VARIATION IN THE CONFIGURATION OF THE MIDDLE SNAKE RIVER AND ITS RELATIONSHIP TO PREHISTORIC FISHING SITE LOCATIONS

by

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A thesis

submitted in partial fulfillment

of the requirements for the degree of

Master of Arts in Anthropology

Boise State University

May 2019

BOISE STATE UNIVERSITY GRADUATE COLLEGE

DEFENSE COMMITTEE AND FINAL READING APPROVALS

of the thesis submitted by

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Thesis Title: Variation in the Configuration of the Middle Snake River and its Relationship to Prehistoric Fishing Site Locations

Date of Final Oral Examination: 14 February 2019

The following individuals read and discussed the thesis submitted by student Joseph Wardle, 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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ACKNOWLEDGEMENTS

This research project was made possible by many individuals. Those who guided my initial inquiries included Rick Rieber of the Bureau of Reclamation, Travis Pitkin of the Idaho State Historical Society, Kirk Halford of the Bureau of Land Management, and Nikki Polson of the Bureau of Reclamation. I knew very little about fish or maps before their insights and experience propelled my research.

I am also indebted to Edwin DeYoung for aiding my early efforts to create maps in ArcGIS and Dr. Kristin Snopkowski for advice on the statistical analyses used in this study. Karl Mertens and Conner Neal provided useful criticism and suggestions during early conversations. Barbara Valdez edited a final version of the thesis, for which I am very grateful.

Finally, much is owed to my committee members, Dr. Mark Plew, Dr. Nicole Herzog, Dr. Russell Gould, and my committee chair, Dr. Pei-Lin Yu, all of whom gave countless hours of guidance over the past two years. It was an honor having four sharp minds to cut into my ideas, and I have learned a great deal about archaeological research in the process.

ABSTRACT

The configuration of the various elements of a river system can have significant impacts on the availability, abundance, and nutritional profitability of aquatic organisms utilized as food by groups of human foragers. These factors may have influenced the location and timing of prehistoric fishing along the Middle Snake River in southern Idaho during the Late Archaic when use of fish as a resource increased (beginning approximately 1500 B.P.). Previous work has established a relationship between physiographic features of the Middle Snake River channel and the presence of fishing sites. To improve on future studies of this type, it is important to question two assumptions: 1) the category of "fishing site" is useful and defensible; and 2) the configuration of the Middle Snake River was static during the period when archaeological evidence suggests increased use of fish. This study assesses the argument that prehistoric camp locations, regardless of evidence for fishing, were influenced by physiographic features of pre-dam channels and by possible changes in features over time.

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OFT	Optimal Foraging Theory
MCW	Minimum Channel Width

CHAPTER ONE: INTRODUCTION

In the western Snake River Plain of southern Idaho, archaeological site location has been shown to correlate with two physiographic features of the Snake River's configuration: islands and localized narrows where the river channel funnels (Pitkin 2010). Archaeological investigations of this kind must contend with the fact that fluvial landscapes are complex, dynamic systems (Chatters and Hoover 1986). The variability of these systems is intricately tied to the productivity, abundance, and nutritional content of aquatic species that are utilized as prey by human foragers. Because of this, changes in the configuration of a river system alter the costs and benefits associated with pursuing aquatic prey.

This study expands on previous work by focusing on one section of the river that runs through the western Snake River Plain, increasing the sample of archaeological sites within this area, and evaluating two assumptions regarding site function type and past river configuration. The first assumption is that the category of "fishing site" is useful when describing archaeological sites on the Middle Snake River, a view which is not supported by the archaeological evidence. The second of these, that the current configuration of the Middle Snake River is representative of the configuration over time, is questionable based on what is known of the factors that can alter river configuration.

River configuration is a dynamic interaction between a range of variables such as seasonal variation in stream flows (Doulatyari et al. 2014), historic cycles of floods and droughts (Lytle and Poff 2004), the fluvial geomorphology of river channels (Charlton

2008), geologic intrusions such as lava flows or landslides (Davis 2007), and human intervention in the form of dams, canals, irrigation, and pollution (Surian et al. 2009). The extent to which these dynamic processes can be inferred will inform assessments of the relationship between archaeological site placement and physiographic features, both of which would have been in flux.

