the Snake less than 3 km upstream of the site, while the nearest tributary exhibiting salmon spawning habitat is the Clearwater River, over 38 km upstream. Now inundated, a single major island occurred in the vicinity of 45WT36. Log Cabin Island was located less than 600 m downstream of the site. Two sets of rapids occurred within the site vicinity. The nearest, Ofields Rapids, were located just over 1 km downstream from 45WT36.

45GA61, Wexpusnime, Lower Snake River

Wexpusnime (46GA61) is situated upon the downstream end of Offield Bar, located on the south bank of the Lower Snake River near RM 108. Currently inundated behind the Lower Granite Dam, Area A and Area B were excavated at Wexpusnime between 1969 and 1970 (Leonhardy, Schroedl, Bense, and Beckerman 1971). Area B proved to be a Cascade Phase component (4,500 B.C.-6,000 B.C.) and exhibited no evidence for fishing. Seven houses and associated features were excavated at Area B. Leonhardy et al. (1971:17) report 7 notched net weights and three harpoon tips. Nakonechny (1998) would later expand on the description and analysis of Area A, defining six occupation intervals (Components 1-6). Component 1 was comprised of the Plow Zone and the Late Camp. Based on the presence of horse bone (and the absence of historic trade goods) from the Late Camp component, this component has a relative date range of A.D. 1730 to A.D. 1800 (Nakonechny 1998: 118). One four-notch and two perforated net weights were collected from the Plow Zone (Nakonechny 1998: 95). One each, notched and perforated net weights and one bone harpoon point were associated with the Late Camp (Nakonechny 1998: 117). No evidence for fishing could be associated with the Early Camp (Component 2). Fill from House 2 (Component 3) contained "several salmon remains" associated with a bone harpoon point (Nakonechny 1998: 152). Burned grass "thatch" retrieved from below the rim of House two returned a radiocarbon date of 1190 ± 60 B.P. (WSU-4997) (Nakonechny 1998: 146, 151). Component 4 yielded salmon vertebrae (no counts) from storage pits (Features 59A, 64A, 68A) associated with House 6, and fish remains and a single, notched net weight were recovered from House 1 (Nakonechny 1998: 169). A notched net weight was recovered from a hearth feature (Feature 71) at House 5 (Component 5). House 5 also yielded three bone harpoon points and another notched net weight with no additional provenience information (Nakonechny 1998: 181, 196). Finally, a notched net weight was associated with House 4 (Component 6). A sample of burned wood from the floor of House 4 returned a radiocarbon date of 1050 ± 100 B.P. (WSU-4996) (Nakonechny 1998: 201).

The site vicinity of 45GA61 has an AMCW of 205 m. The MCW is 20 m and located within 1 km downstream of the site. The nearest perennial stream is Wawawai Canyon Creek, entering the Snake less than 3 km upstream of the site, while the nearest tributary exhibiting salmon spawning habitat is the Clearwater River, over 38 km upstream. A single major island occurs in the vicinity of 45GA61.

Log Cabin Island is located adjacent to the site. Two sets of rapids occur within the site vicinity. The nearest, Ofields Rapids, are located less than 1 km downstream from 45GA61.

45WT49, Lower Snake River

Site 45WT49 is a small rockshelter located above the north bank of the Lower Snake River near RM 108. Test excavations at 45WT49 confirmed little depth within the rockshelter and yielded two corner notched points and scrapers along with a notched net weight (Sprague and Combes 1966: 20).

The site vicinity of 45WT49 has an AMCW of 176 m. The MCW is 20 m and located within 1 km upstream of the site. The nearest perennial stream is Wawawai Canyon Creek, entering the Snake less than 4 km upstream of the site, while the nearest tributary exhibiting salmon spawning habitat is the Clearwater River, nearly 39 km upstream. A single major island occurs in the vicinity of 45WT49. Log Cabin Island is located adjacent to the site. Two sets of rapids occur within the site vicinity. The nearest, Ofields Rapids, are located less than 1 km downstream from 45WT49.

45WT35, Lower Snake River

Site 45WT35 was destroyed by construction of the Lower Granite Dam. It was located at the lower end of Davis Bar, on the north bank of the Lower Snake River at approximately RM 107. Prior to its destruction, salvage excavations at site 45WT35 recovered Windust Phase points, Corner- and Side-notched points, hammerstones, scrapers, bone awls, a pestle and a net weight (Sprague and Combes 1966: 17). Based on the presence of Corner-notched points, the pestle, bone awls and the net weight, evidence for fishing at 45WT35 can be dated relatively to the Tucannon Phase (4500 B.P to 2500 B.P.) or later.

The site vicinity of 45WT35 has an AMCW of 166 m. The MCW is 21 m and located within 2 km upstream of the site. The nearest perennial stream is Wawawai Canyon Creek, entering the Snake over 4 km upstream of the site, while the nearest tributary exhibiting salmon spawning habitat is the Clearwater River, over 40 km upstream. A single major island occurs in the vicinity of 45WT35. Log Cabin Island is located adjacent to the site. Two sets of rapids occur within the site vicinity. The nearest, Log Cabin Rapids, are located less than 1 km downstream from 45WT35.

45GA26, Lower Snake River

Site 45GA26 is located on Illia Bar along the south bank of the Lower Snake River near RM 103. Block excavations (Blocks A-J) at 45GA26 identified three features: an oven or roasting pit, a hearth, and an open occupation surface (Cannell 2001). Thirteen notched net weights were recovered from the open camp at 45GA26. Feature 1 (Block A), the large oven feature, yielded four net weights (Cannell 2001: 77). Another five sinkers were recovered from Block B, the occupational surface (Feature 2) (Cannell 2001: 84). The remaining net weights were recovered from Blocks F and G (Cannell 2001: 98-99). No fish bones were noted at 45GA26.

The site vicinity of 45GA26 has an AMCW of 223m. The MCW is 99 m and located within 3 km downstream of the site. The nearest perennial stream is Stine Gulch, entering the Snake directly across from the site, while the nearest tributary exhibiting salmon spawning habitat is the Clearwater River, over 45 km upstream. Four islands occur in the vicinity of 45GA26. The nearest island is located 500 m upstream of the site. Three sets of rapids occur within the site vicinity. The nearest, Almota Dead March Rapids, are located 2 km upstream from 45GA26.

45WT48, Lower Snake River

Now inundated behind the Little Goose Dam, site 45WT48 is located on the north bank of the Lower Snake River upon Schultz Bar at RM 101. Recordation of the site prior to inundation noted net weights (n=?) along with projectile points and scrapers on the surface of this open site (Washington State DAHP 2005).

The site vicinity of 45WT48 has an AMCW of 119 m. The MCW is 35 m and located within 1 km downstream of the site. The nearest perennial stream is Casey Creek, entering the Snake nearly 1 km upstream of the site, while the nearest tributary exhibiting salmon spawning habitat is the Clearwater River, over 46 km upstream. Four islands occur in the vicinity of 45WT48. The nearest island is located adjacent to the site. Two sets of rapids occur within the site vicinity. The nearest, Lower Ilia Rapids, are located just over 1 km downstream from 45WT48.

45WT31, Swift Bar East, Lower Snake River

Now inundated behind the Little Goose Dam, the Swift Bar East Site (45WT31) was located on the first terrace above the Lower Snake River upon Swift Bar near RM 96. Test excavations at the site prior to inundation yielded net weights (n=?) (Sprague and Combes 1966, 17). Johnston (1987: 146) indicates that the assemblage resulting from test excavations in 1965 also included unidentified fish bone (n=?).

The site vicinity of 45WT31 has an AMCW of 147 m. The MCW is 35 m and located within 3 km upstream of the site. The nearest perennial stream is Hart Gulch, entering the Snake less than 1 km downstream of the site, while the nearest tributary exhibiting salmon spawning habitat is the Tucannon River, roughly 45 km downstream. A single island, Atwoods Island, occurs in the vicinity of 45WT31, less than 2 km upstream from the site. Two sets of rapids occur within the site vicinity. The nearest, Wade's Rapids, are located less than 2 km upstream from 45WT31.

45WT30, Lower Snake River

Mostly inundated behind the Little Goose Dam, site 45WT30 is located on the north bank of the Lower Snake River, upon the second terrace at Swift Bar near RM 95. The site was test excavated prior to inundation (Sprague and Combes 1966). Johnston (1987: 142) indicates the 1965 test excavations yielded fish harvesting tools, presumably net sinkers (n=?).

The site vicinity of 45WT30 has an AMCW of 154 m. The MCW is 37 m and located within 4 km upstream of the site. The nearest perennial stream is Hart Gulch, entering the Snake less than 1 km upstream of the site, while the nearest tributary exhibiting salmon spawning habitat is the Tucannon River, roughly 44 km downstream. A single island, Atwoods Island, occurs in the vicinity of 45WT30, nearly 3 km upstream from the site. Two sets of rapids occur within the site vicinity. The nearest, Rice Bar Rapids, are located roughly 2 km downstream from 45WT30.

45GA17, Lower Snake River

Site 45GA17 is situated on the south bank of the Lower Snake River at approximately RM 92 at the downstream end of Rice Bar. Now inundated behind the Little Goose Dam, excavations in 1966 at site 45GA17 yielded a single four-notch net weight and salmon bones (no count) (Sprague, Leonhardy, and Schroedl 1968: 28, 34). A radiocarbon date of 2230 ± 310 B.P. (WSU 465) was obtained from charcoal recovered at Feature 8 (Sprague et al. 1968: 35). The provenience of the salmon bone in relation to Feature 8 is unknown, though, according to Sprague et al (1968), the primary culture-bearing deposit at 45GA17 is dated between 850 B.C. and A.D. 390 (p. 35).

The site vicinity of 45GA17 has an AMCW of 174 m. The MCW is 87 m and located within 5 km downstream of the site. The nearest perennial stream is Penawawa Creek, entering the Snake less than 1 km downstream of the site, while the nearest tributary exhibiting salmon spawning habitat is the Tucannon River, less than 42 km downstream. A single island, Willow Island, occurs in the vicinity of 45GA17, 5 km downstream from the site. Three sets of rapids occur within the site vicinity. The nearest, Penewawa Rapids, are located roughly 500 m downstream from 45GA17.

45CO11, Lower Snake River

Now inundated behind the Little Goose Dam, site 45CO11 was located at the mouth of Dry Gulch, on the south bank of the Lower Snake River at RM 76. Surface collection at the site prior to inundation included net weight (n=?) (Sprague and Combes 1966, 14). Johnston (1987: 142, 145) indicates the assemblage resulting from test excavations in 1965 also yielded artifacts suggesting individual fish capture tools (harpoon parts, fish spear points) and unidentified fish bone (n=?)

The site vicinity of 45CO11 has an AMCW of 188 m. The MCW is 52 m and located within 1 km downstream of the site. The nearest perennial stream is Meadow Creek, entering the Snake nearly 10 km upstream of the site, while the nearest tributary exhibiting salmon spawning habitat is the Tucannon River, little more than 20 km downstream. Three islands occur in the vicinity of 45CO11. The site is immediately adjacent to Goose Island. Upper Goose Island Rapids is the lone set within the site vicinity and is located adjacent to 45CO11.

45CO1, Tucannon Site, Lower Snake River

The Tucannon Site (45CO1) is located at the confluence of the Snake and Tucannon Rivers. The site is situated upon the first terrace and bounded by the east bank of the Tucannon and the south bank of the Lower Snake River near RM 62. Test excavations in 1965 identified six cultural material assemblages. Cold Springs points in one of the initial assemblages (Assemblage 2) indicates an early occupation range between 4500 B.C. and 2000 B.C. (Nelson 1966a: 7). Fish bone were present in each of the four earliest assemblages (Assemblages 1-4), though no identification or counts are available (Nelson 1966a). Notched net weights were associated with all but the earliest assemblage. All told, 98 notched net weights were recovered during the 1966 test excavations. Two antler projectile point fragments from Assemblage 4 were suggested to have been parts of three-pronged fish spears (Nelson 1966a: 54). A radiocarbon date of 1720 ± 165 B.P. is associated with Assemblage 4 (Nelson 1966a: 71).

The site vicinity of 45CO1 has an AMCW of 157 m. The MCW is 40 m and located within 4 km downstream of the site. The nearest perennial stream, as well as nearest tributary exhibiting salmon spawning habitat is the Tucannon River, entering the Snake less than .5 km upstream of the site. Four islands occur in the vicinity of 45CO1, the nearest nearly 3 km downstream. Two sets of rapids occur within the site vicinity. Hunter's Rapids are located less than 2 km upstream from 45CO1.

45WT134, Hatiuhpuh Village, Lower Snake River

The Hatiuhpuh Village (45WT134) is located on the north bank of the Lower Snake River upon a large, gently sloping terrace at RM 62. The site is situated across from the confluence of the Snake and Tucannon Rivers. Chance et al. (1989) excavated portions of two pithouses and an external activity area. The upper deposit of House 1 provided meager evidence for fishing, yielding only 12 Salmonidae bone and one each Cyprinidae and Catostomidae bone (Olson in Chance et al. 1989: 196). The main floor at House 1 proved more fruitful. Indeterminable fish (n=31), Cyprinidae (n=1), Catostomidae (n=1), and Salmonidae bone (n=63) were recovered here corresponding to radiocarbon dates of 1410 ± 70 (UGa5734) and 1250 ± 70 (Tx5831) (Olson in Chance et al. 1989: 196-198; Chance et al. 1989: 60). Another 43 Salmonidae and 36 indeterminable fish bone were recovered just below the main floor at House 1 (Olson in Chance et al. 1989: 198-200). Salmonidae bone were also recovered at the House 2 main floor (n=27) and from House 2 Feature 34 (n=9) (Olson in Chance et al. 1989: 200-201). Later data recovery efforts at 45WT134 opened four block excavations (Blocks A, B, C, and D) focusing on Houses 1, 2, and 3 as well as external activity areas (Brauner et al.

1990). These data recovery efforts recovered additional Salmonidae vertebrae at each excavation block: Block A n=12; Block B n=3; Block C n=99 (Brauner et al. 1990: 207-210). Each house floor (Houses 1, 2, and 3) and two external activity areas outside House 3 yielded Salmonidae bone (Brauner et al. 1990: 58-95). Net weights were recovered from surface work areas of Block C (n=1), the floor of House 3 (n=1), the lower floor of House 2 (n=2) (Brauner et al. 1990: 68, 81, 93). Radiocarbon dates from floors of Houses 2 and 3 indicate earlier occupations than for House 1. Charcoal from House 2 returned an age of 3980 ± 50 B. P.(Tx5828) and from House 3, 4200 ± 70 (Tx6402) (Brauner et al. 1990: 53).

The site vicinity of 45WT134 has an AMCW of 157 m. The MCW is 40 m and located within 4 km downstream of the site. The nearest perennial stream, as well as nearest tributary exhibiting salmon spawning habitat, is the Tucannon River, entering the Snake directly across the river from the site and adjacent to the Tucannon Site. Four islands occur in the vicinity of 45WT134, the nearest nearly 3 km downstream. Two sets of rapids occur within the site vicinity. Hunter's Rapids are located less than 2 km upstream from 45WT134.

45FR50, Marmes Site, Lower Snake River and Palouse River Confluence

The Marmes Site (45FR50) consists of a rockshelter and associated floodplain deposits located adjacent to the Palouse River approximately 2.4 km upstream from the Palouse and Snake Rivers confluence. Now inundated behind the Lower Monumental Dam, the Marmes site has been investigated numerous times beginning in 1962, with the identification of eight strata within the rockshelter (stratigraphic units I-VIII) (see Hicks

2004). Butler's analysis of fish remains from the Marmes Site indicate *Oncorhynchus* sp. made up nearly 14% of fish available for study from the rockshelter (NISP=94). However, Butler cautions that not all fish remains recovered from the Marmes Rockshelter were included in this analysis or -- many having been lost -- and that the analysis should be considered nominal only (Butler in Hicks 2004: 323). The remainder of the analyzed fish assemblage was dominated by Cyprinidae/Catostomidae remains (NISP=185) and unidentifiable fish remains (NISP=268). The floodplain deposits were again dominated by Cyprinidae/Catostomidae remains (NISP=1,503) and unidentifiable fish remains (NISP=719) with *Oncorhynchus* sp. (NISP=12) also present (Butler in Hicks 2004: 329). The bulk of the salmon bone from the rockshelter was recovered in Strata V (n=62). A radiocarbon date from Strata V indicates use of the rockshelter at 4250 ± 300 B.P. (WSU-207) (Hicks 2004: 27). The earliest evidence for salmon at the Marmes Site was encountered in Stratum I. Three radiocarbon dates from the earliest strata range between 10475 ± 300 (WSU-366) and 10810 ± 300 (WSU-363). A net weight was also recovered from the rockshelter (Hicks 2004: Appendix A).

The site vicinity of 45FR50 has an AMCW of 24 m. The MCW is 15 m and located within 1 km downstream of the site (Palouse River). The nearest perennial stream, as well as nearest tributary exhibiting salmon spawning habitat is the Snake River. The confluence of the Snake and Palouse rivers is roughly 3 km downstream of the 45FR50. Four islands occur in the vicinity of 45FR50, on the Palouse River, the nearest less than 1 km downstream. Two sets of rapids occur within the site vicinity on the Palouse River.

Another two sets occur on the Snake within the site vicinity. The nearest set of rapids, the Steamboat Bend Rapids are located on the Snake less than 4 km downstream from 45FR50.

45FR201, McGregor Cave, Lower Snake River and Palouse River Confluence

McGregor Cave (45FR201) is located in a band of basalt lava flow upon a mesa overlooking the Palouse River and nearly a mile north of the Marmes Site (45FR50) and approximately 2.5 miles from the Palouse and Snake River confluence. Initial testing efforts at McGregor Cave described 34 lined (grass and mat) storage features with net weights (n=?) among the recovered artifacts (Mallory 1966). Subsequent testing yielded 99 fish bone, the majority recovered from two test units adjacent to storage Feature 7 (Hicks and Morgenstein 1994: 79, Appendix A-5). *Oncorhynchus* species was present (n=?) along with other chub or minnow-sized bone (Hicks and Morgenstein 1994: 97). A radiocarbon date from Feature 6 provided a date of 220 ±80 B.P. (WSU4533) (Hicks and Morgenstein 1994: Appendix A-17).

The site vicinity of 45FR201 has an AMCW of 24 m. The MCW is 15 m and located within 2 km downstream of the site (Palouse River). The nearest perennial stream, as well as nearest tributary exhibiting salmon spawning habitat is the Snake River. The confluence of the Snake and Palouse rivers is roughly 4 km downstream of 45FR201. Four islands occur in the vicinity of 45FR201, on the Palouse River. The nearest is 550 m upstream. Three sets of rapids occur within the site vicinity on the Palouse River. Another two sets occur on the Snake within the site vicinity. The nearest set of rapids is located on the Palouse River, less than 3 km upstream from 45FR201.

45WT2, Lower Snake River and Palouse River Confluence

Now inundated behind the Lower Monumental Dam, site 45WT2 was located at the mouth of the Palouse River, on the north bank of the Lower Snake River near RM 60. The site was situated on a broad, low shelf above the previous floodplain. Excavations within four Site Areas (A, B, C, and D) identified five Cultural Layers (A, B, C, D, and E) with evidence for intermittent occupation beginning some time before 7300 B.P. and lasting through the mid-nineteenth century (Nelson 1966b: 29-43). Fish remains were encountered at each of the five Cultural Layers, though no specific identifications were made (Gustafson in Nelson 1966b: 116-129). A notched bone point recovered from the lowest levels of Cultural Layer E is comparable to other notched harpoon head found at the Lind Coulee Site (Daugherty 1956) and The Dalles (Cressman 1960). A radiocarbon date from its boundary with Cultural Layer D indicates that Cultural Layer E predates 7300 ± 180 B.P. (Nelson 1966b: 30). Three notched net weights were also recovered at 45WT2 from Cultural Layer D (Nelson 1966b: 41).

The site vicinity of 45WT2 has an AMCW of 149 m. The MCW is 16 m and located within 1 km upstream of the site. The nearest perennial stream, as well as nearest tributary exhibiting salmon spawning habitat, is the Palouse River entering the Snake immediately adjacent downstream. Four islands occur in the vicinity of 45WT2. The nearest is less than 1 km upstream. Two sets of rapids occur within the site vicinity. The nearest, the Palouse Rapids, are located less than 1 km upstream from 45WT2.

45WW25, Squirt Cave, Lower Snake River

Squirt Cave (45WW25) is located at the base of basalt cliffs approximately 300 feet above the Snake River Canyon floor. The shelter overlooks the confluence of the Palouse and Lower Snake Rivers near RM 59. The storage facility site consists of eight storage pits, lined with grass, stone, cedar or woven matting (Combes 1969: 7). Recovered evidence for fishing includes a grooved net weight (p 11), five toggle harpoon points fashioned from antler (p 18), and two bone composite harpoon valves (p 20). No faunal remains were reported.

The site vicinity of 45WW25 has an AMCW of 165 m. The MCW is 16 m and located within 2 km upstream of the site. The nearest perennial stream, as well as nearest tributary exhibiting salmon spawning habitat, is the Palouse River, entering the Snake fewer than 2 km upstream. Four islands occur in the vicinity of 45WW25. The nearest is less than 2 km upstream. Two sets of rapids occur within the site vicinity. The nearest, the Steamboat Bend Rapids, are located less than 2 km upstream from 45WW25.

45FR39, Three Springs Bar Site, Lower Snake River

Now inundated behind the Lower Monumental Dam, the Three Springs Bar Site (45FR39) was situated on a low bench of the adjacent floodplain on the north bank of the Lower Snake River near RM 47. A series of twelve pithouse depressions were discernable at the Three Springs Bar Site and excavations centered in and around three of the housepits (1, 2, and C) with a fourth, the “Early Housepit”, encountered beneath House 2 (Daugherty, Purdy, and Fryxell 1967: 25). Fish bone was noted in nearly every component described but no identification, counts or provenience were given. A harpoon valve was recovered below the Early Housepit. The Early Housepit provided charcoal from the floor that returned a radiocarbon date of 2760 ± 240 B.P (WSU-430) (Daugherty et al. 1967: 30-34). Housepits 1 and 2 were contemporaneous, 757 ± 187 B.P. (WSU-431) and yielded one notched and three perforated net weights (Daugherty et al. 1967: 35-36). House C represented the final aboriginal occupation at the Three Springs Bar Site.

Six perforated net weights were recovered from House C which dates to the early to mid-nineteenth century based on a "modern ± 127 B.P." radiocarbon date (WSU-432, WSU-462) (Daugherty et al. 1967: 37-38).