The relationship is still worth testing, since it may contribute to the understanding of foraging decisions made by prehistoric individuals who were seasonally mobile hunter-gatherers on the Snake River Plain. However, a methodology that seeks to assess this relationship must weigh the evidence for fishing and hinge on a diachronic analysis that accounts for changes in river configuration over time. The primary function of these archaeological sites was likely activities other than fishing. Furthermore, if river configuration influenced decisions of where to forage, those decisions would have varied over time because the prime fishing locations would have changed. The extent and scale of changes in river configuration will condition suitable habitats for fish populations (Knapp et al. 1998; Simpson and Wallace 1982). All other things being equal, greater variation in flow levels and funneling at local narrows should increase encounter rates and reduce search time as reflected in simple optimal foraging models (see Bettinger 2009) and allow the use of simple low-cost technologies (Oswalt 1976). The spatial distribution of aquatic prey should either increase the bulk return, decrease the search time, or do both (Kelly 1996). This assumes that groups had labor specialization geared toward fishing, and could be positioned to take advantage of temporary changes in the encounter rate of aquatic species.

The goal of this project is to grapple with the variability that characterizes river configuration and assess whether the relationship between camp locations chosen by aboriginal hunter-gatherers on the Middle Snake River and physiographic features of the river configuration holds up when analyzed from a diachronic perspective. This involves understanding the factors that condition changes in river configuration, the extent that dams have altered the present-day configuration near which archaeological sites are presently positioned, and the variability in foraging strategies and tactics that can be inferred from the archaeological record. Within this framework, the following hypotheses are proposed: 1) that the Middle Snake River configuration influenced the positioning of camp locations; and 2) that the Middle Snake River configuration influenced the duration of re-occupation of camp locations. Assuming prey variability is constant over time, if configuration were stable over the time period, camp locations near optimal physiographic features should have repeated occupations.

Defining the Study Area and Time Period

The study area is defined as the Middle Snake River and includes a section from a western boundary at 43.680887° N, -117.026529° W – where the Snake River first crosses into Oregon – to an eastern boundary at Shoshone Falls (Figure 1.1). This is distinct from the Upper Snake in eastern Idaho and its headwaters in western Wyoming; as well as the Hells Canyon and Lower Snake portions downstream of the study area. The western limit is chosen to create a distinct Middle Snake section within Idaho, and the eastern limit is based on reports that salmon did not venture farther upstream than Shoshone Falls (Murphy and Murphy 1960). An expanded study area would have included sections with different ethnographic contexts and would not have aided in understanding the foraging spectrum on the Middle Snake River.

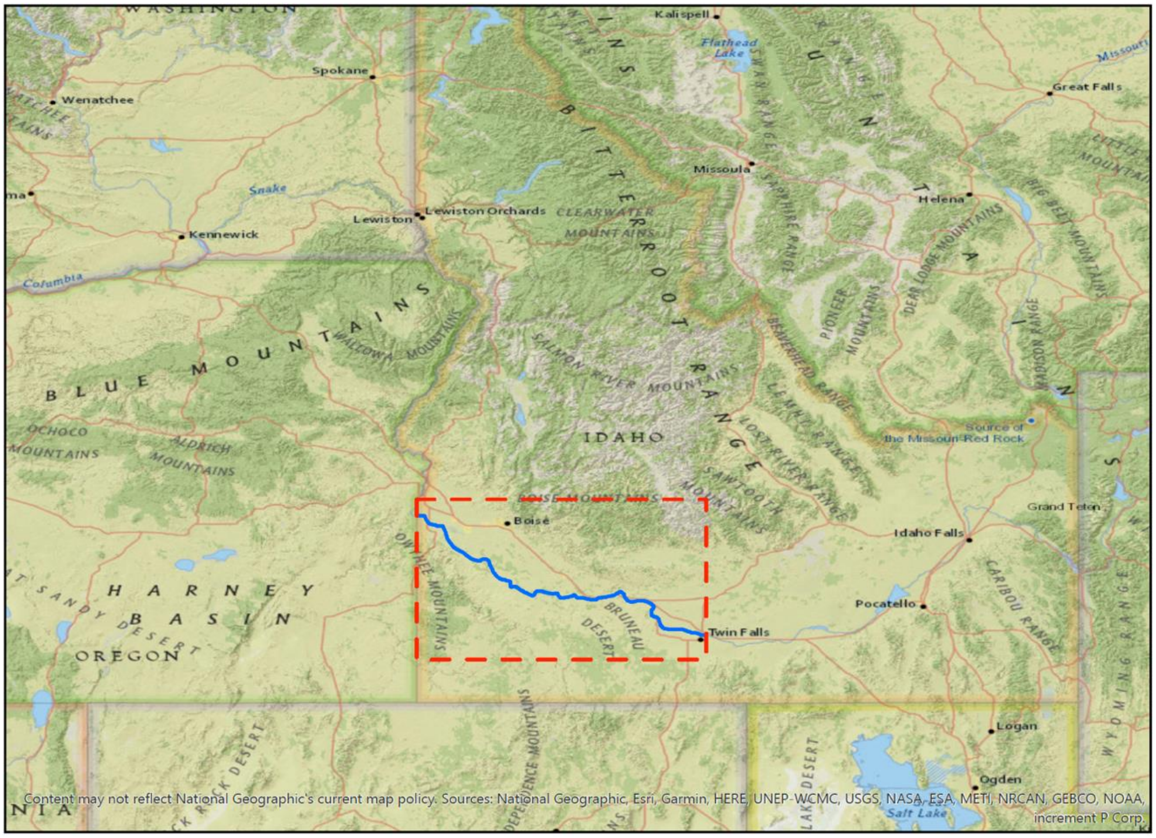

Figure 1.1 Map of Middle Snake River within western Snake River Plain

This study focuses on the Late Archaic time period when fishing was a part of the subsistence spectrum of groups on the western Snake River Plain, as suggested by archaeological evidence (Table 1.1). As of 2015, 31% of known Late Archaic sites on the Middle Snake River contain salmonid or non-salmonid fish remains (Plew and Guinn 2015: 49).

It is likely that fishing was a portion of the subsistence spectrum during earlier periods, though remains are fewer suggesting it played a smaller role than in later times. Three individual fish remains from the Early and Middle Archaic have been documented on the Middle Snake River, and fishing activity may have occurred 11,000 years ago at the Hetrick site near Weiser, Idaho (Plew and Guinn 2015; Plew 2016). Similarly, in the Owyhee tributary to the southwest, faunal remains and residences have been documented on a terrace at Birch Creek (35ML181) (Andrefsky and Presler 2000). However, there is little evidence of significant fishing on the Snake River Plain during the Early or Middle Archaic. An absence of evidence could be explained by river terraces still forming (Bentley 1981; Bentley 1983) and by the poor preservation of fish remains (Lubinski and Partlow 2012).

Table 1.1 Chronology of Snake River Plain Archaeology (Plew 2016)

Period	Dates
Paleoindian Tradition	12,000-8,000 B.P.
Early Archaic	8,000-5,000 B.P.
Middle Archaic	5,000-2,000 B.P.
Late Archaic	2,000-250 B.P.
Proto-Historic	250 B.P.- Historic period

However, even in the Columbia River System, where salmon would not have experienced the 78-96% fat and 31-61% protein losses associated with spawning by the time they reached the Middle Snake River (Plew 1983), and where we find more substantial numbers of faunal remains (see Butler and O'Connor 2004), warmer temperatures during 8,000-6,000 B.P. likely reduced adult Chinook salmon populations by 30-60% (Chatters et al. 1991). Even if fishing were occurring on the Snake River before the Late Archaic, salmon populations were reduced during a substantial period of time.

The aim of this study, to reassess whether river configuration and fisheries characteristics influenced archaeological site location, is best served by focusing on the Late Archaic because of the evidence for fishing that dates to this time period. If it can be shown that camp locations were not influenced by fishery locations during this period, it is unlikely that they would have done so during earlier periods when climatic conditions were less favorable for fisheries.