The site vicinity of 45FR39 has an AMCW of 275 m. The MCW is 205 m and located within 4 km upstream of the site. The nearest perennial stream, as well as nearest tributary exhibiting salmon spawning habitat is the Palouse River entering the Snake fewer than 18 km upstream. No islands occur in the vicinity of 45FR39. Three sets of rapids occur within the site vicinity. The nearest, the Three Springs Shoal are located less than .5 km upstream from 45FR39.

45FR40, Harder Site, Lower Snake River

The Harder Site (45FR40) is inundated behind the Lower Monumental Dam at approximately RM 43. Previously, the Harder Site had been situated upon Berry Bar, a low alluvial terrace along the north bank of the Lower Snake River. The site is made up of 24 pithouse depressions laid out in two parallel lines along the terrace. The first row of ten depressions (Houses I-X) is partially eroded out of the cutbank while the remaining 14 depressions (Houses 1-14) are set further inland from the cutbank (Kenaston 1966:

105). Houses 3 and 4 were excavated, yielding limited evidence for fishing. Three notched net weights were collected from in and adjacent to House 3 (Kenaston 1966: 55). Three fish gorges were also collected (Kenaston 1966: 59). Kenaston reports “several” fish vertebrae -- “probably salmon” -- from both housepits (1966: 78). An articulated fish skeleton, sans the skull and tail section, was recovered from House 3, although in all it is estimated that fewer than ten fish specimens were recovered at the Harder Site (Kenaston 1966: 79). A reassessment of the Harder Site faunal assemblage by Kimball confirms a total of seven Salmonidae vertebrae, along with three unidentifiable vertebral fragments (2005: 33) A single radiocarbon date (charcoal) from the lowest occupational level at House 4 returns an age of 1525±125 B.P. (Kenaston 1966: 82). The radiocarbon date and the fish remains from House 4 were recovered from the same occupational layer.

The site vicinity of 45FR40 has an AMCW of 272 m. The MCW is 200 m and located within 3 km upstream of the site. The nearest perennial stream, as well as nearest tributary exhibiting salmon spawning habitat, is the Palouse River, entering the Snake just over 23 km upstream. No islands occur in the vicinity of 45FR40. Two sets of rapids occur within the site vicinity. The nearest, the Haunted House Rapids, are located less than 1 km downstream from 45FR40.

45WW61, Ash Cave, Lower Snake River

Ash Cave (45WW61) is a rockshelter situated on the south side of the Lower Snake River near RM 40. The rockshelter is located at the base of the first basalt bench above the river. Test excavations identified four stratigraphic layers. Stratum 1 included debris from livestock, a layer of volcanic ash (Stratum 2), midden debris (Stratum 3), and a course basalt sand layer (Stratum 4) (Butler 1958). Fishing evidence from Ash cave proved minimal, consisting of a notched net weight and a possible composite harpoon bone point (Butler 1958: 7-8). Two fish vertebrae were also recovered. Butler leaves the fish vertebrae unidentified, although Johnston (1987: 55, 146) indicates the bones as being salmon. Each item of fishing evidence was recovered from Stratum 3. A hearth overlying the bone returned a radiocarbon date of 7940 ± 150 B.P. (Butler 1962: 71).

The site vicinity of 45WW61 has an AMCW of 208 m. The MCW is 37 m and located within 5 km downstream of the site. The nearest perennial stream, as well as nearest tributary exhibiting salmon spawning habitat is the Palouse River entering the Snake fewer than 27 km upstream. No islands occur in the vicinity of 45WW61. Two sets of rapids occur within the site vicinity. The nearest, the Matthew's Rapids, are located less than 1 km downstream from 45WW61.

45FR46, Windust Cave C, Lower Snake River

Windust Cave C (45FR46) is located at the base of a basalt outcrop on the north bank of the Lower Snake River near RM 36. One of nine caves that comprise the Windust Caves Site, Cave C yielded cultural material from all but the earliest of the ten identified geological strata representing a 9,000 year span (Rice 1965: 28-32). While no fish remains were recovered at Windust Cave C, two possible notched net weights were recovered from Stratum VI (Rice 1965: 45). The net weights are reported to have been retrieved at the same levels as Cascade-type points, which would relatively date them to ca. 6500 B.P., two millennium before the use of net weights became widespread during the Tucannon Phase.

The site vicinity of 45FR46 has an AMCW of 136 m. The MCW is 37 m and located within 2 km upstream of the site. The nearest perennial stream, as well as nearest tributary exhibiting salmon spawning habitat, is the Palouse River entering the Snake fewer than 33 km upstream. A single major island and two smaller islands occur in the vicinity of 45FR46. The site is located immediately adjacent to the major island. Two sets of rapids occur within the site vicinity. The nearest, the Pine Tree Rapids, are also located immediately adjacent to 45FR46.

45FR272, Burr Cave, Lower Snake River

Burr Cave (45FR272) is located along an outcropping of basalt, approximately on mile south of Windust Cave, above the west bank of the Lower Snake River near RM 34. Johnston (1987; 143) reports the presence of net weights at the rockshelter (n=?). Two radiocarbon dates show an occupation range between 7965 ± 140 (WSU-1812) and 2660 ± 90 (Gilbow and Mierendorf 1978). The site vicinity of 45FR272 has an AMCW of 153 m. The MCW is 35 m and located within 3 km upstream of the site. The nearest perennial stream, as well as nearest tributary exhibiting salmon spawning habitat, is the Palouse River which enters the Snake over 33 km upstream. Three major islands and two smaller islands occur in the vicinity of 45FR272. The nearest island, Rescue Island, is located less than 1 km downstream of the site. Three sets of rapids occur within the site vicinity. The nearest, the Rescue Islands Rapids, are located little more than 1 km downstream from 45FR272.

45FR32, Votaw Site, Lower Snake River

The Votaw Site (45FR32) is situated upon a minimally sloped floodplain bar on the north bank of the Lower Snake River at approximately RM 23. The site is now inundated behind the Ice Harbor Dam. Excavations at three separate areas (Area A, B, and C) revealed two major cultural strata (Occupation I and II) (Grater 1966: 15-16). Occupation I can be dated relatively on the basis of the presence of Cold Springs Side-notched points with an approximate temporal range of 6000-4000 B.P. A house pit floor was also encountered in Occupation I, along with six hearth features in the same strata, although no radiocarbon date was obtained (Grater 1966: 15, 81-82). Fishing evidence at the Votaw Site includes notched weights. The younger Occupation II yielded 11 two-notched weights and two multiple-notched weights. Three two-notched weights and a single multi-notched weight were recovered from Occupation I (Grater 1966: 72-73).

The site vicinity of 45FR32 has an AMCW of 163 m. The MCW is 40 m and located within 1 km upstream of the site. The nearest perennial stream is the Columbia River, the nearest stream exhibiting salmon spawning habitat. The confluence of the Snake and Columbia Rivers is fewer than 32 km downstream of the site. Three major islands occur in the vicinity of 45FR32. The site is located immediately adjacent to the nearest island. Two sets of rapids occur within the site vicinity. The nearest, Copley's Cut-off Rapids, are located less than 1 km upstream from 45FR32.

45FR34, Lower Snake River

Now inundated, site 45FR34 is situated on a steep sandy and rocky slope above the north bank of the Lower Snake River and below a large plateau near RM 16. Site

45FR34 is untested, though recordation of the site noted two- and four-notched variety net weights (n=?) (Washington State DAHP 2005).

The site vicinity of 45FR34 has an AMCW of 171 m. The MCW is 65 m and located within 3 km upstream of the site. The nearest perennial stream is the Columbia River, the nearest stream exhibiting salmon spawning habitat. The confluence of the Snake and Columbia Rivers is fewer than 23 km downstream of the site. Six major islands occur in the vicinity of 45FR34. The site is located equidistant between the nearest islands, both 2600 m in each direction. Two sets of rapids occur within the site vicinity. The nearest, Fish Hook Rapids, are located just over 2 km upstream from 45FR34.

45FR42, Fishhook Island Site, Lower Snake River

Now inundated behind the Ice Harbor Dam, a village of 17 housepit depressions (site 45FR42) is located on Fishhook Island at RM 14 in the Lower Snake River (Washington State DAHP 2005). Numerous housepit depressions and burials were excavated in 1958 (Daugherty 1961), and Johnston (1987: 142) reports net weights (n=?) and fish spear or harpoon element artifacts.

The site vicinity of 45FR42 has an AMCW of 167 m. The MCW is 34 m and located within 5 km downstream of the site. The nearest perennial stream is the Columbia River, and also the nearest exhibiting salmon spawning habitat. The confluence of the Snake and Columbia Rivers is fewer than 20 km downstream of the site. Five major islands occur in the vicinity of 45FR42.

The site is located directly upon one of a series of closely related islands. Three sets of rapids occur within the site vicinity. The nearest, Levey Rapids, are located fewer than 3 km downstream from 45FR42.

45FR7, Lower Snake River

Site 45FR7 is located on the north bank of the Lower Snake River at RM 9. The site is situated upon the first narrow terrace above the river and eroding from the sloping embankment. Site 45FR7 is untested, though recordation of the site noted five notched net weights and a single spall knife (Washington State DAHP 2005).

The site vicinity of 45FR7 has an AMCW of 237 m. The MCW is 40 m and located within 4 km upstream of the site. The nearest perennial stream is the Columbia River, which is also the nearest exhibiting salmon spawning habitat. The confluence of the Snake and Columbia Rivers is fewer than 12 km downstream of the site. Two major and two smaller islands occur in the vicinity of 45FR7. The site is located directly adjacent to Goose Island as well as a smaller island. Two sets of rapids occur within the site vicinity. The nearest, Gauge Island Rapids, are located fewer than 4 km downstream from 45FR7.

45FR283, Lower Snake River

Site 45FR283 is located on the north bank of the Lower Snake River near RM 6. The site is currently situated on Martindale Island, although prior to the construction of McNary Dam on the Columbia River, site 45FR283 would have been found spread over the salient portion of a gently sloping flood plain. The site, consisting of numerous housepit depressions, was tested by Gilbow and Mierendorf (1978) and determined to fit chronologically within the Harder Phase (2500 B.P. to A.D. 1700). Johnston (1987: 143) indicates that net weights (n=?) were part of the recovered assemblage.

The site vicinity of 45FR283 has an AMCW of 243 m. The MCW is 50 m and located within 5 km downstream of the site. The nearest perennial stream is the Columbia River, which is also the nearest exhibiting salmon spawning habitat. The confluence of the Snake and Columbia Rivers is fewer than 8 km downstream of the site. Three major and two smaller islands occur in the vicinity of 45FR283. The nearest island, Strawberry Island, is less than 2 km downstream from the site. Three sets of rapids occur within the site vicinity. The nearest, Five Mile Rapids, are located immediately adjacent to 45FR283.

45FR5, Miller Site, Strawberry Island Village, Lower Snake River

The Miller Site (45FR5) is situated at the upstream end of Strawberry Island at approximately RM 4. The Miller Site is a late prehistoric village site with over 120 depressions resulting from housepit construction and various caches. During the 1976 field season, three depressions were excavated (D96, D117, and D119). Fish bone and fish bone fragments were recovered, including skull fragments, vertebrae, and rib/spine fragments of both salmonids and non-salmonid species (Huelsbeck in Cleveland et al. 1976: 55-67). At least two notched net weights were also recovered (Flenniken in Cleveland et al. 1976: 93). Continued excavations greatly increased the faunal assemblage at the Miller Site (see Schalk 1983). Excavations between 1976 and 1979 produced salmonid bone at 32 of 43 excavation areas. The composite number of identified specimens (NISP) of fish remains recovered at the Miller Site was 13,356. Indeterminable fish account for 9,283, Catostomidae 62, and Salmonidae 4,011 (Schalk and Olsen in Schalk 1983: 78-80).

The site vicinity of 45FR5 has an AMCW of 241 m. The MCW is 50 m and located within 3 km downstream of the site. The nearest perennial stream and the nearest exhibiting salmon spawning habitat is the Columbia River. The confluence of the Snake and Columbia Rivers is fewer than 6 km downstream of the site. Three major and one smaller island occur in the vicinity of 45FR5. The site is located upon Strawberry Island. Three sets of rapids occur within the site vicinity. The nearest, Strawberry Island Rapids, are located less than 1 km downstream from 45FR5.

CHAPTER 8: RESULTS

In this study the relationship between archaeological sites containing evidence of fishing and selected physiographic features was evaluated with the aid of GIS. Available archaeological data were assessed in terms of background variables, quantifying which topographic and hydrographic features condition fishing site selection. The results appear to provide a basis for predicting where aboriginal fishing activities may have taken place.

If we assume that upstream migrations of salmon were intercepted with the intent of preserving for storage and immediate consumption, then the critical constraint of time to avoid spoilage would tend to minimize the proximity between points of extraction and fishing evidence. Such a factor of time between harvest and processing for preservation, as it relates to spoilage, is most critical during the late spring through early fall when temperatures above 41 degrees Fahrenheit are common. Therefore, to minimize handling costs and transport time, the situation of a fishing site would likely include the targeted point of interception.

Sixty fishing sites along the Snake River were identified in the archaeological literature based on the presence of fish bone and, or features and artifacts associated with fishing. These sites were examined within a framework of their surrounding physiographic features that relate to fishing strategies, salmon behavior, and decisions regarding how the landscape conditioned fishing site selection. In an examination of the immediate stretch of the adjacent river, or site vicinity, certain physiographic features were identified, inventoried, and their intervals recorded (Table 5).

To assess where fishing sites are located in relation to the various physiographic variables, “site vicinity” is defined again. The vicinity of each site is defined as that area covering a distance of 5 km of river channel in both upstream and downstream directions (Figure 3).

The stretch of river within the first kilometer is termed “adjacent.” This proximity measurement is considered to show the strongest relationship between sites with fishing evidence and background variables. The background variables inventoried within an adjacent area are a subset of those within the “immediate vicinity”. The immediate vicinity consists of the stretch of river 2 km or less from a site. Background variables within a site’s immediate vicinity may have impacted fishing site selection to a greater degree than those further out. Background variables within a site’s immediate vicinity are considered to show a strong relationship between the variable and fishing site location. The areas of the site vicinity at a distance greater than 2 km from a site are considered the “general vicinity.” Background variables within only the general vicinity of a site are considered to be less likely to be exploited, owing to the effort required to access them. The further the background variable is from the site the less likely that that variable impacted site selection. The notion of distance from the site is particularly important in areas where travel across the landscape is most difficult.

The spatial definition of the site vicinity, although an arbitrary distance, is based on the assumption that moving harvested fish to processing locations was constrained by transport over varied terrain, the volume of haul to be moved, and time constraints associated with spoilage. At an average pace across even terrain, an adult human can cover close to five kilometers in an hour (4.8 km/h), or about 12 minutes per kilometer (Powers and Burnfield 2001). Clearly, this average will be increased according to changes in the type of surface and terrain being traversed. For example, covering a distance of 5 km within Hells Canyon where the terrain is steep, rugged and often inaccessible requires a far greater effort than covering the same distance along a level canyon floor or floodplain. Five kilometers are assumed to be the outer limit of travel from the site location (where fish bone or fishing artifacts are found) to a preferred fishing location. Transporting harvested fish farther would require additional expenditures of time and energy toward an already expensive resource. Labor forces and time required to prepare and position for harvest, and to process and prepare fish for preservation would have been substantial (see Plew 1990). The factor of time between harvest and processing for preservation, as it relates to spoilage, will be most critical during the late spring through early fall when bacteria-friendly temperatures are common. Temperatures above 41 degrees Fahrenheit are known to promote the growth of bacteria which causes food borne illness (U.S. Department of Health and Human Services Public Health Services, Food and Drug Administration 2005).

Table 5 indicates the background variables appearing to influence fishing site location. Figure 4 provides a graphic representation of these relationships. For the study area as a whole the closest associations are found with islands, falls and rapids. Proximity of confluences to perennial streams appears to condition the location of fishing sites but to a lesser degree. The distribution of the minimum channel width measurement (MCW) appears to have a minimal impact. Furthermore, no clear connection can be made between both salmon spawning stream confluences or the general width (AMCW) of the river and fishing site locations.

Table 5 Site Vicinity and Background Variable Associations; All Fishing Evidence

Site Vicinity and Background Variable Associations For All Fishing Evidence number of sites associated with background variables arranged by river segment and distribution within site vicinity*				
Site Vicinity Segment	**All River Segments** (60 sites)	**Middle Snake** (17 sites)	**Hells Canyon** (8 sites)	**Lower Snake** (35 sites)
Islands				
General Vicinity	n=15 (25%)	n=4 (24%)	n=2 (25%)	n=9 (26%)
Immediate Vicinity	n=40 (67%)	n=12 (71%)	n=6 (75%)	n=22 (63%)
Adjacent	n=30 (50%)	n=11 (65%)	n=5 (63%)	n=14 (40%)
Absent	n=5 (8%)	n=1 (6%)	n=0	n=4 (11%)
Falls and Rapids				
General Vicinity	n=14 (23%)	n=5 (30%)	n=1 (12%)	n=8 (23%)
Immediate Vicinity	n=39 (65%)	n=5 (30%)	n=7 (88%)	n=27 (77%)
Adjacent	n=28 (47%)	n=4 (24%)	n=7 (88%)	n=17 (49%)
Absent	n=7 (12%)	n=7 (41%)	n=0	n=0
Perennial Stream Confluences				
General Vicinity	n=9 (15%)	n=3 (18%)	n=0	n=6 (17%)
Immediate Vicinity	n=32 (53%)	n=7 (41%)	n=8 (100%)	n=17 (49%)
Adjacent	n=25 (42%)	n=4 (24%)	n=6 (75%)	n=15 (43%)
Absent	n=19 (32%)	n=7(41%)	n=0	n=12 (34%)
Spawning Stream Confluences				
General Vicinity	n=5 (8%)	n=2 (12%)	n=1 (13%)	n=2 (6%)
Immediate Vicinity	n=9 (15%)	n=1 (6%)	n=2 (25%)	n=6 (17%)
Adjacent	n=6 (10%)	n=1 (6%)	n=0	n=4 (11%)
Absent	n=46 (77%)	n=14 (82%)	n=5 (63%)	n=27 (77%)
Minimum Channel Width Distribution				
General Vicinity	n=31 (52%)	n=10 (59%)	n=2 (25%)	n=19 (54%)
Immediate Vicinity	n=29 (48%)	n=7 (41%)	n=6 (75%)	n=16 (46%)
Adjacent	n=15 (25%)	n=4 (24%)	n=2 (25%)	n=9 (26%)
Averaged Minimum Channel Width Measurement* (number of sites by river segment and distributed by AMCW)				
< 50m	n=11 (18%)	n=5 (29%)	n=4 (50%)	n=2 (6%)
51m-100m	n=12 (20%)	n=8 (47%)	n=3 (38%)	n=1 (3%)
101m-150m	n=9 (15%)	n=4 (24%)	n=0	n=5 (14%)
150m-200m	n=19 (32%)	n=0	n=0	n=18 (51%)
>200m	n=9 (15%)	n=0	n=1 (12%)	n=9 (26%)

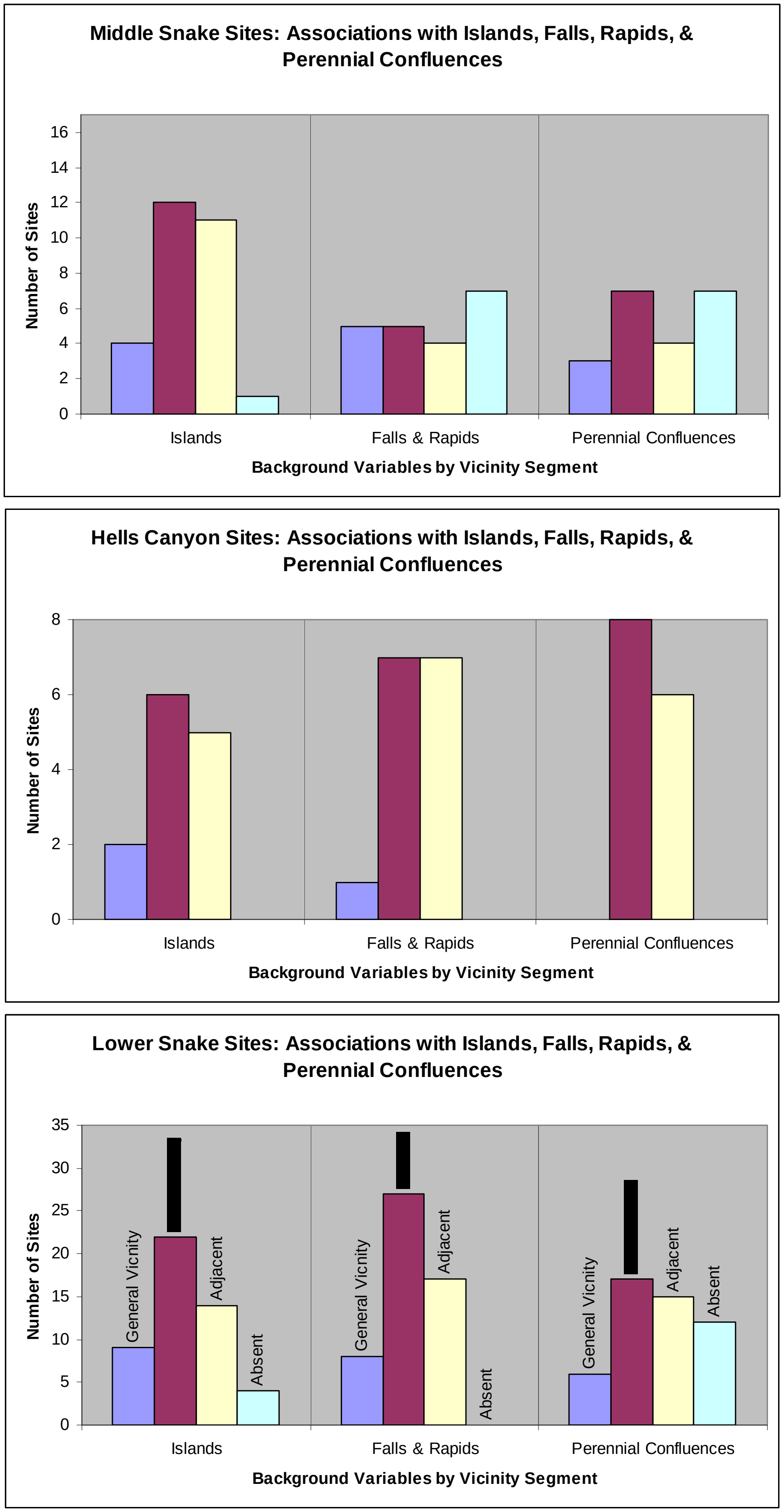

Figure 4 Associations with Background Variables for all Fishing Evidence

Islands

Islands show a close relationship with fishing sites in terms of general targeting. Along the entire length of the Snake River, 55 out of 60 fishing sites (92%) are nearby, or within 5 km of at least one island. A closer look, however, shows that only 15 sites (25%) have islands located in the general vicinity only (>2 km). Sites with islands in the immediate vicinity number 40 (67%) with 30 of those adjacent (50%). Only five fishing sites along the Snake are located farther than 5 km from the nearest island. Of these, four are located along the Lower Snake segment and one along the Middle Snake segment. This pattern of fishing site and island proximity is evident at each of the three segments of river that make up the study area. While 16 of 17 fishing sites (94%) are nearby, or within 5 km of an island along the Middle Snake segment, just four (24%) sites have islands only in the general vicinity. The majority of fishing sites along the Middle Snake (n=11) are situated with islands in the immediate vicinity and 65% are adjacent. Of the Middle Snake fishing sites, only the Crutchfield site (10GG191) has no islands nearby. In Hells Canyon, six of the eight fishing sites (75%) have islands located in the immediate vicinity, five of which are adjacent (63%). The remaining two Hells Canyon fishing sites have islands within the general vicinity, but these are located beyond 3 km.