Background

Pitkin's (2010) study of the relationship between archaeological site locations with evidence of fishing and physiographic features of the Snake River examined 60 sites from three zones: the Middle Snake, Hells Canyon, and the Lower Snake. For the Middle Snake, the section which transects the western Snake River Plain, Pitkin found that archaeological site location correlated with the presence of two of the five physiographic features presented as having possible locations for productive fisheries. These were islands and minimum channel width (the average of 10 minimum width measurements in 1 km increments extending 10 km upstream and downstream from an archaeological site location) (Pitkin 2010: 41-44). Falls or rapids, perennial stream confluences, and spawning stream confluences were mostly absent or not as closely positioned relative to archaeological sites as were islands and locations where the channel funneled to a shorter width. Of the 17 archaeological sites with any evidence of fishing on the Middle Snake River, 65% were within 1 km of at least one island, and 24% were within 1 km of the minimum channel width (see Pitkin 2010: 110 for full results). The results of Pitkin's (2010) study suggest that some locations where productive fisheries are expected were chosen disproportionately by prehistoric foragers. If the profitability of fishing locations were heterogeneous, as is suggested by the ethnographic evidence (see Chapter 2), then knowledge of river configuration and fish behavior should be able to predict where fishing occurred (Figure 1.2). River configuration leads to predictability in certain cases by lowering search time and causing individual fish to aggregate at narrowed points, which then influences inclusion of species in a human diet, based on the assumptions of optimal foraging theory (i.e., knowledge of the local patch and rational actors).

For a review of the logic of this process, see Bettinger's (2009) simple example of an optimal diet breadth model where the return rate is measured in some currency (e.g., kilocalories or protein):

$$\textit{Return Rate} = \textit{kcal} / (\textit{search time} + \textit{handling time})$$

If fish are predictable and included in diet breadth, then they will likely be considered in positioning of camps.