Along the Lower Snake segment, 31 of 35 fishing sites (89%) have islands within 5 km, although only nine (26%) occur in the general vicinity. The majority of Lower Snake fishing sites (63%) have islands in the immediate vicinity, but only 14 are adjacent (40%). Islands are also absent from 11% (n=4) of the Lower Snake site vicinities.

The Middle Snake and Hells Canyon segments exhibit the closest association between fishing and islands. Over 60% of fishing sites along these segments are adjacent to islands. Only 14 of 35 fishing sites along the Lower Snake River are in such close proximity to islands. When the field of view is broadened to include the immediate vicinity, fishing sites along the Lower Snake River show a similar association with islands. By way of example (see Figure 4), the Middle Snake River contains 496 out of 633 islands inventoried within the overall study area; 65 occur within Hells Canyon and 72 along the Lower Snake segment. The high percentages of fishing sites associated with islands, in particular along segments where the sheer numbers of this particular background variable are low, seem to indicate an active targeting of islands for fishing.

Falls and Rapids

Figure 4 illustrates an inverse relationship between the frequencies of rapids and the frequencies of islands along the length of the study area. A similar inverse relationship can be seen among fishing sites along the Middle and Lower Snake segments. Like islands, falls and rapids show a close relationship with fishing site selection in general. Along the length of the study area 53 of 60 fishing sites (88%) are nearby or within 5 km of at least one falls or rapids, though only 14 sites (23%) have rapids located only in the general vicinity. A total of 39 fishing sites are located where falls and rapids exist within the immediate vicinity (65%), but only 28 of those are adjacent (47%). Seven fishing sites (12%) along the Snake River are located farther than 5 km from the nearest rapid or falls. Each of these is located along the Middle Snake segment.

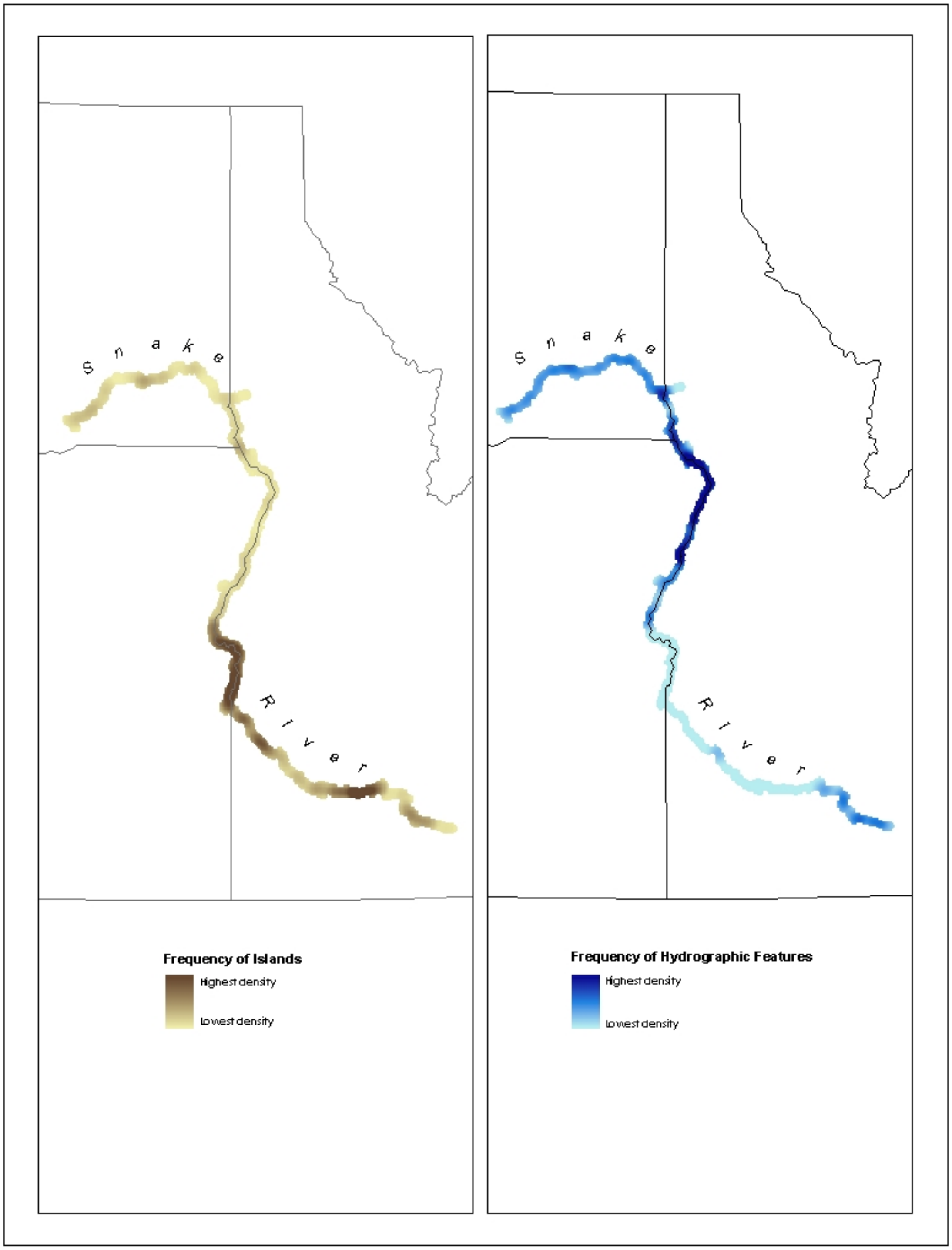

Figure 5 Frequency Distribution of Two Background Variables, Islands and Hydrographic, such as Falls and Rapids. Features along the Snake River Study Area, Mapped here as Densities.

This pattern of proximity for fishing site and rapids is most evident in the Hells Canyon and Lower Snake segments of the study area where fishing sites show the closest affinity for locations of turbulence and high energy flow. Along the Middle Snake River however, the opportunities rapids present in the procurement of fish appears to be less important.

Whereas 10 of 17 fishing sites (59%) are nearby, or within 5 km of a rapids along the Middle Snake segment, five sites (30%) have rapids or falls only in the general vicinity. Relatively few fishing sites along the Middle Snake (n=5) are situated with rapids or falls in the immediate vicinity, and only four sites (24%) are adjacent. Of the seven Middle Snake fishing sites where rapids or falls are absent in the site vicinity (41%), four are adjacent to islands (10CN1; Bonus Cove Ranch, 10OE269; Medbury Site, 10EL1367; Three Island Crossing, 10EL294).

The Hells Canyon segment exhibits a close association between fishing and falls or rapids. Here, rapids or falls are located within the vicinity of all eight fishing sites. Only one site (12%) is located where a rapids or falls does not exist within the immediate vicinity. The remaining seven fishing sites (88%) are adjacent to rapids.

Similarly along the Lower Snake segment, all 35 fishing sites are near a falls or rapids, but only 8 of 35 (23%) are located with rapids or falls in the general vicinity. The majority of Lower Snake fishing sites (n=27) have rapids or falls in the immediate vicinity (77%) and 17 sites are adjacent to them (49%).

Stream Confluences

The associations are less apparent between fishing sites and perennial and spawning stream confluences. Fishing sites along the entire study area appear to be situated near perennial streams, although these proximity measurements are skewed by the Hells Canyon sites. Nearly 70% of Snake River fishing sites are located fewer than 5 km from the introduction of a perennial stream or tributary. In Hells Canyon, where runoff is the greatest among the three river segments, each of the fishing sites (n=8) are located with a perennial stream confluence within the immediate vicinity and six (75%) are adjacent. Less than half of all fishing sites along the Middle Snake (n=7) and Lower Snake (n=17) segments are located where the nearest perennial stream is within the immediate vicinity. Along the Middle Snake segment, perennial stream confluences are absent from seven of 17 (41%) fishing sites. Along the Lower Snake segment, perennial stream confluences are absent from 12 of 35 (34%) fishing sites.

Given the high number of sites where spawning stream confluences are absent within the vicinity, the preference for this variable appears to be the least important of the background variables. Spawning stream confluences are absent from the vicinity of most fishing sites along each of the river segments. No spawning streams enter the Snake River within the vicinity of 14 fishing sites (82%) on the Middle Snake, of five sites (63%) in Hells Canyon, and of 27 sites (77%) on the Lower Snake. Twenty-three major salmon spawning tributaries enter the main stem Snake within the study area. Eleven of these enter the Middle Snake, eight flow into Hells Canyon, and only four enter along the Lower Snake River. In Hells Canyon the Imnaha River enters the Snake within the immediate vicinity of the Knight Creek Site (35WA767), and Big Canyon Creek enters the Snake within the immediate vicinity of the Camp Creek Site (35WA286). Along the Lower Snake segment, salmon spawning streams join the Snake River within the immediate vicinity of six fishing sites (17%). Four of these are adjacent to major salmon spawning tributaries: 45AS47 at the mouth of the Grande Ronde River, Hasotino (10NP151) across from Asotin Creek, Tucannon Site (45CO1) at the mouth of the Tucannon River, and the Hatiuhpuh Village Site (45WT134) directly across the Snake River from the mouth of the Tucannon River.

Channel Width

Fishing sites along the length of the Snake River are often positioned near the narrowest part of the channel within the general vicinity. Just over half the Snake River fishing sites (n=31) are situated where the minimum channel width (MCW) is located in the general vicinity. The remaining sites are situated where the MCW is located in the immediate vicinity. Only 25% of fishing sites along the Snake River are adjacent to the MCW. The MCW distribution for fishing sites on the Middle Snake and Lower Snake segments closely mirror these percentages as well.

Hells Canyon is the single segment that shows a relationship between narrow stream channel and fishing site selection. This may be attributed to the deeply incised canyon setting in Hells Canyon, where the floodplain is much narrower, or even non-existent, compared with the Middle and Lower Snake segments where portions flow through more broad, open areas. In Hells Canyon, six of the eight fishing sites (75%) have the MCW located in the immediate vicinity, and two of those sites are adjacent (25%).

The remaining two Hells Canyon fishing sites have the MCW within the general vicinity, but beyond 3 km away.

This pattern of fishing site and MCW distribution is also apparent when viewed against an averaged channel width measurement (AMCW). For the length of the study area, fewer than 40% of fishing sites were situated along sections of the river where the AMCW is less than 100 m. This variable is skewed somewhat along the Lower Snake segment given the broad nature of the lower reaches of the river. This variable shows that the Lower Snake segment is generally the widest of the three segments and that only 9% of the fishing sites there are associated with an AMCW of 100 m or less.

Selection of fishing sites in both the Middle Snake and Hells Canyon segments appears to attribute greater importance to the river's width. For the Middle Snake segment, 13 of 17 fishing sites (76%) are situated along stretches of river where the AMCW is fewer than 100 m. Five of these sites have an AMCW of 50 m or less.

Along the Hells Canyon segment seven of eight fishing sites (88%) are situated along stretches of river where the AMCW is less than 100 m. Four of these sites (50%) have an AMCW of 50m or less.

Conclusion

This study used a GIS to successfully identify physiographic features that conditioned aboriginal fishing site selection. Known fishing sites were examined in a framework of surrounding physiographic features as they related to fishing strategy, salmon behavior, and decisions regarding how the landscape shapes fishing site selection. Physiographic features were identified, inventoried, and their distributions recorded. The results indicate that sites with fishing evidence are positioned near islands, rapids and falls. The strength of these relationships are conditioned by proximity. Islands, for example, are very common in the vicinity of fishing sites along the Snake River, although relatively few sites have islands only located further than 2 km away. Along each segment of the study area, there is a dramatic increase between the numbers of sites with islands in the general vicinity only, and those with islands in the immediate vicinity. The same pattern appears with falls, rapids, and perennial stream confluences along the Hells Canyon and Lower Snake segments, and to a lesser degree along the Middle Snake segment. This prevalence of fishing evidence within 2 km of exploitable physiographic features suggests that fishing site locations were influenced by these background variables.

The study also reveals that evidence for fishing is associated with background variables that are most prevalent within a given stretch of river. For example, islands occur along the Middle Snake segment at a much higher frequency than in the Hells Canyon or along the Lower Snake segments. Middle Snake fishing sites were situated at or among concentrations of islands to a far greater degree than any other background variable. Conversely, along the Hells Canyon and Lower Snake segments, where rapids are more prevalent, fishing sites were most often situated at or among concentrations of rapids. However, the results also suggest that islands appear to be independent of this frequency distribution pattern. The frequency distribution for islands is by far greatest along the Middle Snake segment and markedly lower through Hells Canyon and along the Lower Snake segment. However, despite this disparity, the associations between fishing sites and the presence of islands is consistent throughout the entire study area.

The results of the study confirm that physiographic features like rapids, low falls, and islands are well suited for the targeted interception of migrating salmon and harvest of other fishes. To further illustrate this point, consider the 31 sites in the study area with salmonid remains (Table 6). For the purposes of this illustration, the background variable inventories of islands, rapids and falls are combined.

Table 6 Site Vicinity and Background Variable Associations; Salmon Bone Evidence.

Site Vicinity and Background Variable Associations For Salmon Bone number of sites associated with background variables arranged by river segment and distribution within site vicinity				
Site Vicinity Segment	**All River Segments** (31 sites)	**Middle Snake** (12 sites)	**Hells Canyon** (8 sites)	**Lower Snake** (11 sites)
Islands and/or Rapids				
General Vicinity	n=4 (13%)	n=3 (25%)	n=0	n=1 (9%)
Immediate Vicinity	n=27 (87%)	n=9 (75%)	n=8 (100%)	n=10 (91%)
Adjacent	n=26 (84%)	n=9 (75%)	n=8 (100%)	n=8 (73%)
Absent	n=0	n=0	n=0	n=0
Perennial Stream Confluences				
General Vicinity	n=4 (13%)	n=2 (17%)	n=0	n=2 (18%)
Immediate Vicinity	n=20 (65%)	n=5 (42%)	n=8 (100%)	n=7 (64%)
Adjacent	n=15 (48%)	n=3 (25%)	n=6 (75%)	n=6 (55%)
Absent	n=7 (23%)	n=5 (42%)	n=0	n=2 (18%)
Minimum Channel Width Distribution				
General Vicinity	n=16 (52%)	n=6 (50%)	n=2 (25%)	n=8 (73%)
Immediate Vicinity	n=15 (48%)	n=6 (50%)	n=6 (75%)	n=3 (27%)
Adjacent	n=8 (26%)	n=3 (25%)	n=2 (25%)	n=3 (27%)

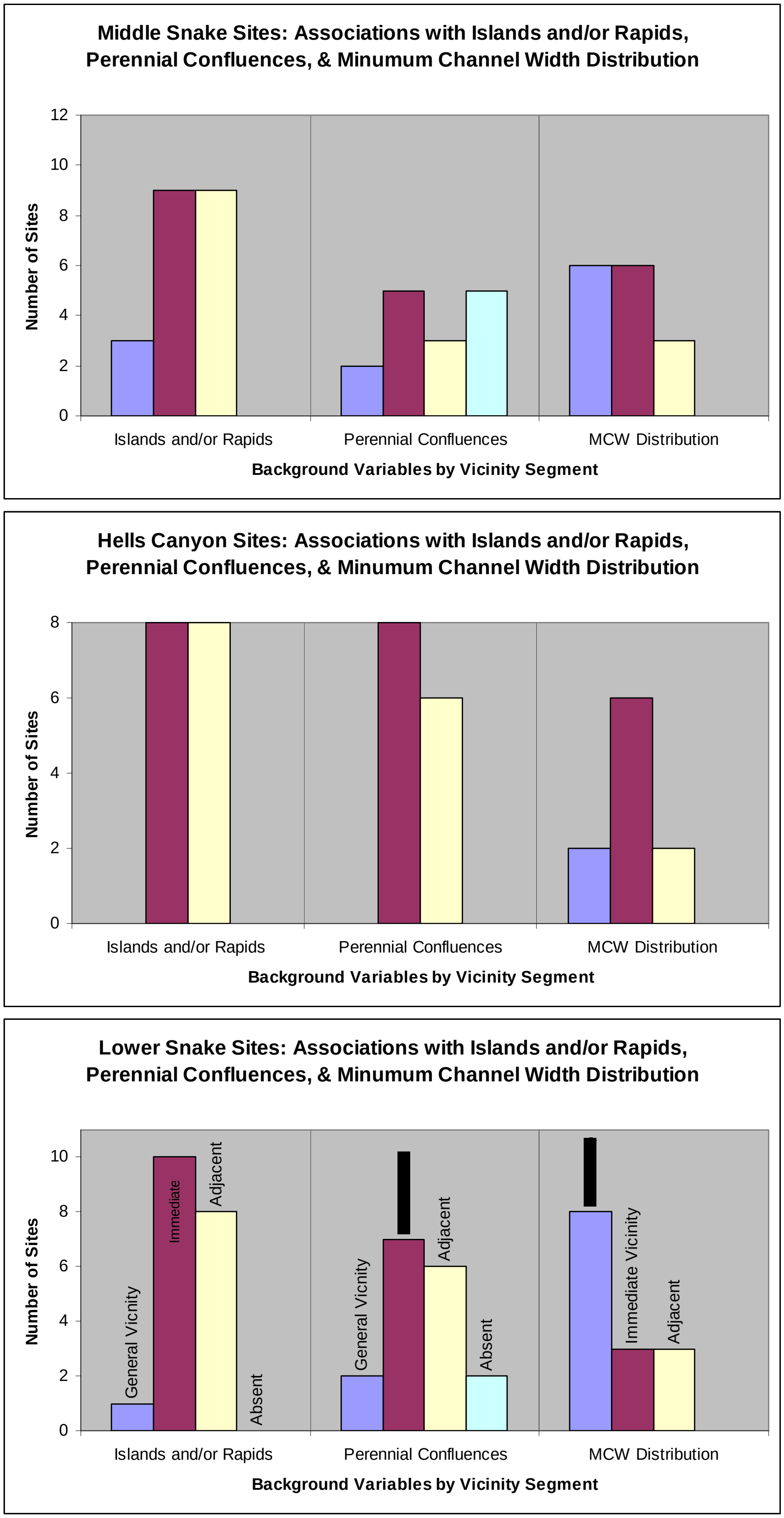

Figure 6 Associations with Background Variables for Salmon Bone Evidence

Table 6 summarizes the background variables closely associated with fishing sites where fish bone has been identified as belonging to the family level of Salmonidae. Figure 6 provides a graphic representation of these relationships.

Proximity to perennial stream confluences and channel widths may have influenced fishing site location in certain situations, but not to the same degree as islands and rapids. That high percentage of fishing sites closely associated with islands and rapids may indicate the importance of these features in the harvesting of salmon and other fishes.

Based on these findings -- that the presence of islands and rapids co-vary with fishing locations -- it appears this line of investigation could be used as a predictive tool to better understand the aboriginal fish harvest. Using these findings as a baseline, archaeologists could build upon our knowledge of the decision-making process for aboriginal fishing site selection. However, additional investigations are needed to test and validate the findings within the current study area. Future testing along the Snake River would either help to strengthen or refute the results of this study. Also, similar studies could be implemented on other rivers of the Snake or Columbia River Basins in order to validate or invalidate the findings of the current study.

Other limitations or problems with this study exist as well. The strength of Pacific salmon runs varied greatly over time and may well have affected fishing strategy from the standpoint of both fishing location and species targeted. Perhaps more important is the inability of the study to control for landscape alteration over time. Each of these limitations is linked to climatic fluctuations over time. Changing environmental conditions and fluctuations occurred throughout the Holocene (Bentley 1983; Butler

1978; Chatters 1984; Pierce et al. 2004; Swanson and Muto 1975). These climactic fluctuations show a general trend of warming and drying, leading to modern environmental conditions with peaks of cooling and increasing moisture. The implications of these climactic shifts are realized in terms of healthy salmon spawning habitat. Buildup of silts, inadequate spring runoff, and higher water temperatures are indicative of warm and arid conditions that could reduce salmon populations. Conversely, cool, moisture-laden periods, while conducive to salmon health and productivity, may have served to alter rivers beyond their present configurations. Increased precipitation and spring runoff from increased snow pack lead to rapid and violent flooding, along with mud and rock slides, and may have changed the anatomy of the river in terms of the physiographic features addressed by this study. Flood events, long-term erosion, and sediment deposition can all act to eliminate islands from one location as well as cause their formation in another. Similar factors resulting from various processes or events like forest fires or paleoseismicity can act to create or eliminate rapids within a fluvial environment as well (Davis 2007; Pierce et al. 2004).

Regardless, this study has shown that fishing sites along the Snake River are associated with certain physiographic features. By using GIS the locations of archaeological sites containing evidence of fishing were analyzed as geographically dependent phenomena. The results indicate that background variables impact and influence decision-making processes regarding fishing strategies and fishing site locations. The results appear to provide a model or predictive tool for identifying where aboriginal fishing activities may have taken place. Therefore, a view from a location with fishing evidence would likely include falls, rapids and islands.