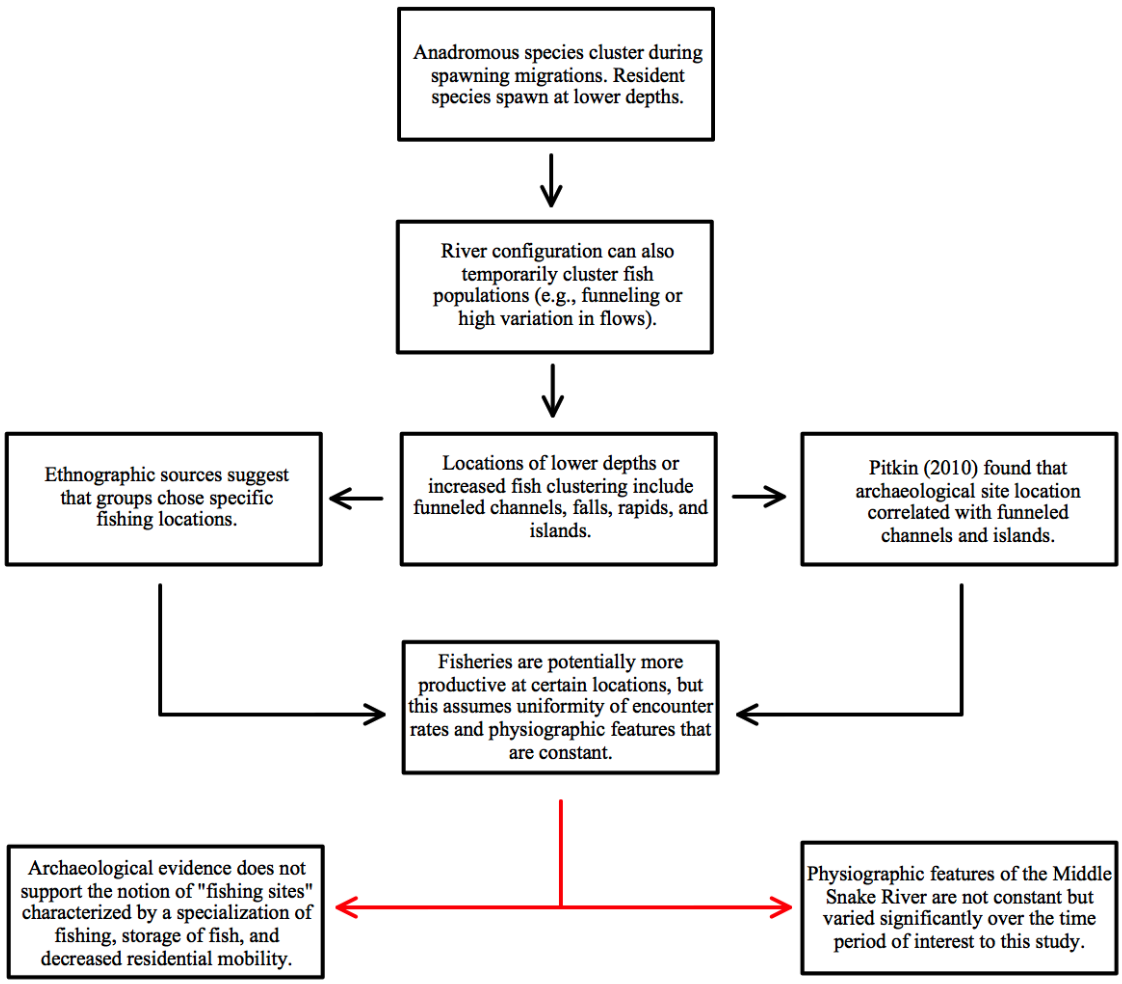

Figure 1.2 Flowchart of the rationale of the study

However, archaeological evidence for fishing is minimal in sites along the Middle Snake River (Appendix B). Possibly, a relationship between site location and physiographic features of the river’s configuration was influenced by factors other than decisions of fishing location (e.g., wood for fuel, river crossings of deer or other larger terrestrial prey, or the ability for humans themselves to cross the river and access patches on either side).

It is also possible that the relationship is not as strong as indicated in the 2010 study. Rather than noting physiographic features near sites with fishing evidence, this study works from the other end, identifying features where these sites are expected and testing whether site locations correlate (Chapter 4). This includes possible points of productivity that are no longer visible in the present-day river configuration. This approach ensures that sections of the river without sites are included in the analysis. Islands could be ubiquitous and seem to correlate with archaeological site location (rendering this correlation as meaningless as the correlation between site location and a feature like water). Instead of relying on a purely inductive approach that records features near sites with evidence of fishing, the present study predicts where sites should be located relative to the river's pre-dam configuration if fisheries influenced site placement along the Middle Snake River.

The present study updates and expands on Pitkin's (2010) research in two ways. First, this study includes sites with minimal evidence of fishing, comparing the frequency of features in areas with archaeological evidence to those without such data. Including sites with no or minimal evidence of fishing is based on several factors. To begin with, there is minimal evidence of fish remains at sites (Eastman 2011; Gould and Plew 1996). At Three Island Crossing near Glenns Ferry, Idaho, the minimum number of individual (MNI) fish is less than 300 from over 19,000 individual fish remains (Gould and Plew 1996).

Also, this study merely tests the relationship between archaeological site placement and river configuration. The extent of fishing on the western Snake River Plain has been addressed elsewhere (Gould and Plew 1996; Plew and Guinn 2015), with evidence suggesting that fishing was merely incidental and part of a general foraging pattern (see Chapter 2). However, if fishing were a part of the foraging spectrum in this region during the Late Archaic, it is reasonable to question whether locations of potentially productive fisheries influenced foraging decisions. The Late Archaic period of the last 1,500 years, during which archaeological evidence suggests fishing became more common, was likely a period of general foraging with some resource specialization (Plew 2016). As environmental conditions became warmer and drier, artiodactyl populations would likely have aggregated near water sources, leading to salmon being included in greater numbers within a general foraging strategy that was based on contingencies of encounters along the Middle Snake River (Gould and Plew 1996; Plew 2016). It is also likely that groups in the Proto-Historic Period, with new competition and resource bases influenced by a changing ecosystem, and lower transportation costs associated with horses, found that a strategy of intensive salmon exploitation was profitable (Gould and Plew 1996). This study seeks to know whether river configuration played a role in Late Archaic placing of camps, regardless of the resources utilized.

Second, this study reviews the factors that alter river configurations over time, culminating in an assessment of the flow levels that have altered the configuration of the Middle Snake River and their effect on aquatic species. Understanding the structure of prehistoric fisheries on the western Snake River Plain demands recognition that river configurations are not simply the arrangement of various elements but rather the interplay between these elements over time. Pitkin recognized that his study, and any study of this nature, has a fundamental limitation: “the inability…to control for landscape alteration over time” (Pitkin 2010: 122). Yet an inability to control for this does not limit the ability to outline its possible effects and infer to the greatest degree whether patch choice varied over time in response to this landscape alteration. Almost no archaeological problem can control completely for specific changes over time at the level of years, or even decades, but general trends can be inferred.