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APPENDIX

GIS Maps of Sites and Background Variables

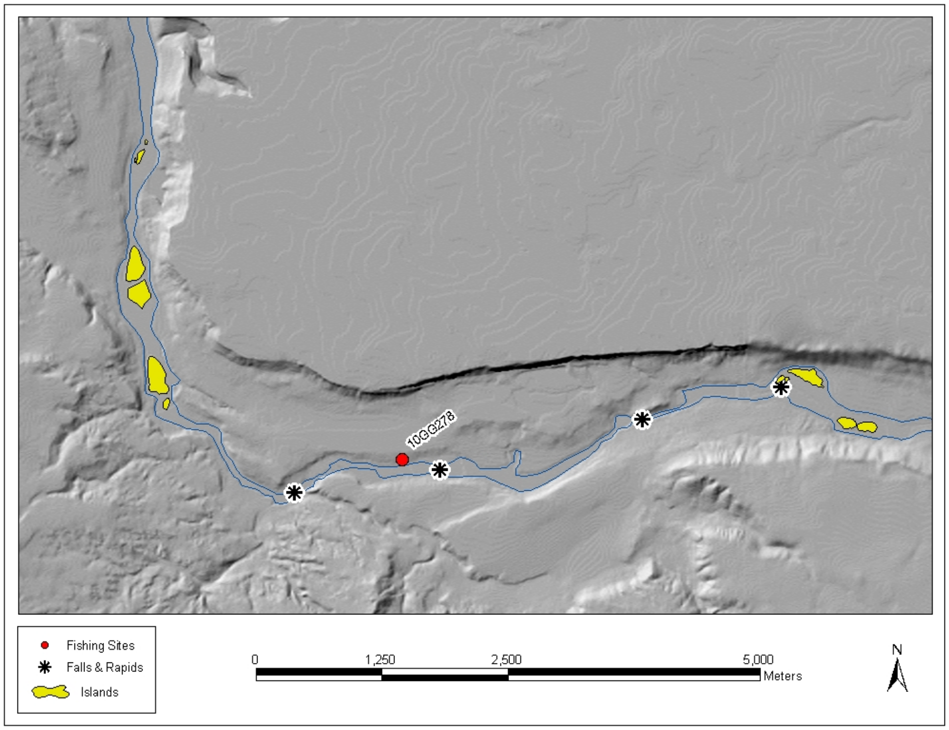


Figure A.1 10GG278, Middle Snake River

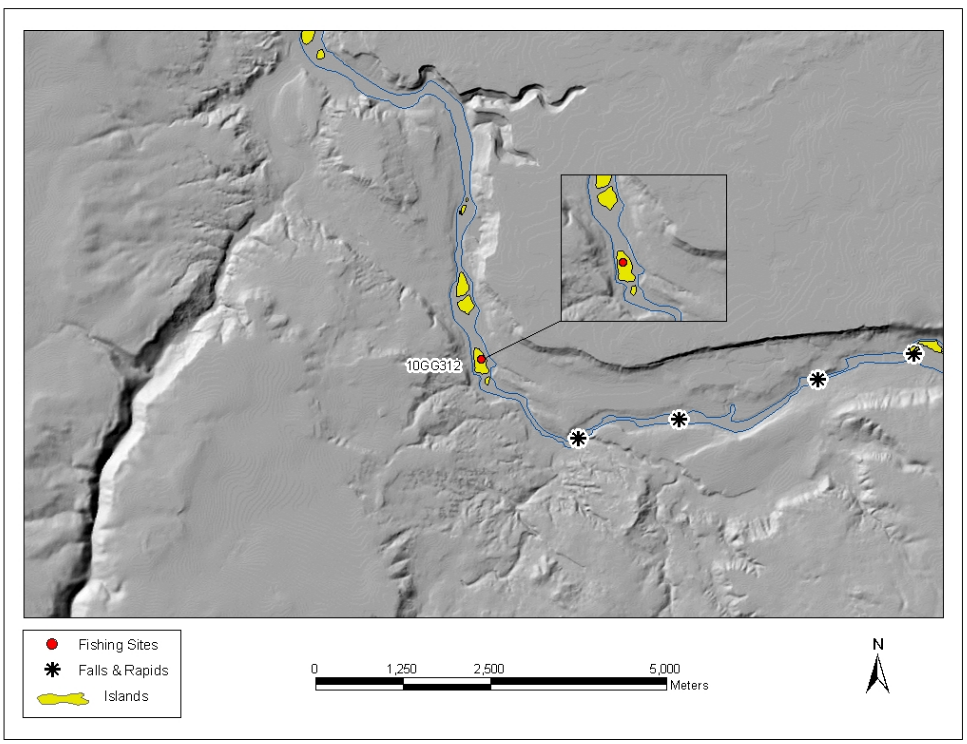


Figure A.2 10GG312, Middle Snake River

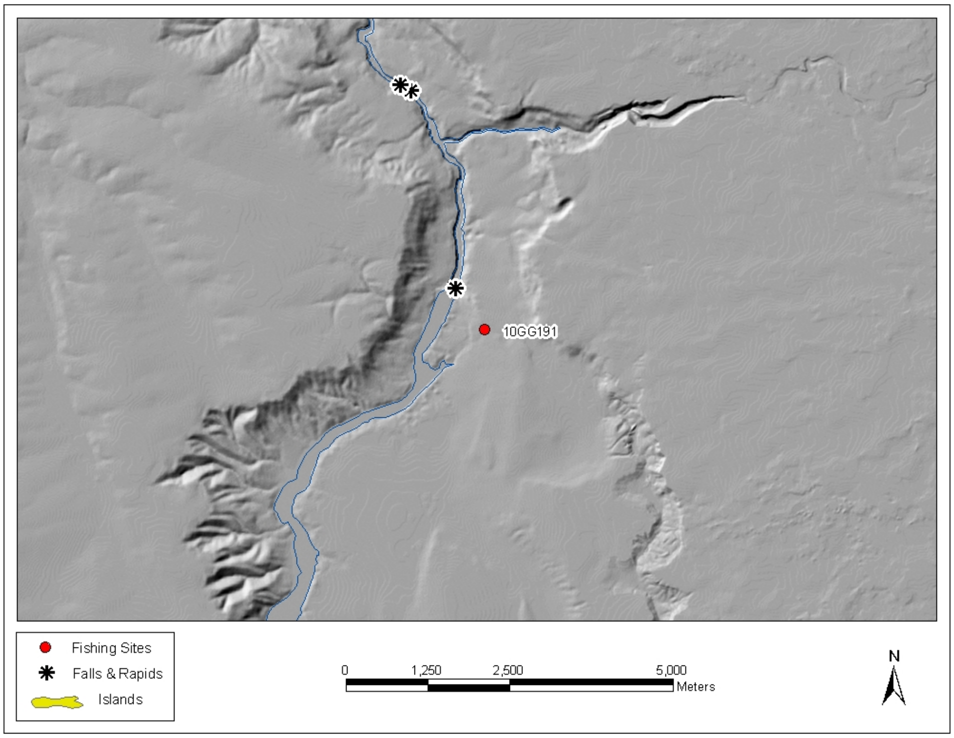


Figure A.3 10GG191, Middle Snake River

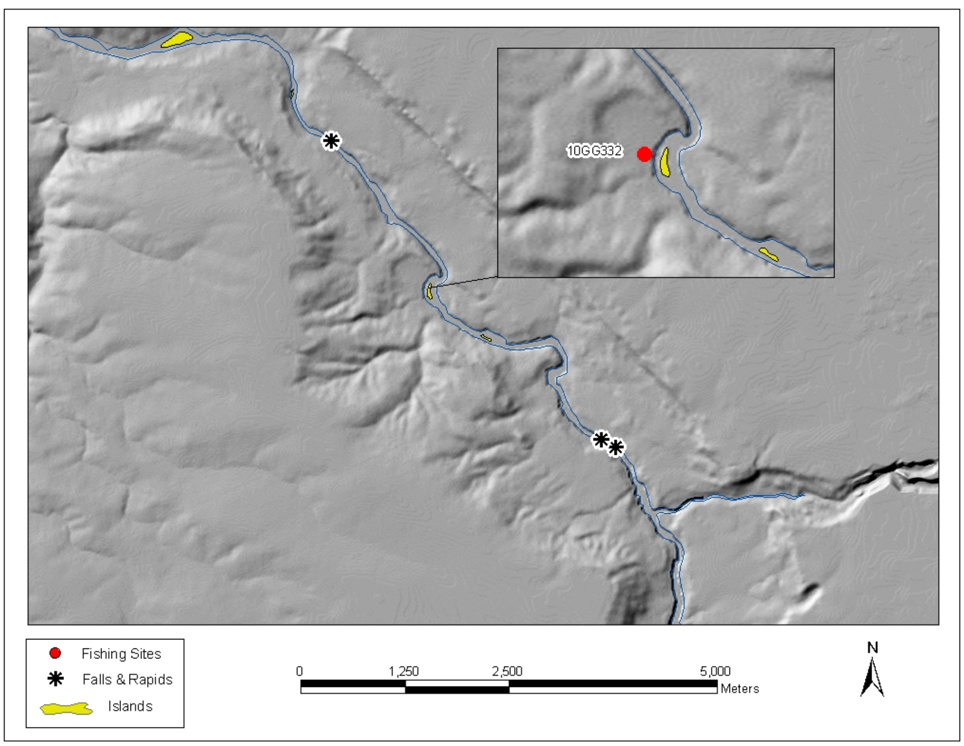


Figure A.4 10GG332, Middle Snake River

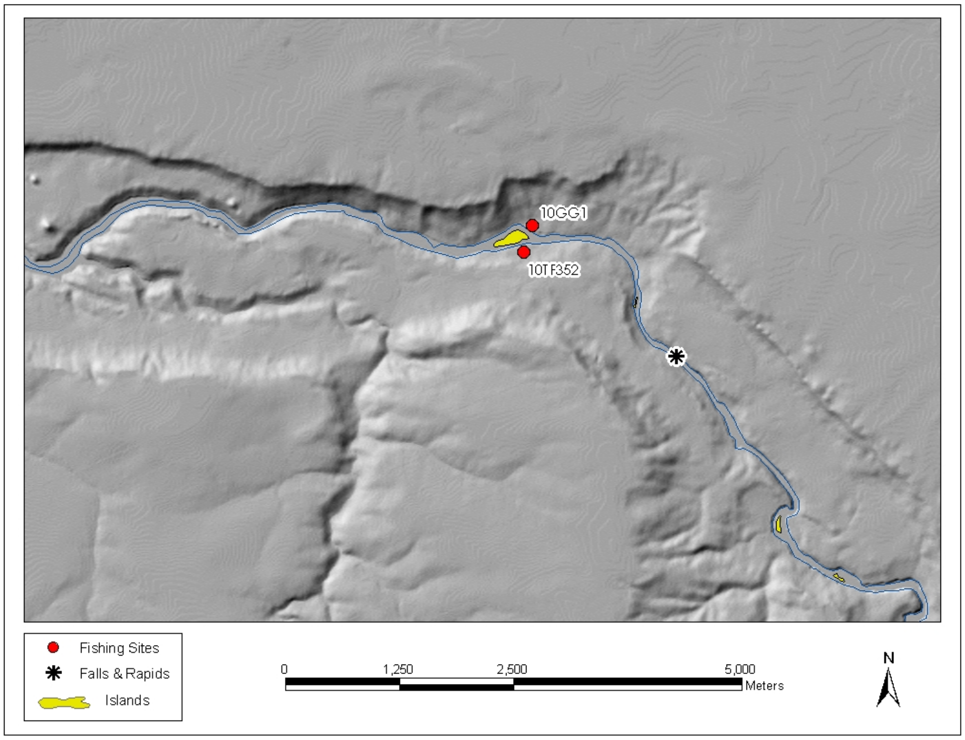
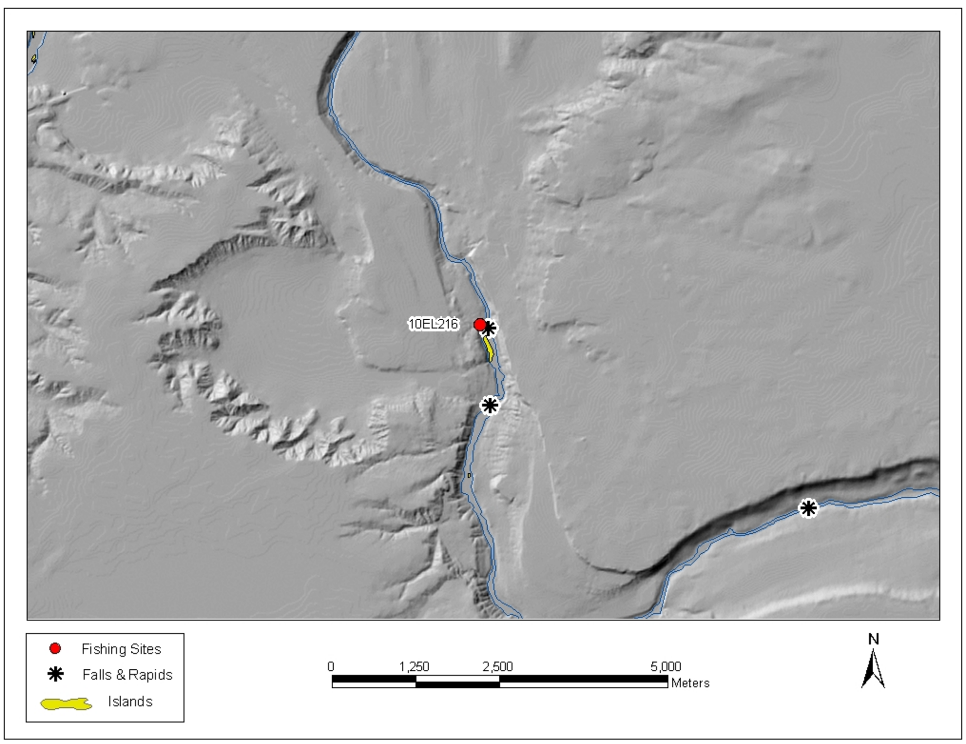


Figure A.5 10GG1 and 10TF352, Middle Snake River



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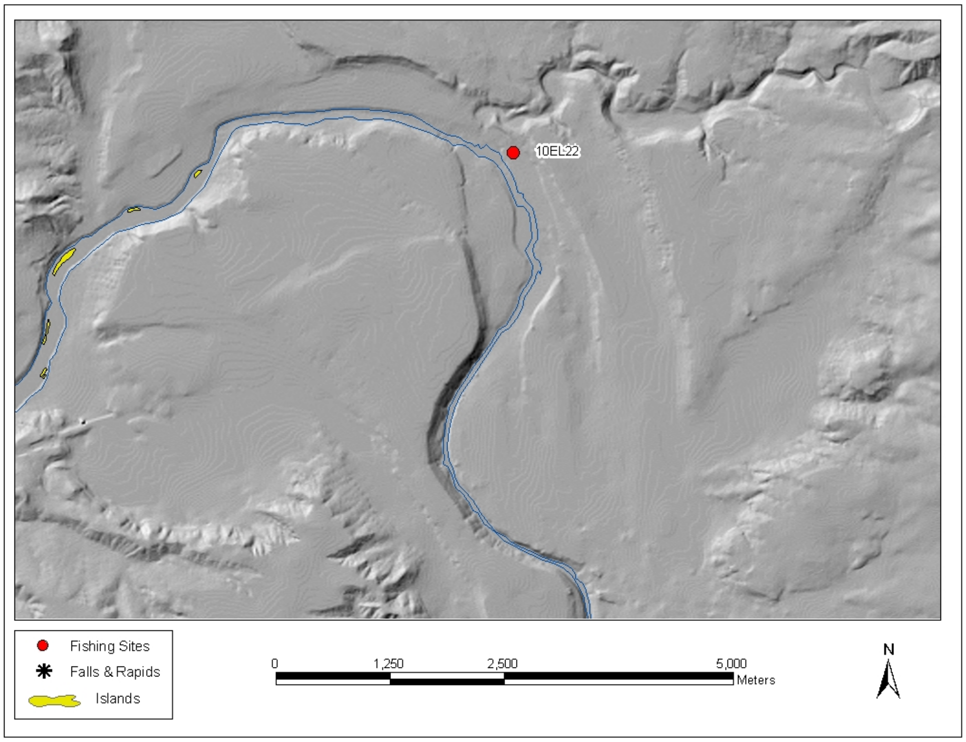

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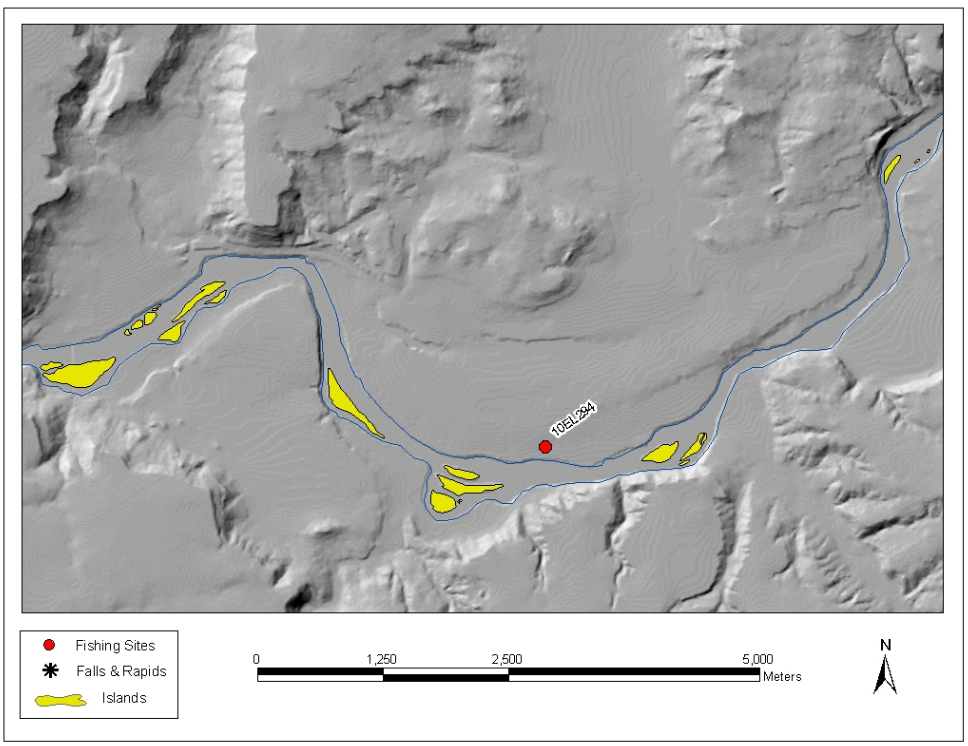

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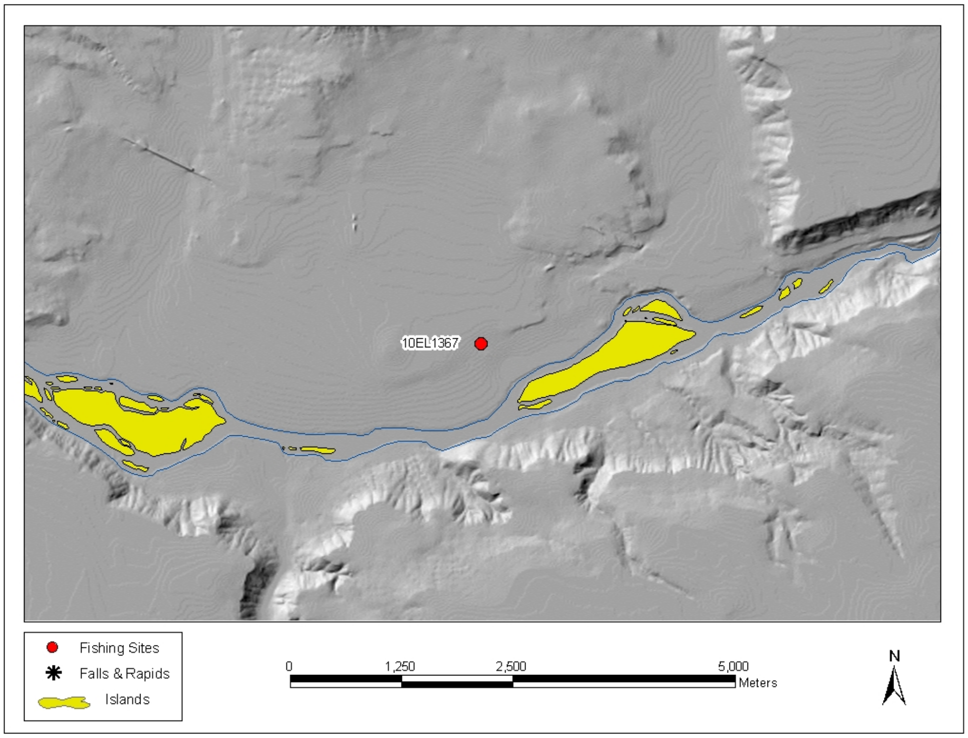