Research Questions

The following research questions guide the project. In no way do they represent the full array of possible research questions related to changes in river configuration influencing human foraging decisions but are the prime questions with which to begin an investigation on the Middle Snake River. The first research question is explored in Chapter 3 with a survey of inferences about fluvial geomorphology, Late Archaic climate cycles, and dam construction on the Middle Snake River. An attempt to answer the second and third questions can be found in the research design (see Chapter 4) and results (see Chapter 5), which predict where sites should be located if foraging is influenced by river configuration and length of use if used over time.

Research Question 1

What physiographic features of the Middle Snake River configuration are conducive to productive fisheries and where are these located on the Middle Snake River's pre-dam configuration (before 1901)? How much variation in the configuration of the Middle Snake River over the last 2,000 years is expected?

Research Question 2

Do archaeological site locations correlate with these physiographic features in proportion to the entire study area? Or are some physiographic features (i.e., islands) ubiquitous?

Research Question 3

Were these locations repeatedly used by Late Archaic foragers?

Outline of Chapters

Chapter 2 outlines the archaeological and ethnographic evidence for fishing, variation in fishing strategies, and whether the primary function of certain sites on the Middle Snake River would have been expected to be fishing. Chapter 3 addresses how river configurations generally can be altered over time (including drastic, modern change caused by the construction of dams), evidence for historic changes in the configuration of the Middle Snake River, and data on modern attributes of the river. Additionally, Chapter 3 addresses what is known about the life history and behavior of the aquatic prey choices and how these factors influenced their nutritional profitability, abundance, and predictability, all of which contribute to where productive fishing sites should be expected (if fishing were related to camp placement decisions). Chapter 4 describes the research design and methods of the study. Chapter 5 presents the results of tests of hypotheses developed in Chapter 4. Finally, Chapter 6 discusses and summarizes findings and their implications for future studies of the archaeology of the western Snake River Plain.

CHAPTER TWO: THE MIDDLE SNAKE RIVER FORAGING SPECTRUM

Across the western Snake River Plain, and along the Middle Snake River, archaeological sites have produced little evidence (Plew 2016) to support the view that aggregated winter villages were supported by caches of salmon (sensu Meatte 1990) or even the view that sites were "fishing sites" in any way. This study draws from a sample of 25 archaeological sites selected on the presence of archaeological data suggestive of Late Archaic occupations. Although most of the sites reveal some evidence of fishing, evidence is minimal and doesn't warrant the claim that fishing was a primary activity (see Appendix D for descriptions of the archaeological sites used in this study). Although a definition of "fishing site" will, and likely should, vary depending on time and location, for the purpose of this study it is useful to compare Middle Snake River sites to those in nearby regions. For example, a typical fishing site in the Columbia Plateau has fish faunal frequencies similar to terrestrial faunal frequencies (Butler and Martin 2013), tabular tools such as knives associated with fish butchering (Yu and Cook 2015), and extensive fishing technology like weights, sinkers, spear points, weirs, nets, etc. (Lyons 2015). No site on the Middle Snake River exhibits fish remains at a frequency relative to terrestrial prey like that seen on the Lower Columbia River (Gould and Plew 1996; Plew 2016; Plew and Willson 2013). No site on the Middle Snake River has specialized toolkits (Gould and Plew 1996). Finally, no extensive fishing gear is known other than a cache of such gear found at Schellbach Cave (Schellbach 1967).

Closer examination of historic inhabitants of the western Snake River Plain indicates that Late Archaic groups would have likely engaged in a general foraging pattern that varied seasonally (Plew and Gould 1990; Plew and Guinn 2015; Roberts 2015) and moved people to resources (*sensu* Binford 1980). To date, all lines of evidence suggest that fishing was not the predominant subsistence activity in the region during the Late Archaic period.

The Archaeological Evidence

The 25 sites utilized in the study sample are representative of those in the Middle Snake River study area; in fact, they are similar to most of the sites having any evidence of fishing (Figure 2.1). The evidence for fishing, however, is minimal. It is highly unlikely that these were fishing sites whose primary function was the collection, bulk processing, and storage of salmon species or other aquatic resources. For this reason, the sample used in this study includes two sites with no evidence of fishing. If a site with n=20 faunal specimens (10-AA-188) is included, and fish remains are unlikely to be preserved, a site with no faunal specimens but positioned near the river should be included.