Figure A.9 10EL1367, Middle Snake River

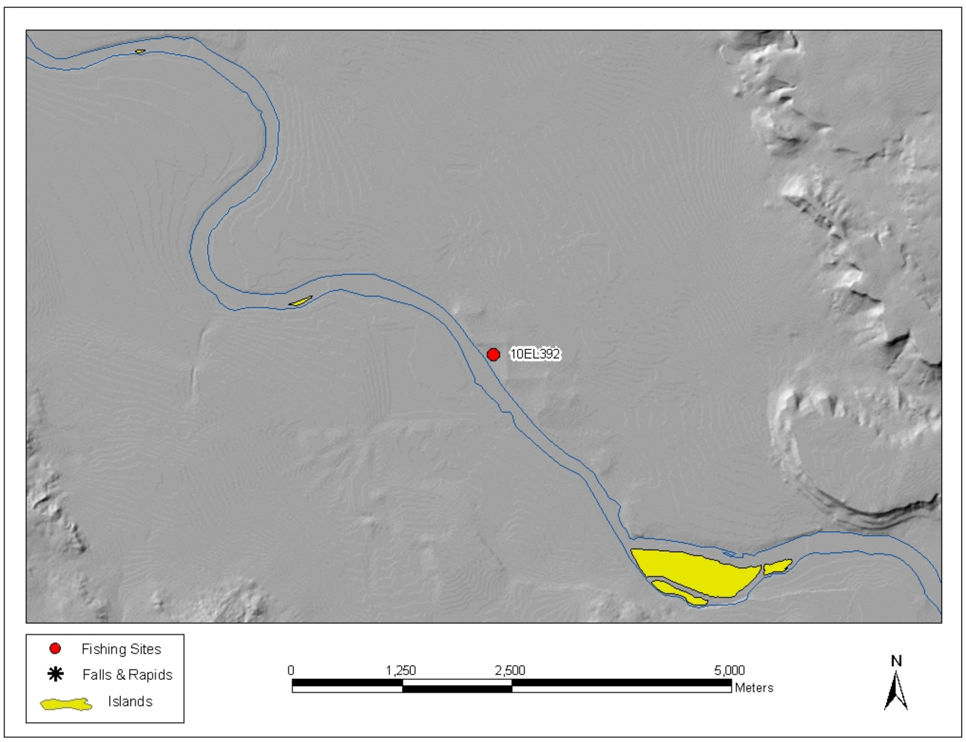
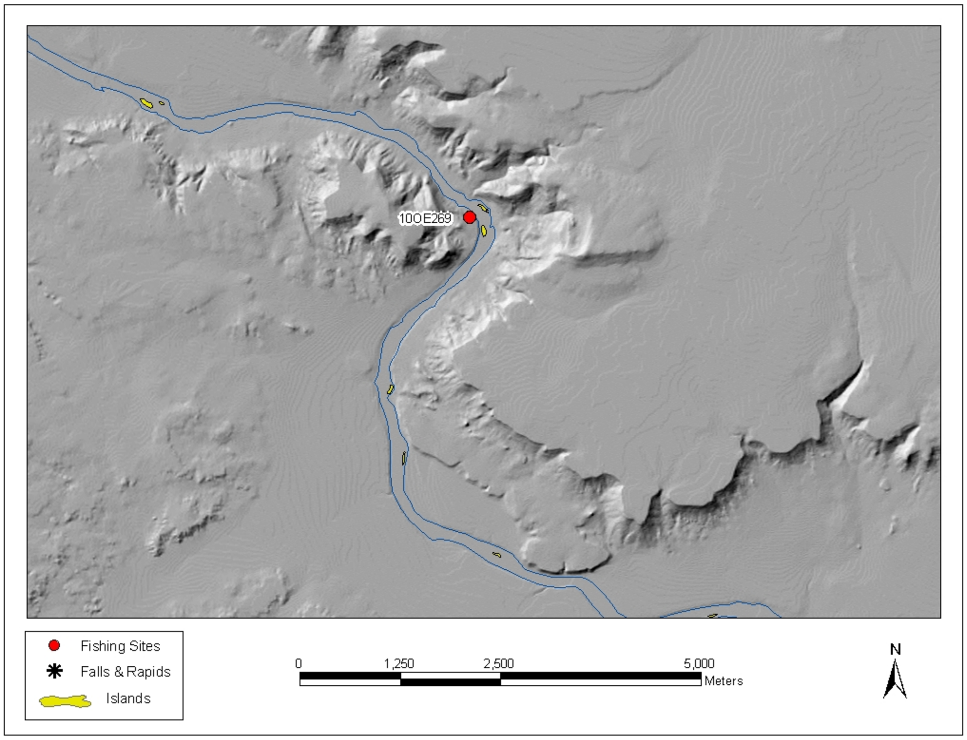


Figure A.10 10EL392, Middle Snake River



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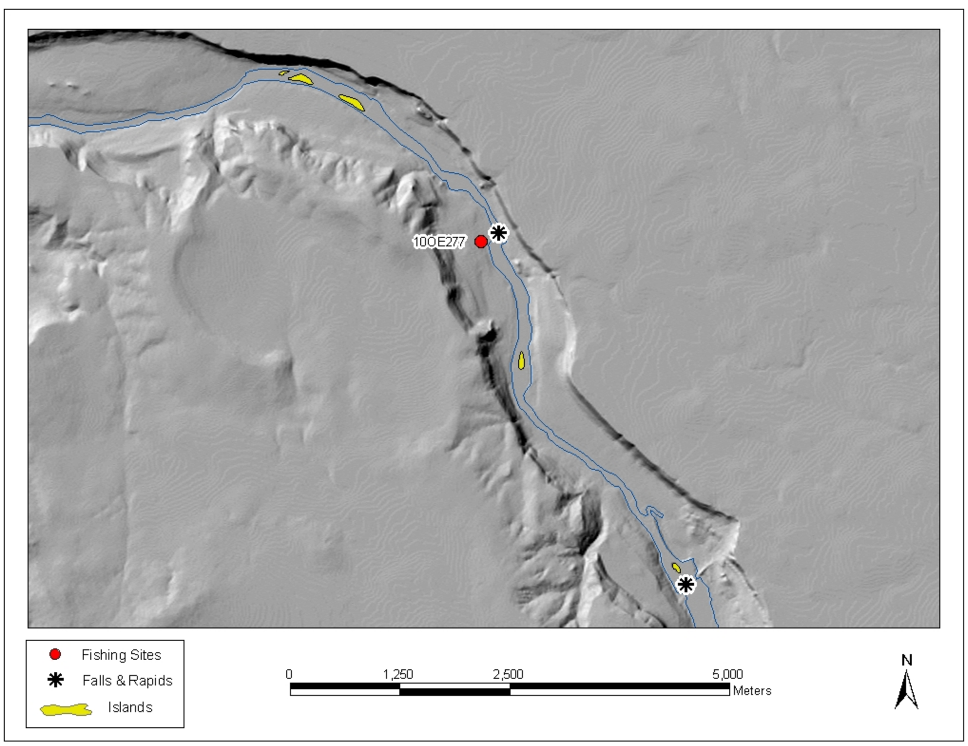

Figure A.12 10OE277, Middle Snake River

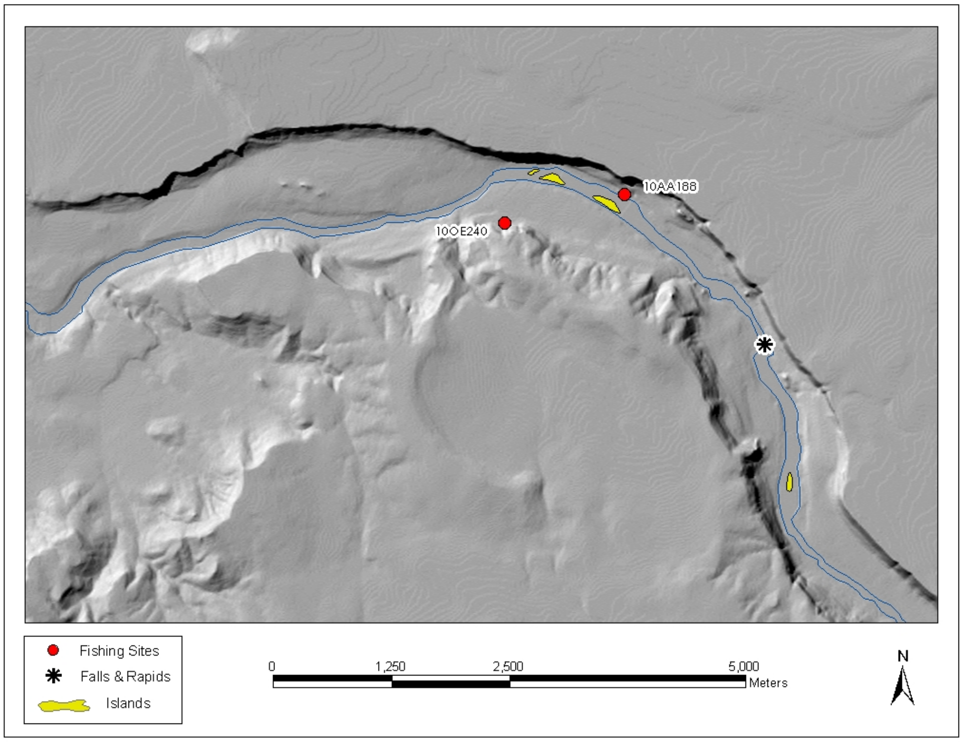

Figure A.13 10AA188 and 10OE240, Middle Snake River

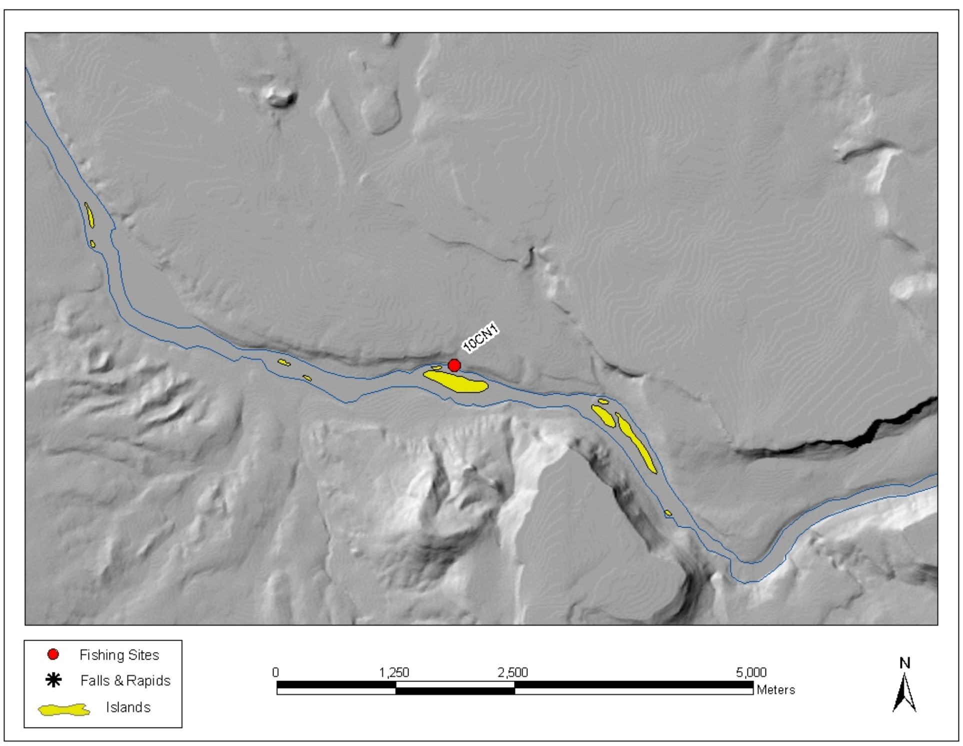

Figure A.14 10CN1, Middle Snake River

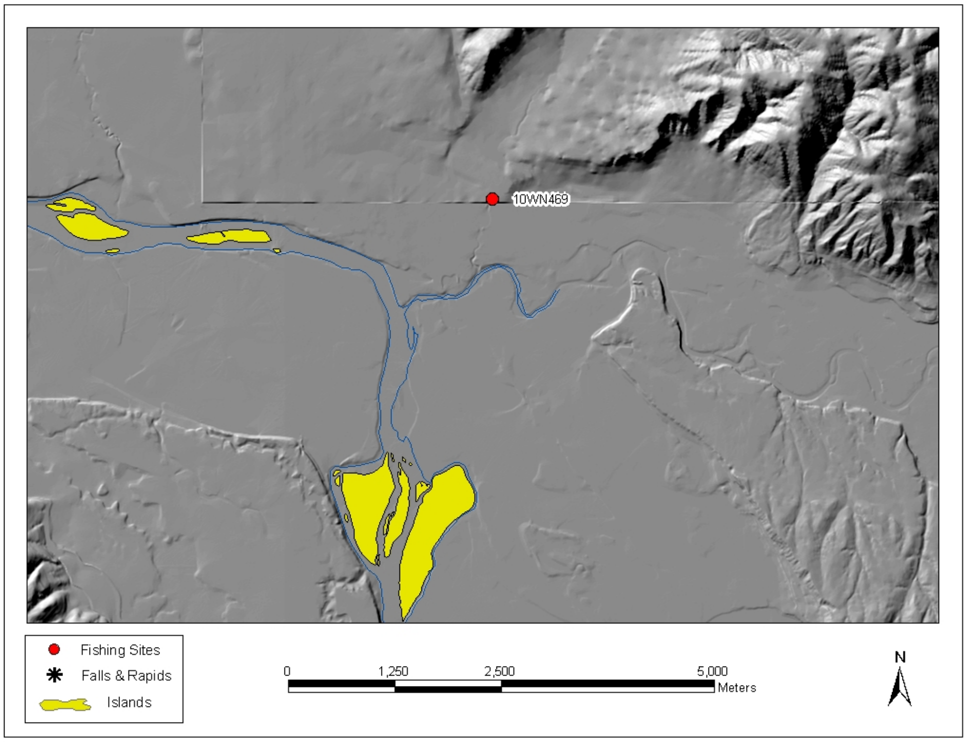

Figure A.15 10WN469, Middle Snake River

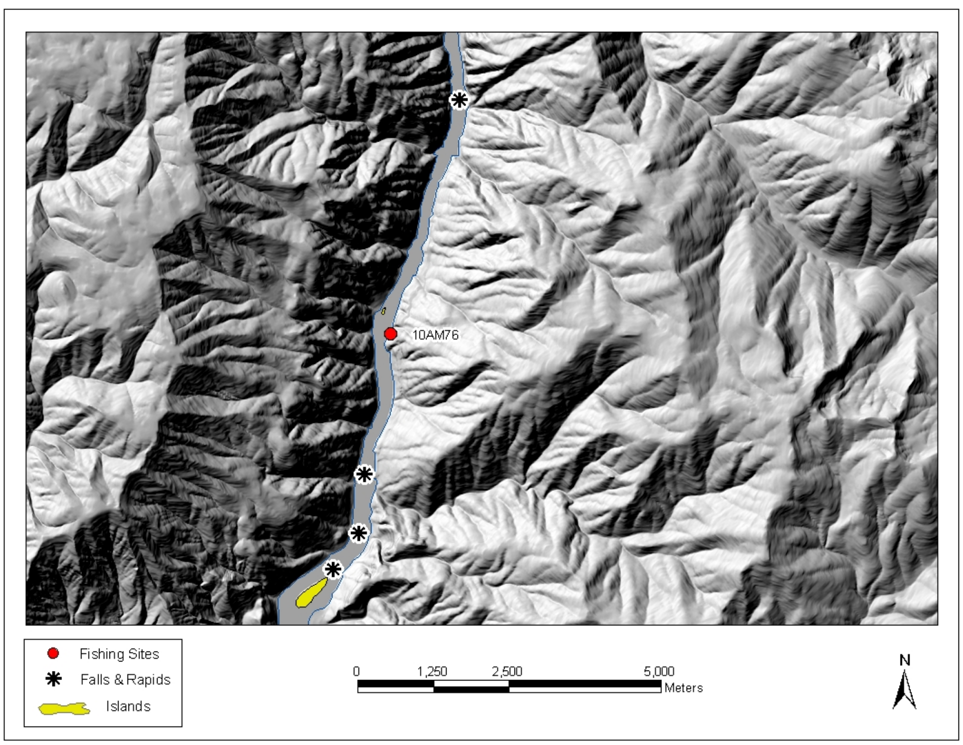

Figure A.16 10AM76, Hells Canyon

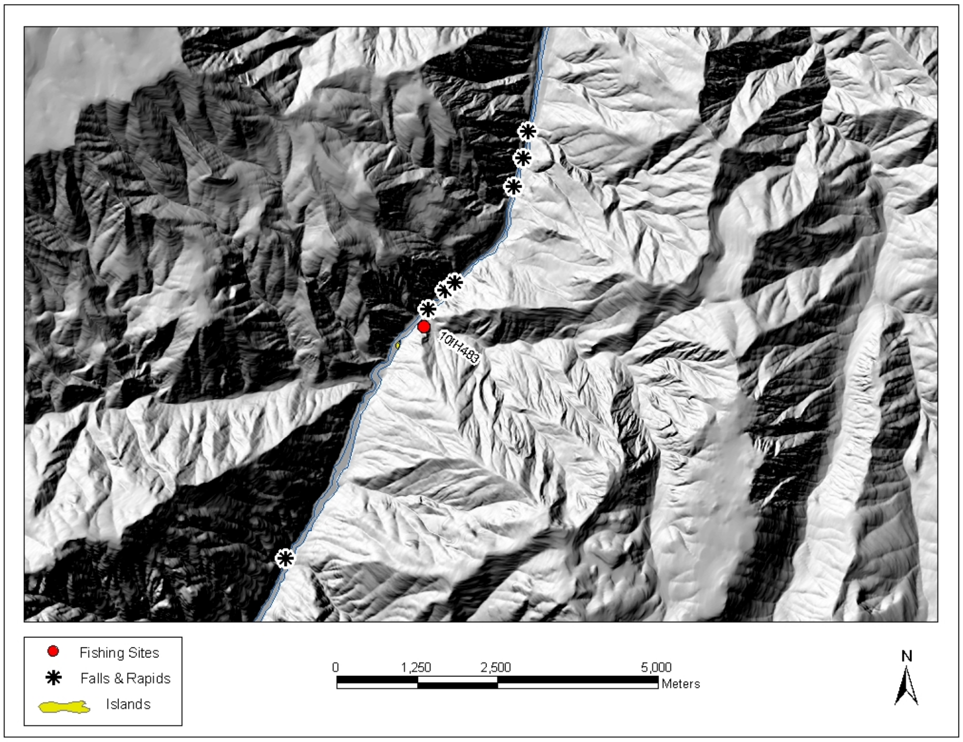

Figure A.17 10IH483, Hells Canyon

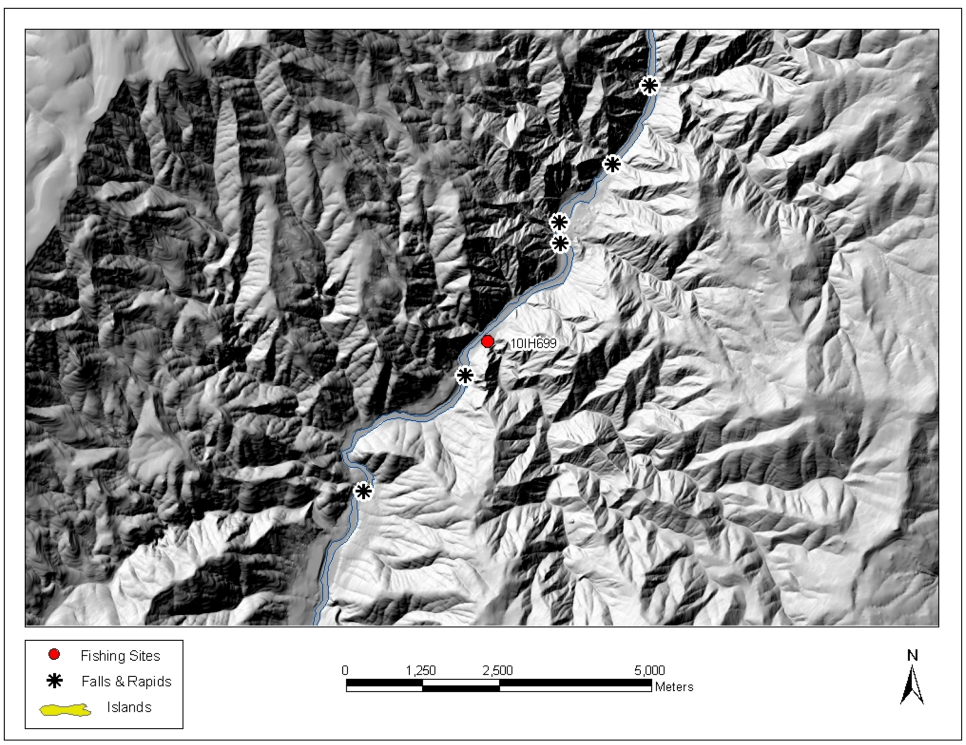

Figure A.18 10IH699, Hells Canyon

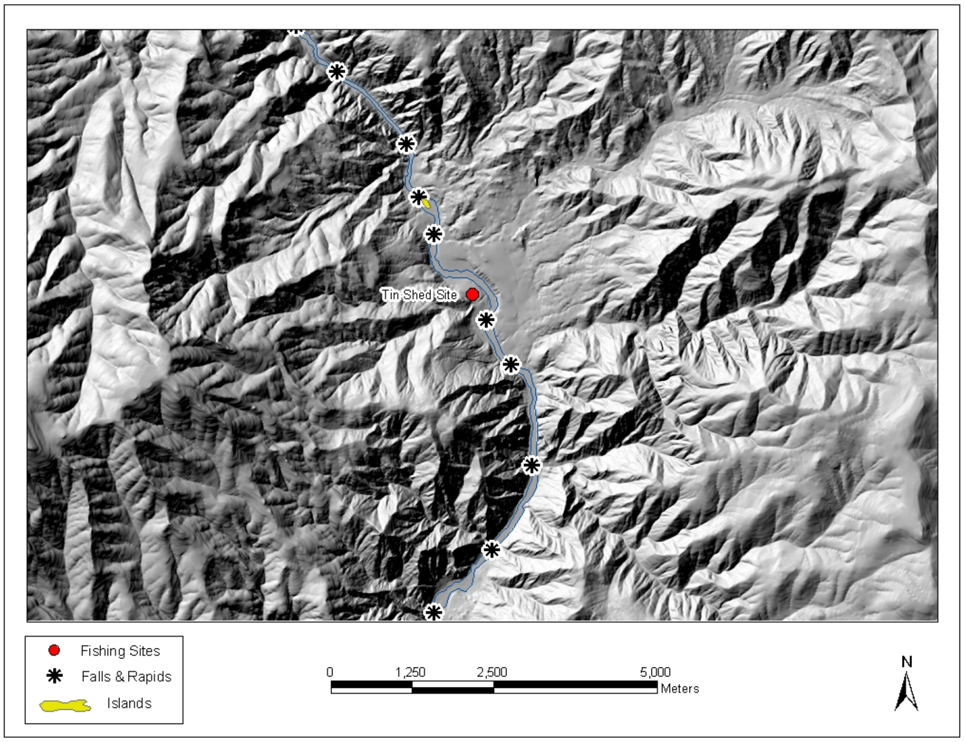

Figure A.19 Tin Shed Site, Hells Canyon

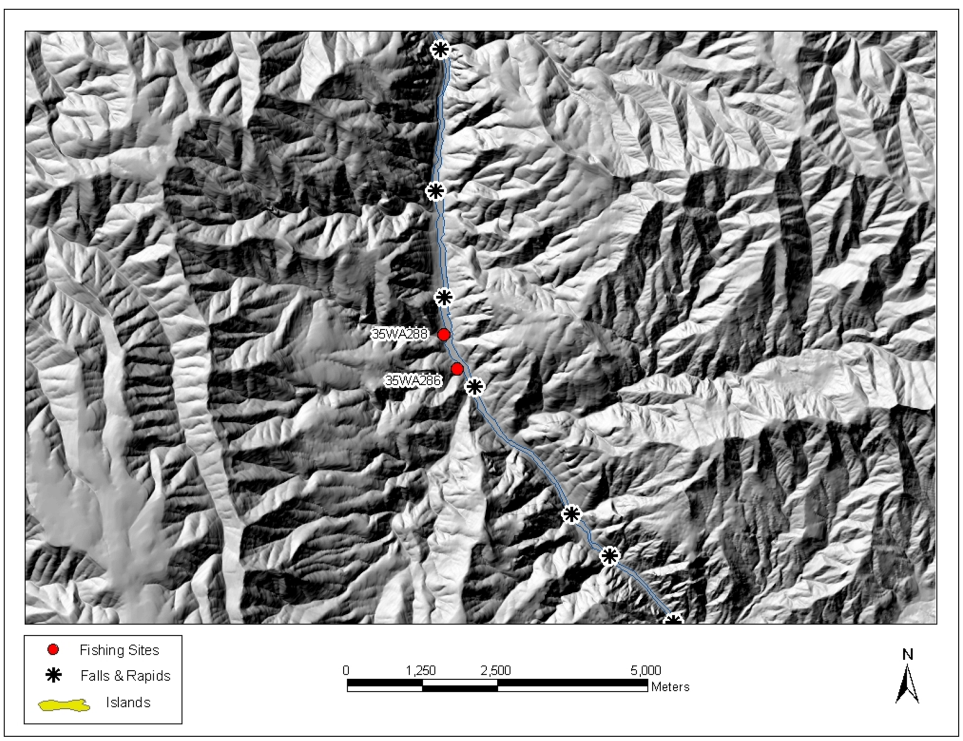

Figure A.20 35WA286 and 35WA288, Hells Canyon

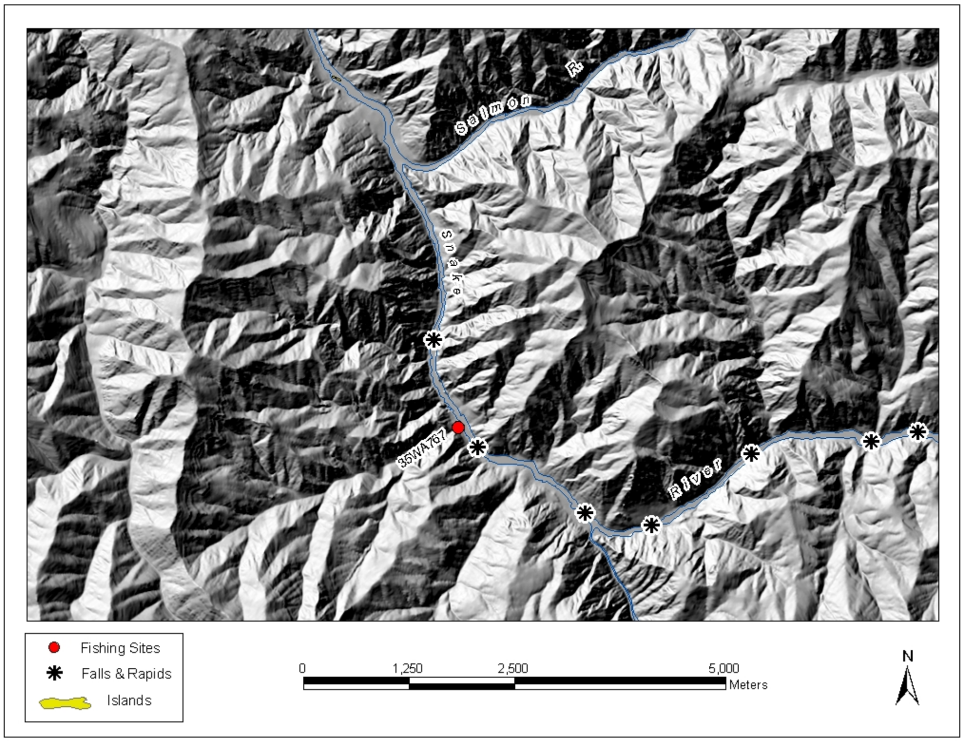

Figure A.21 35WA767, Hells Canyon

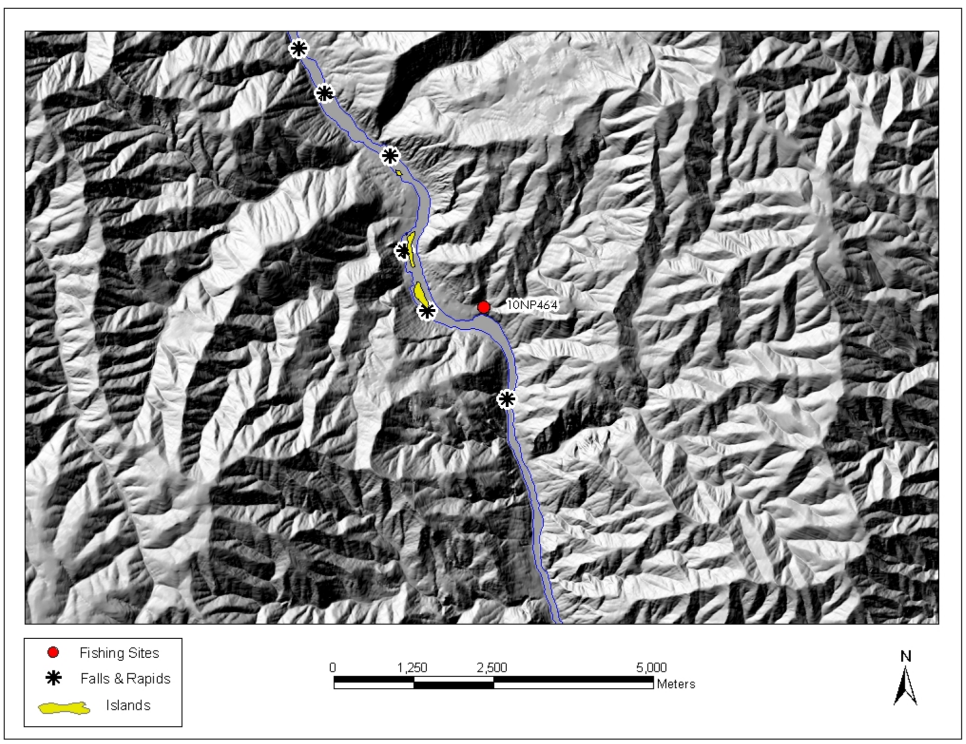

Figure A.22 10NP464, Hells Canyon

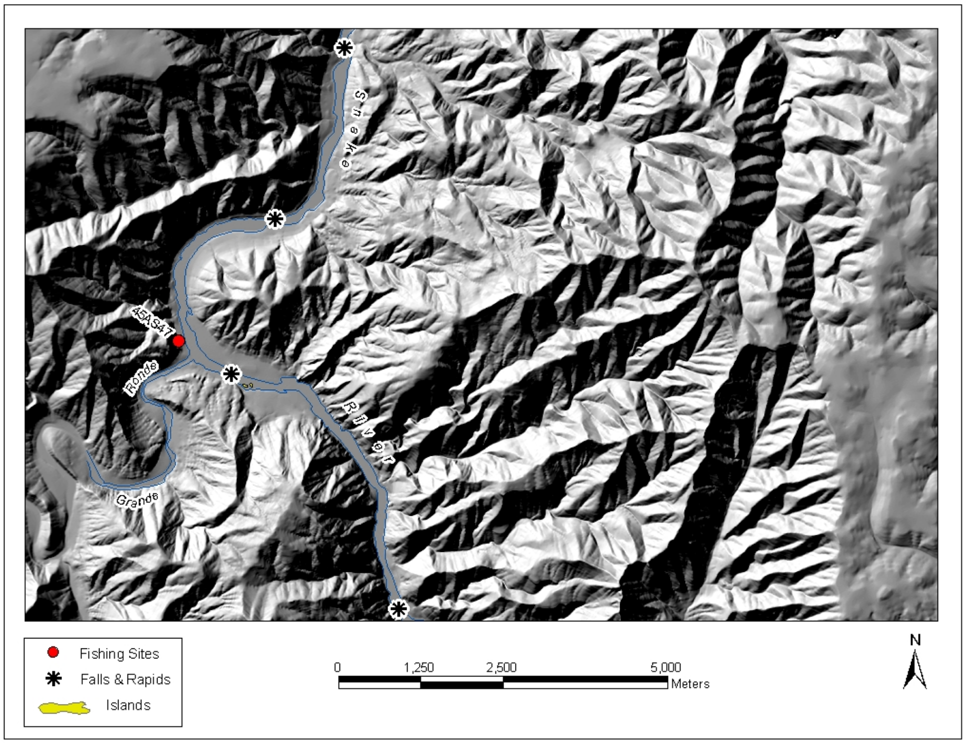

Figure A.23 45AS47, Lower Snake River

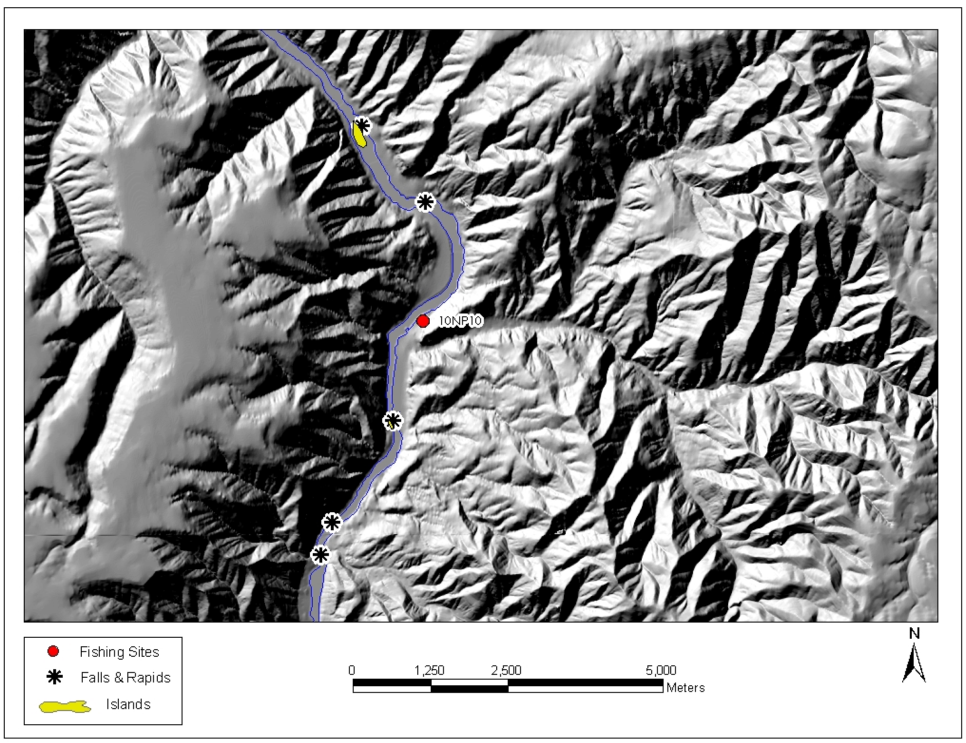

Figure A.24 10NP10, Lower Snake River

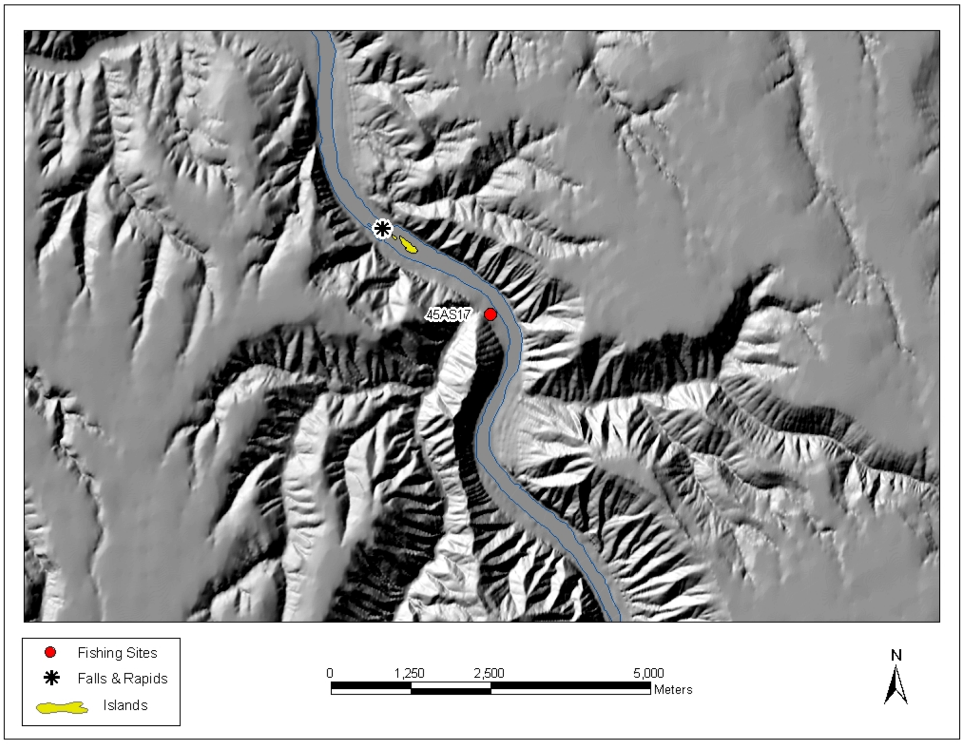

Figure A.25 45AS17, Lower Snake River

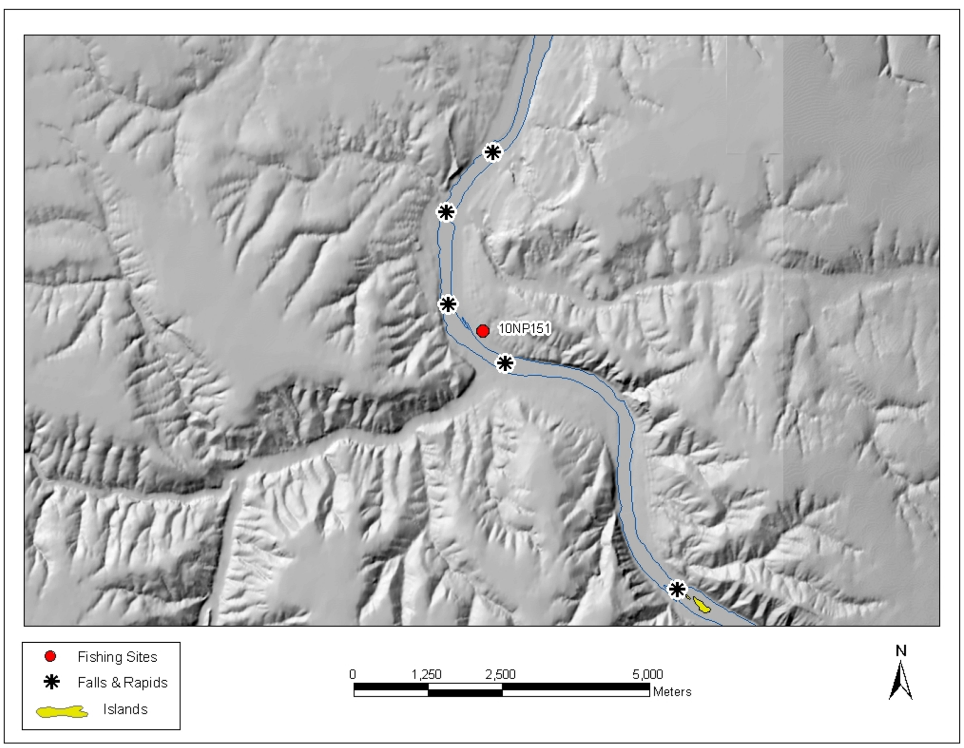

Figure A.26 10NP151, Lower Snake River

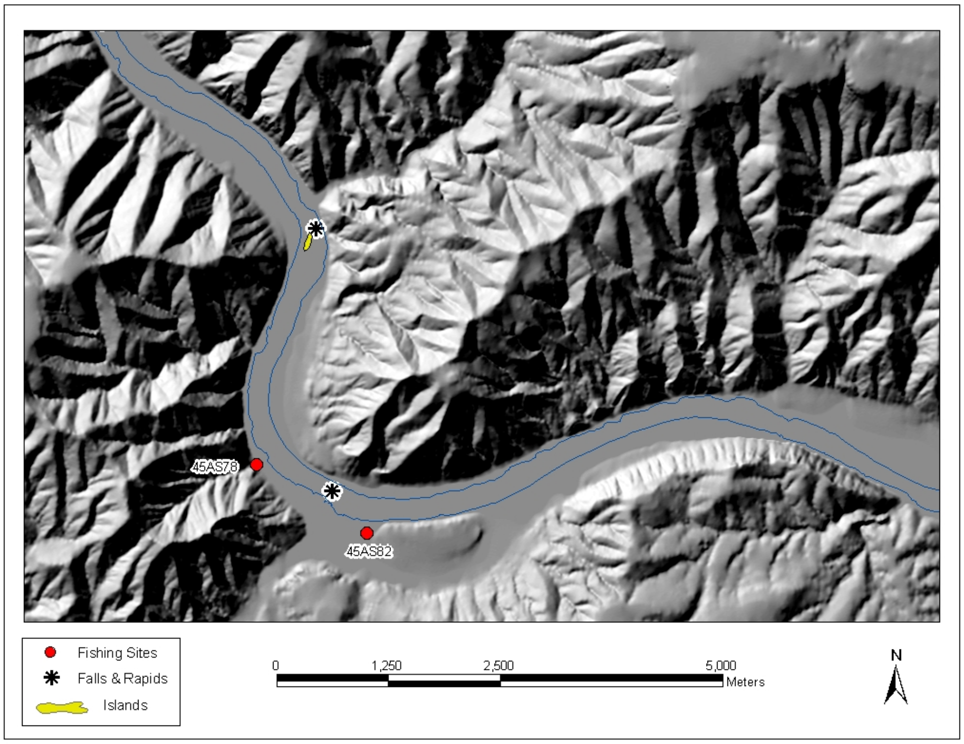

Figure A.27 45AS78 and 45AS82, Lower Snake River

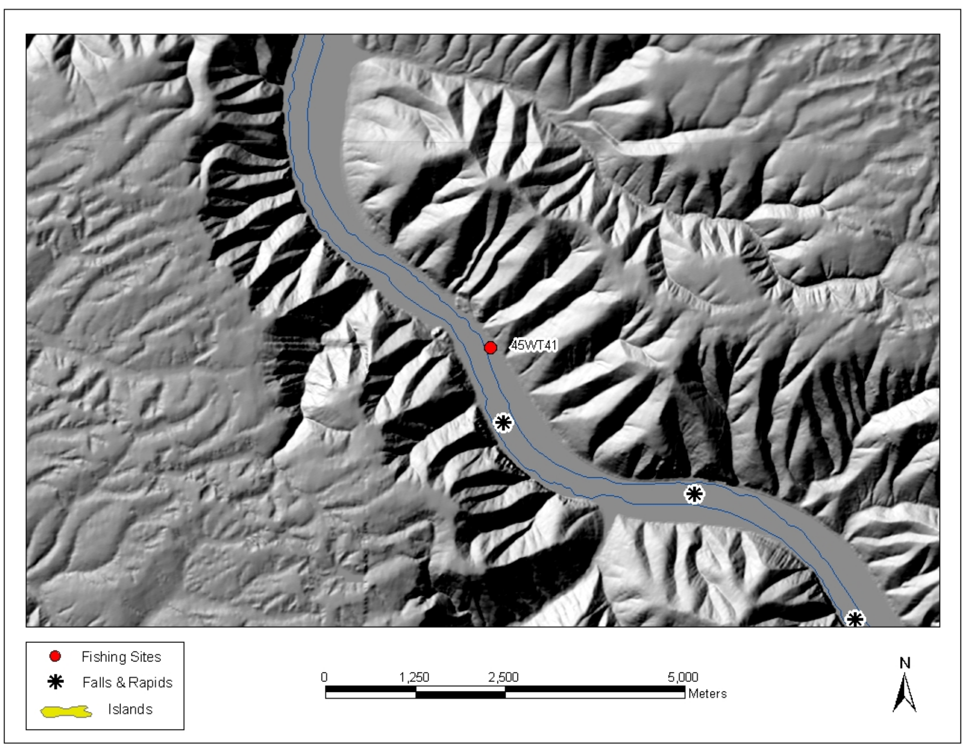

Figure A.28 45WT41, Lower Snake River

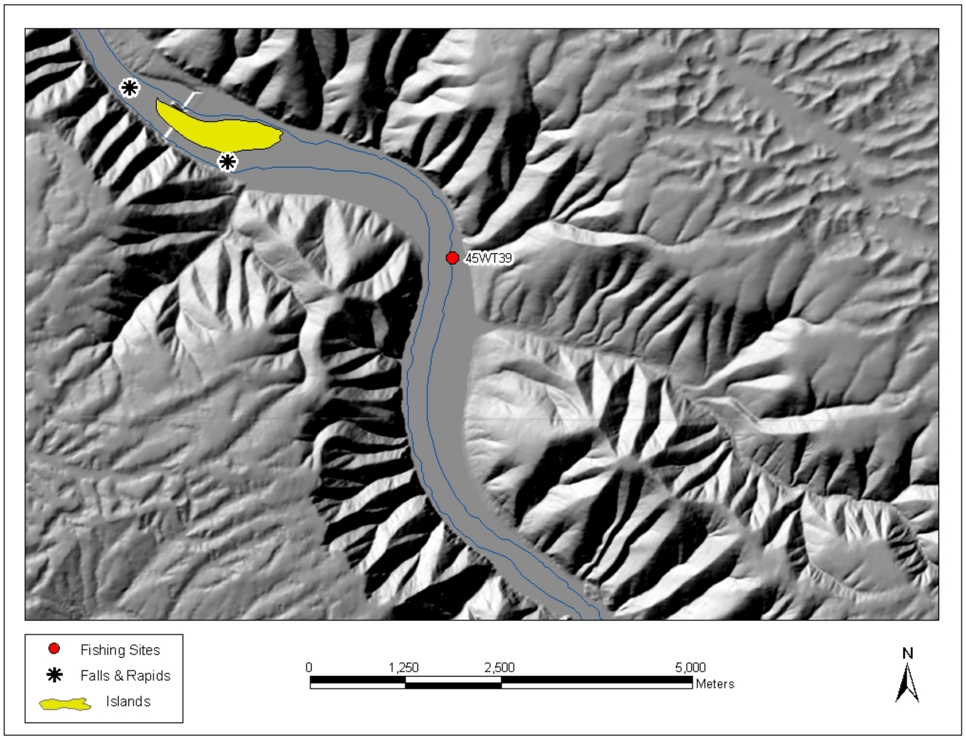

Figure A.29 45WT39, Lower Snake River

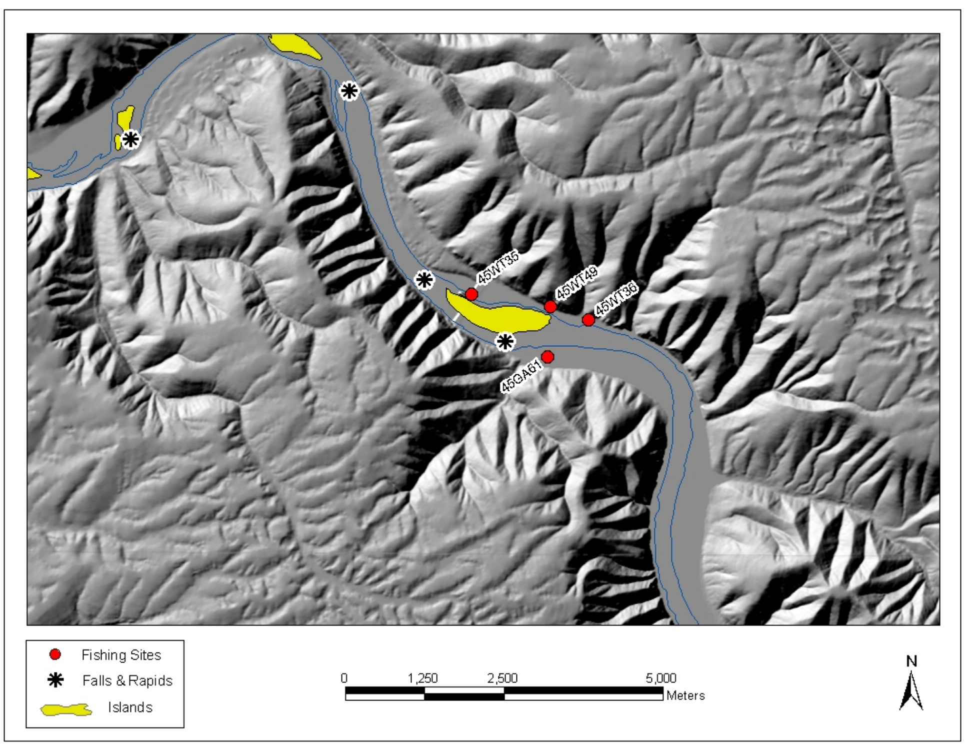

Figure A.30 45WT35, 45WT36, 45WT49 and 45GA61, Lower Snake River

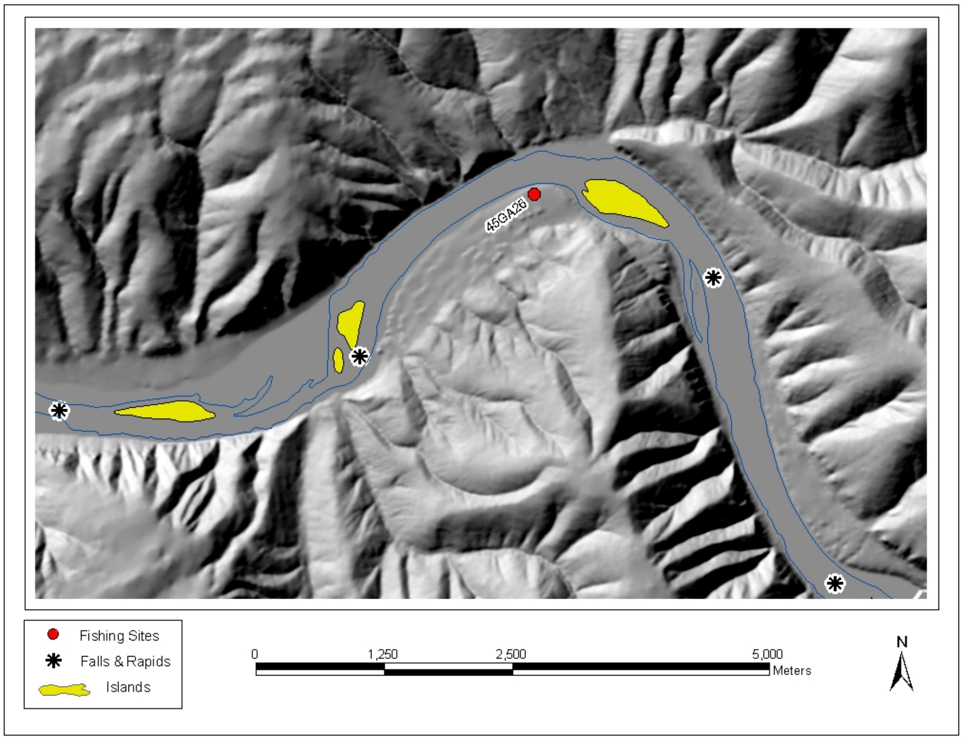

Figure A.31 45GA26, Lower Snake River

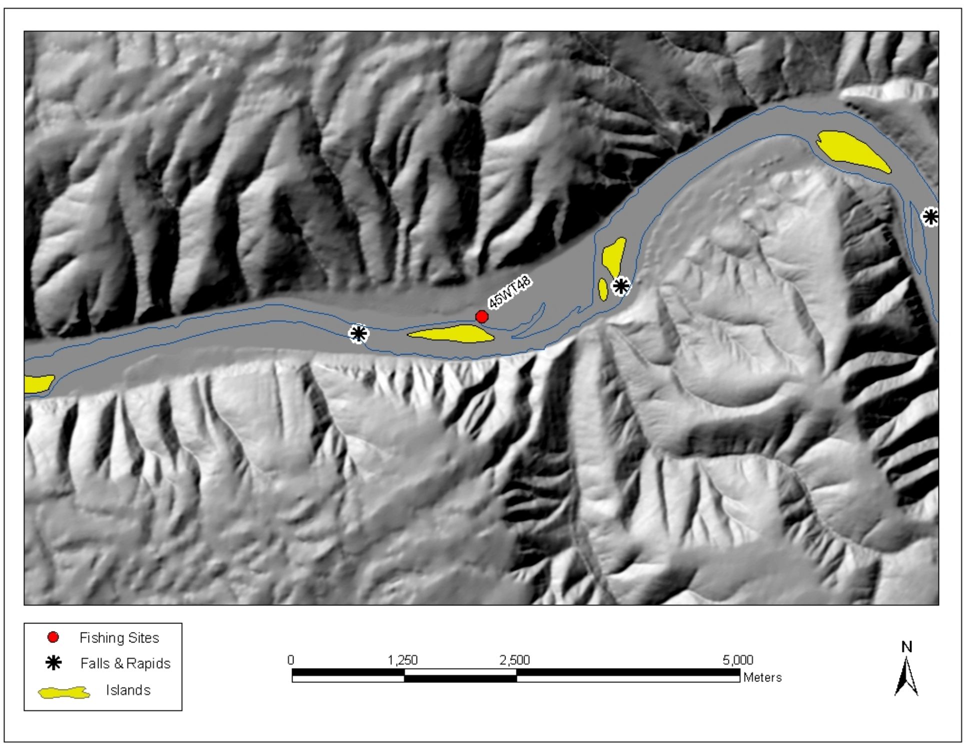

Figure A.32 45WT48, Lower Snake River

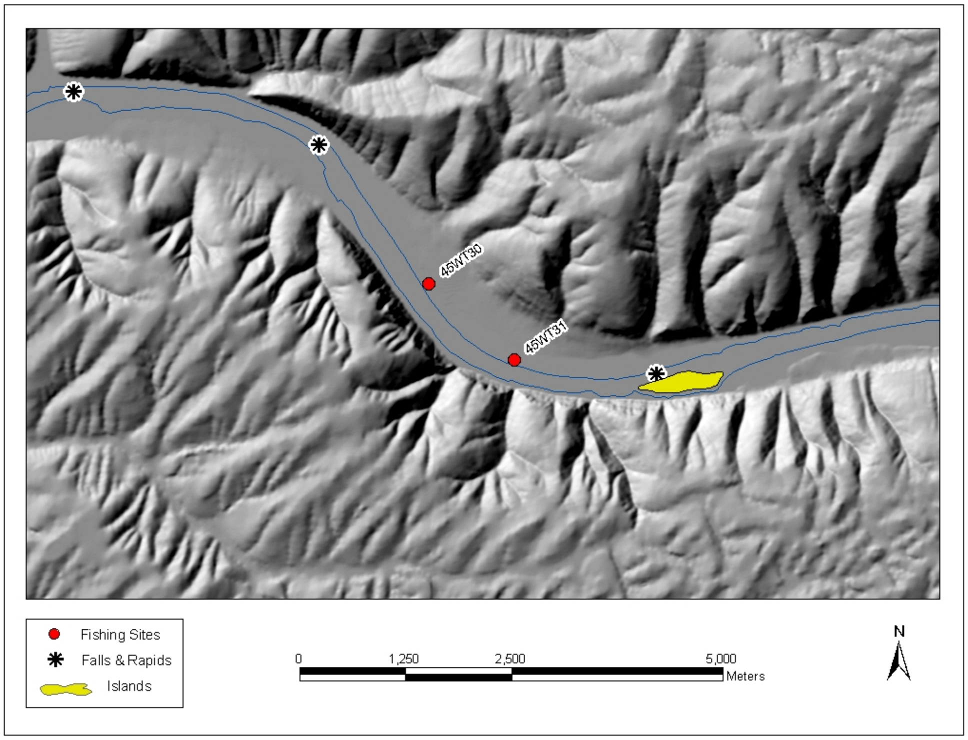

Figure A.33 45WT30 and 45WT31, Lower Snake River

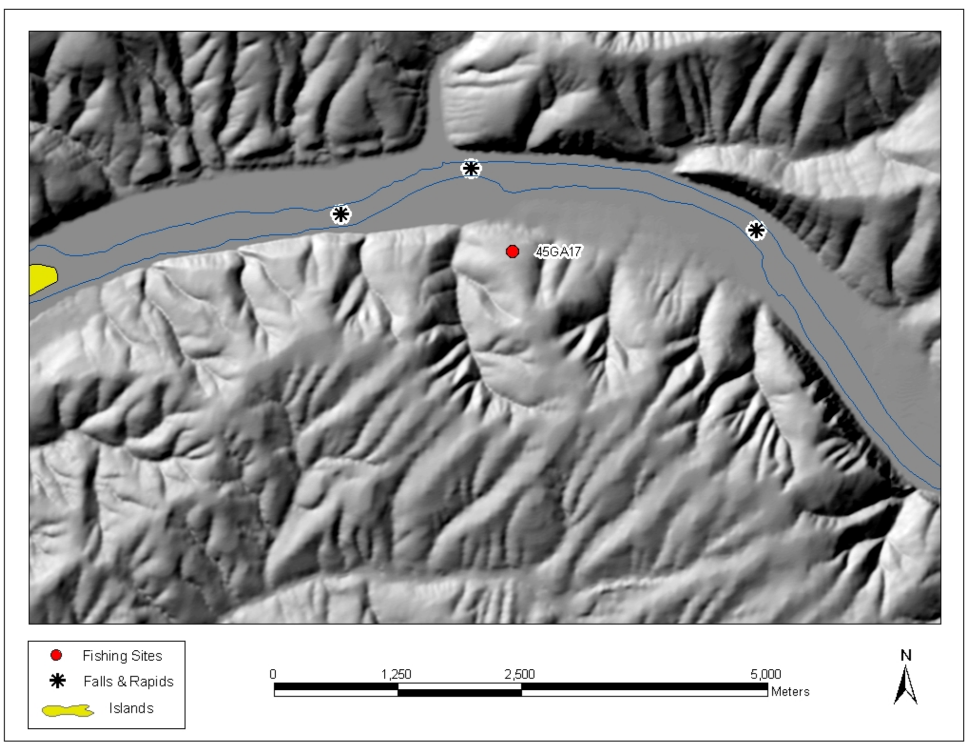

Figure A.34 45GA17, Lower Snake River

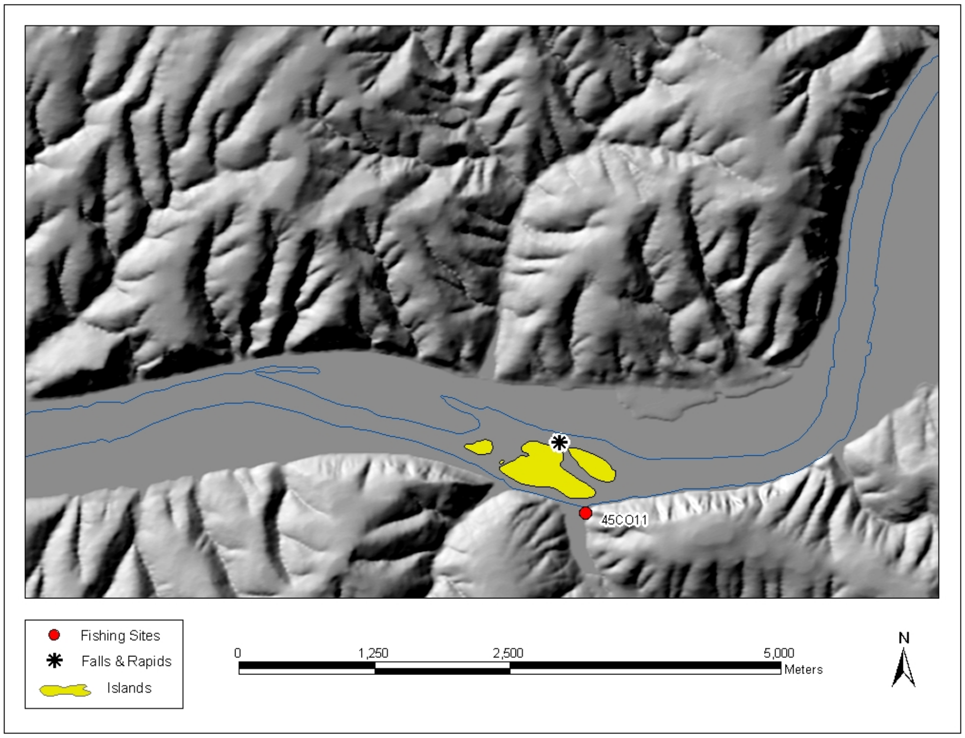

Figure A.35 45CO11, Lower Snake River

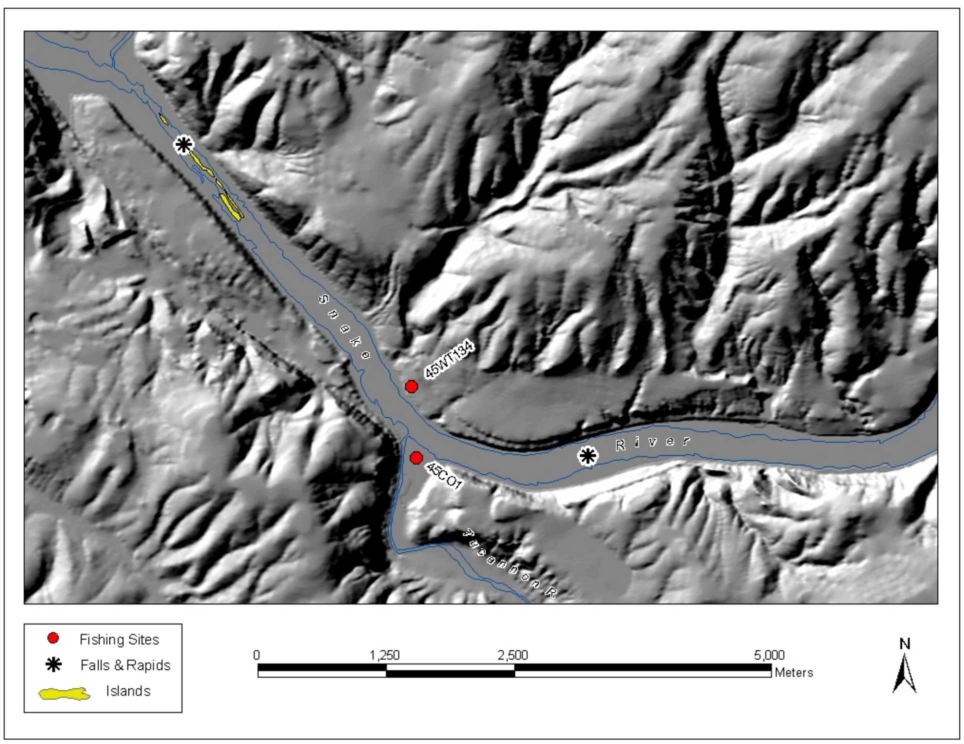

Figure A.36 45CO1 and 45WT134, Lower Snake River

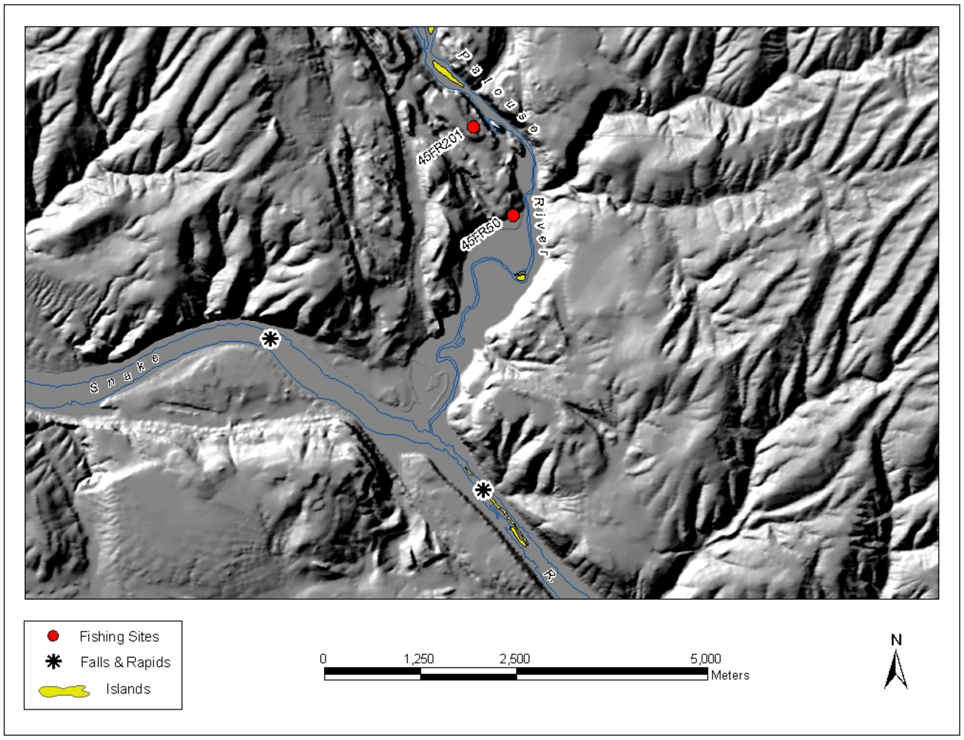

Figure A.37 45FR50 and 45FR201, Palouse River

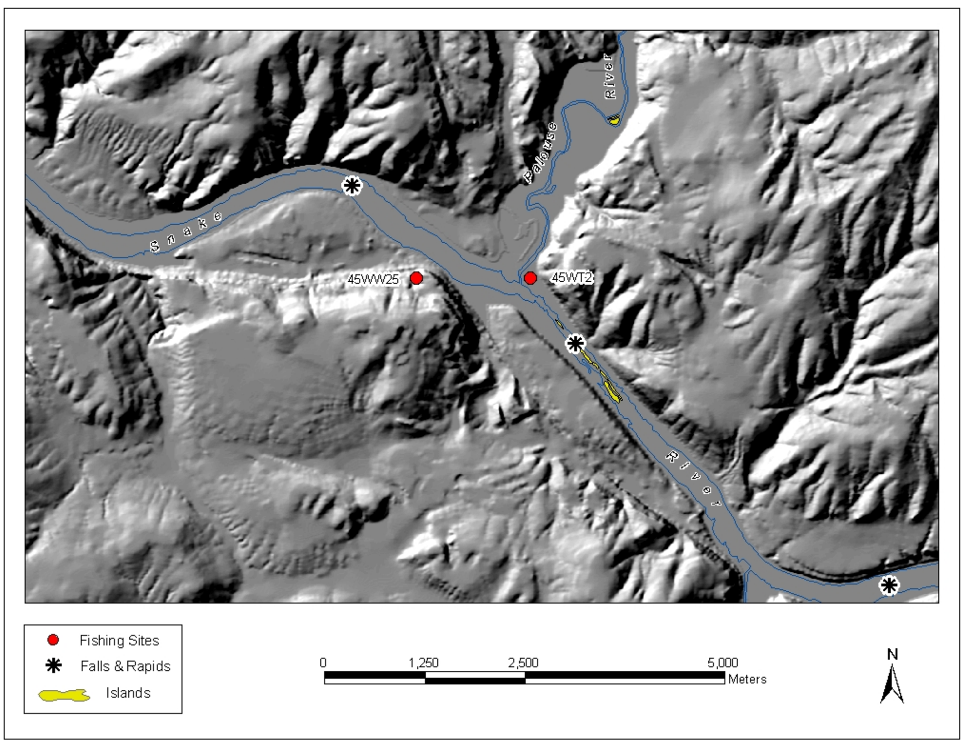

Figure A.38 45WT2 and 45WW25, Lower Snake River

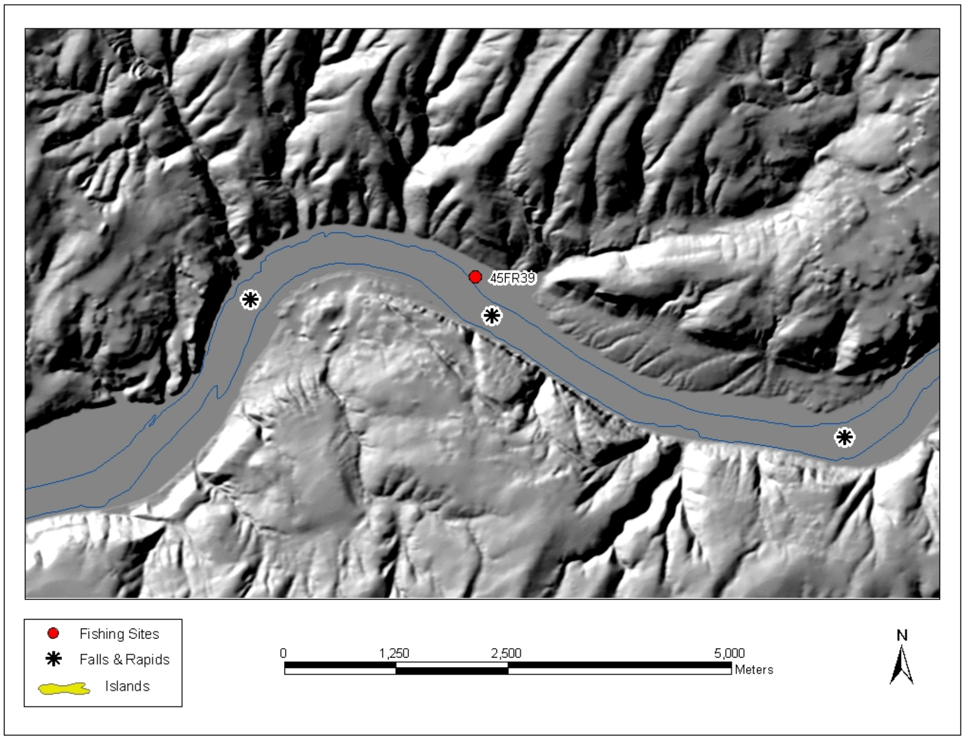

Figure A.39 45FR39, Lower Snake River

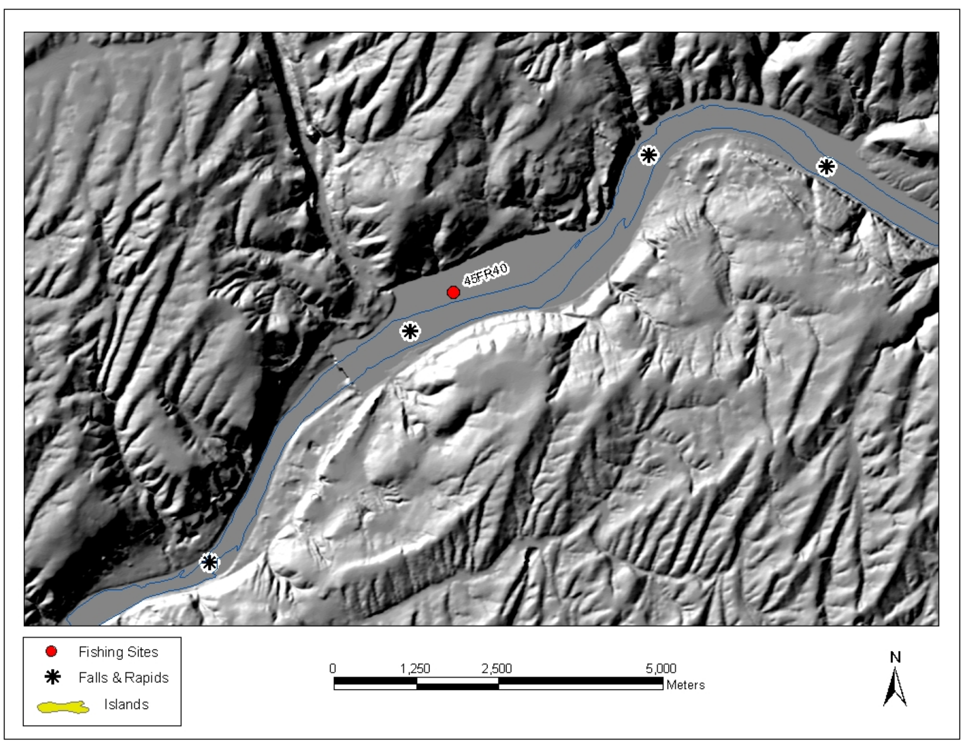

Figure A.40 45FR40, Lower Snake River

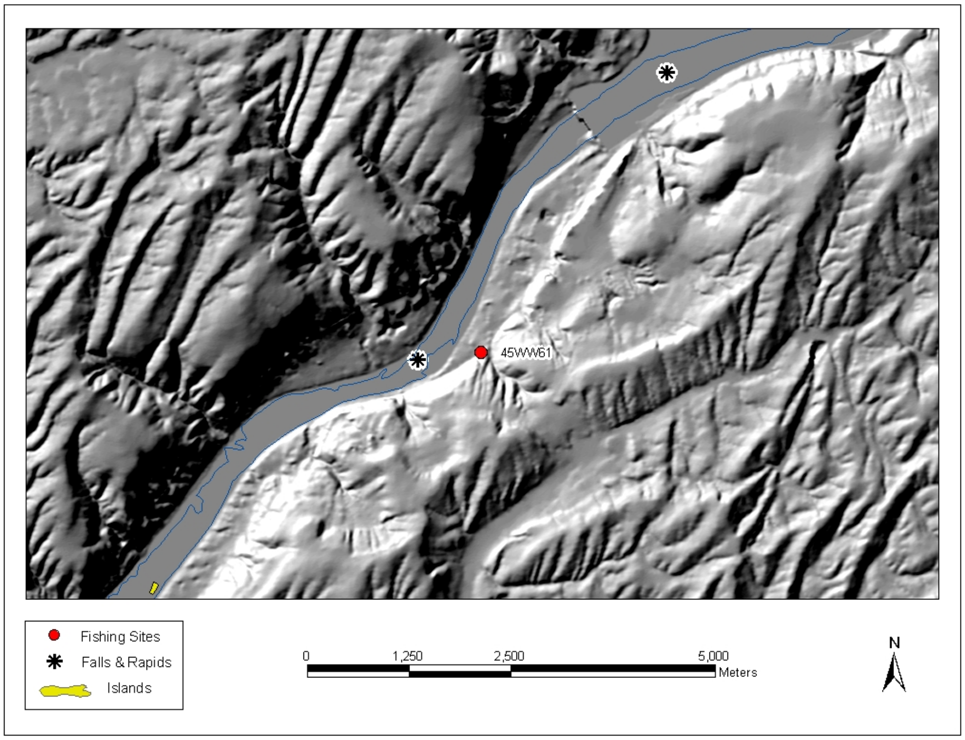

Figure A.41 45WW61, Lower Snake River

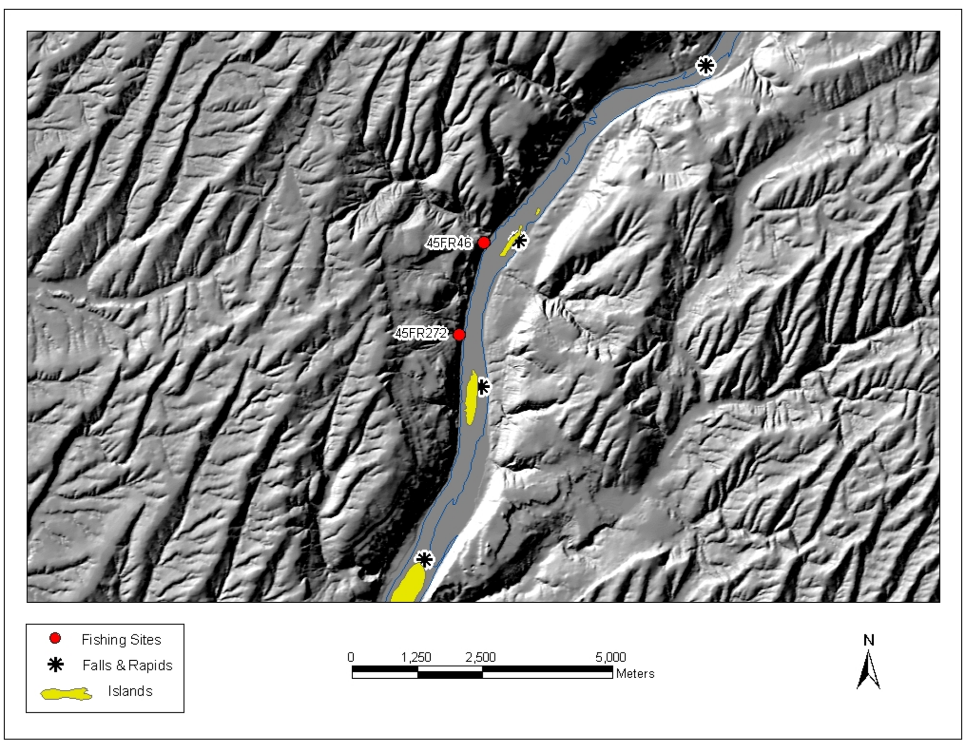

Figure A.42 45FR46 and 45FR272, Lower Snake River

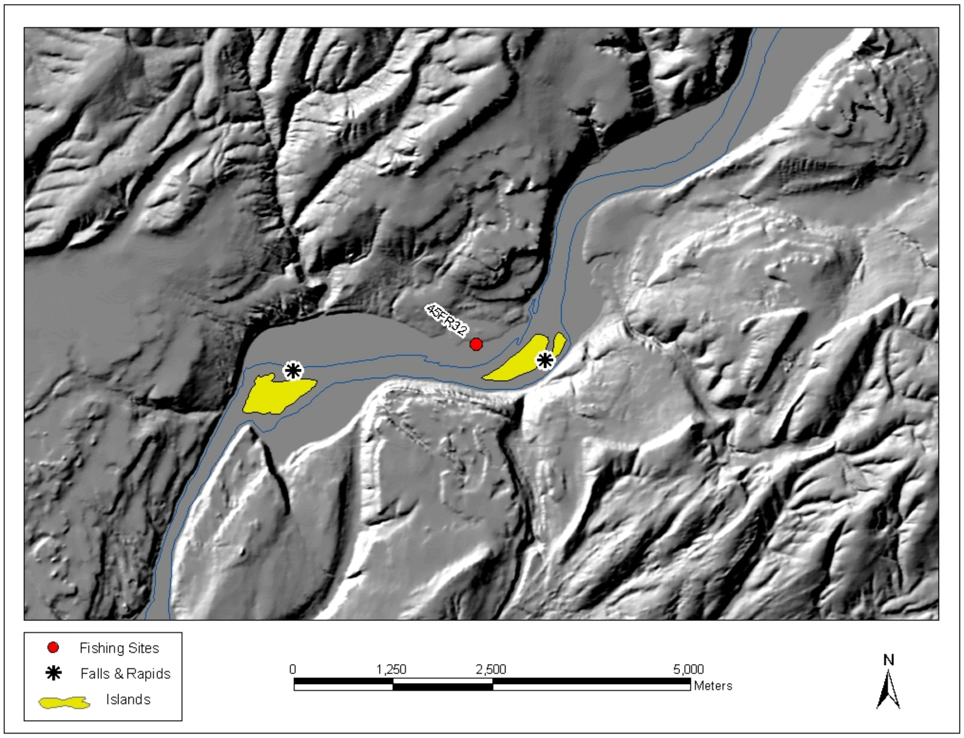

Figure A.43 45FR32, Lower Snake River

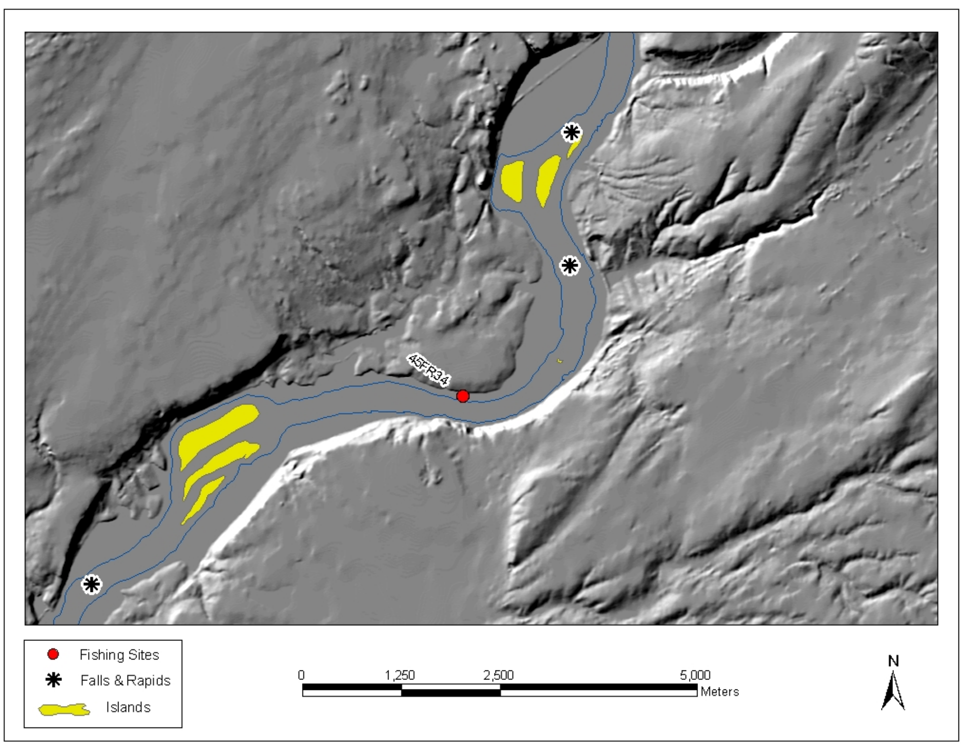

Figure A.44 45FR34, Lower Snake River

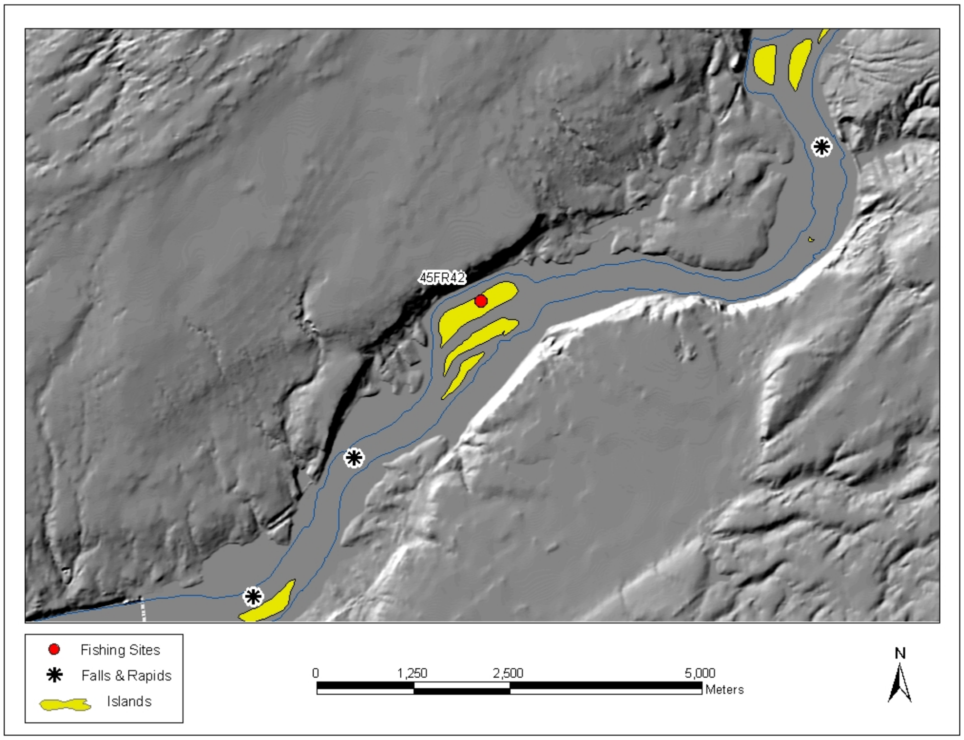

Figure A.45 45FR42, Lower Snake River

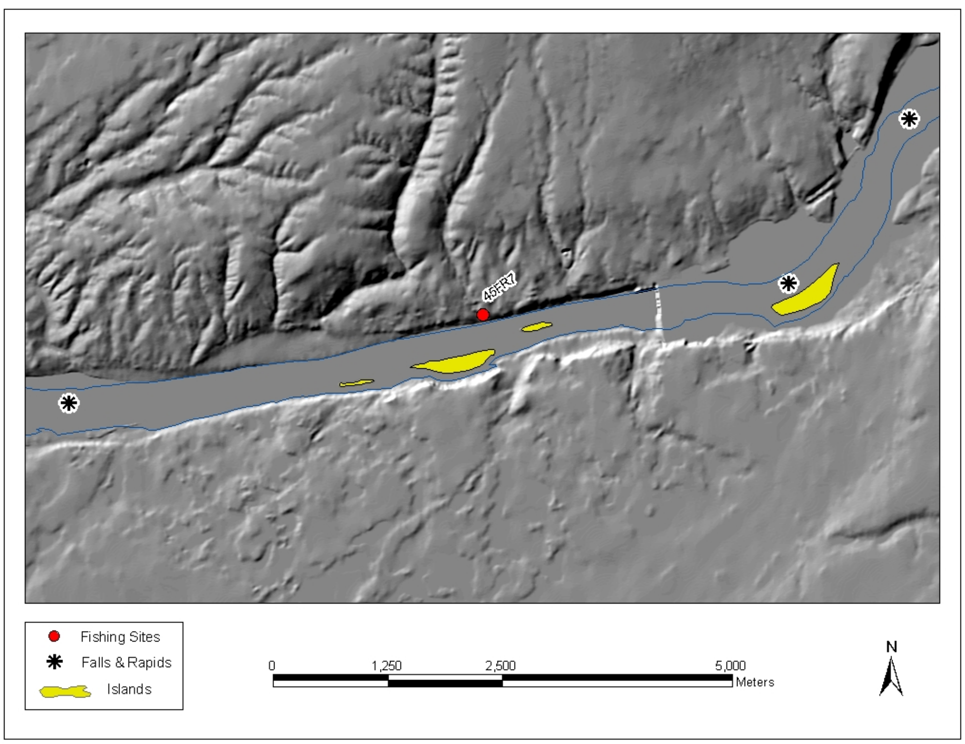

Figure A.46 45FR7, Lower Snake River

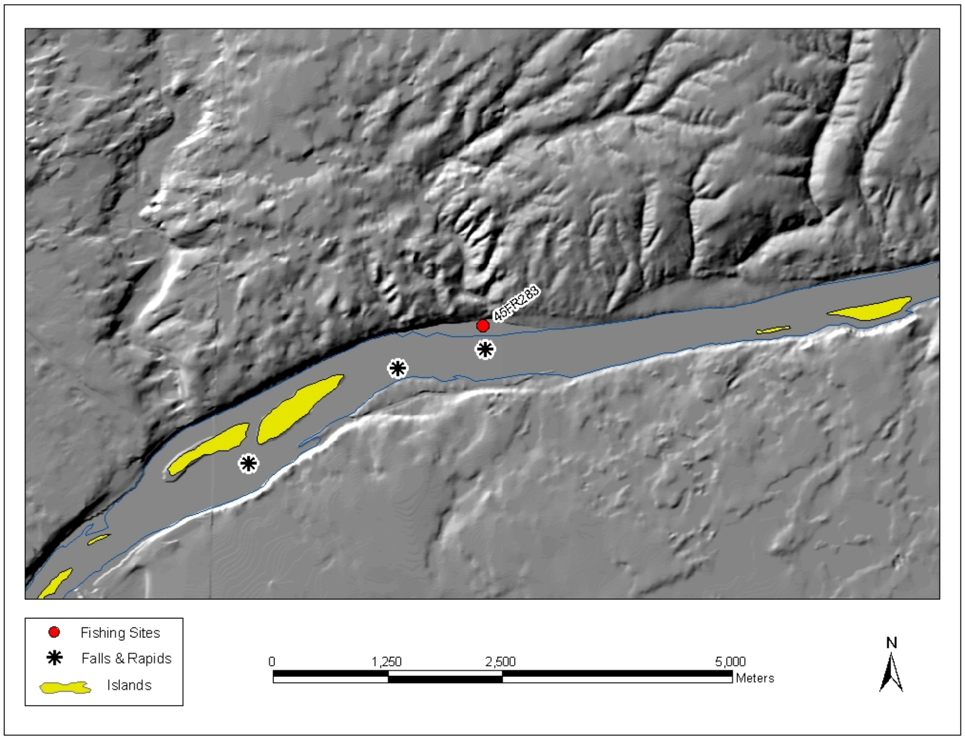

Figure A.47 45FR283, Lower Snake River

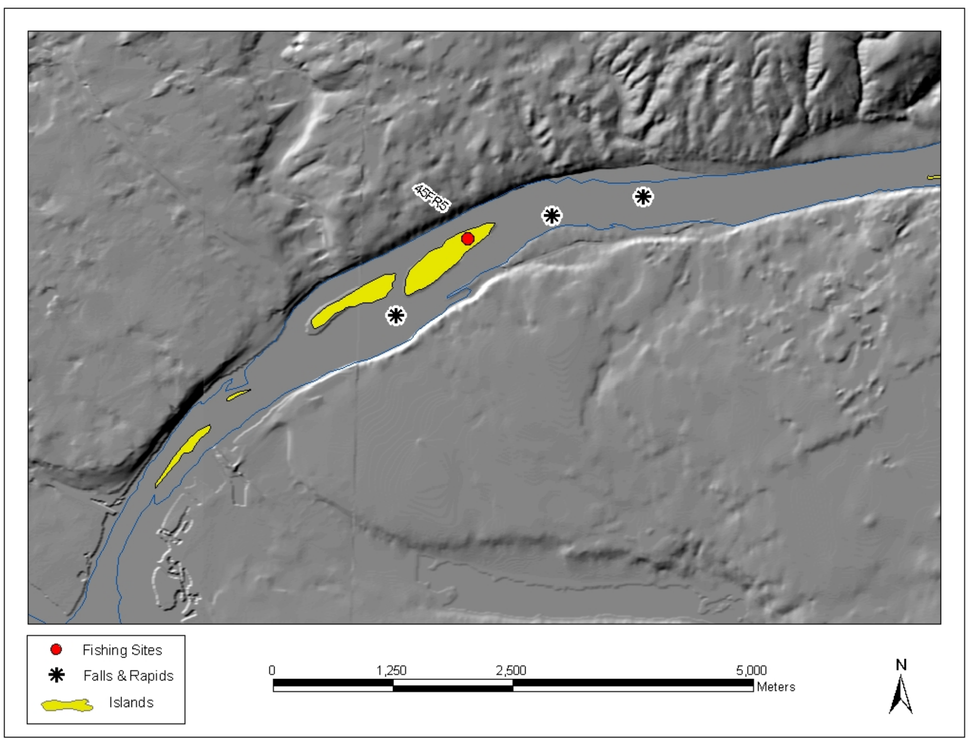

Figure A.48 45FR5, Lower Snake River