A brief outline of the evidence for fishing in site descriptions in Appendix D suggests that the category of fishing site is not useful for sites near the Middle Snake River. A summary of the evidence is presented below (Table 2.1). Two archaeological sites used in the study sample have no evidence of fishing.

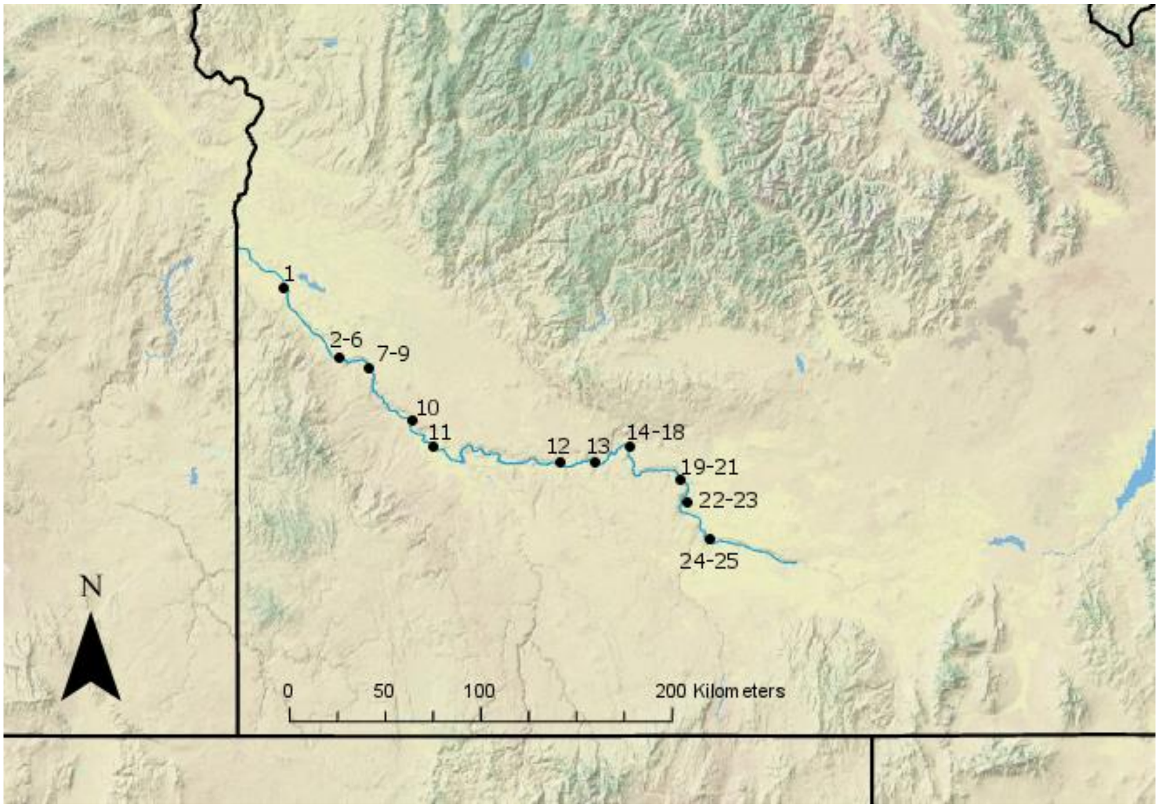

Figure 2.1 Map showing location of Late Archaic archaeological sites used in study sample (1=10-OE-2792, 2=10-CN-1, 3=10-CN-5, 4=10-CN-6, 5=10-OE-240, 6=10-AA-306, 7=10-OE-277, 8=10-AA-188, 9=10-AA-17, 10=10-OE-269, 11=10-EL-392, 12=10-EL-1367, 13=10-EL-294, 14=10-EL-110, 15=10-EL-1417, 16=10-EL-22, 17=10-EL-215, 18=10-EL-216, 19=10-GG-1, 20=10-TF-352, 21=10-GG-332, 22=10-GG-191, 23=10-GG-176, 24=10-GG-312, 25=10-GG-278)

Table 2.1 Location of archaeological sites used in this study; and the type of fishing evidence produced (Pitkin 2010; Plew 2016)

Site	General Location	Type of Fishing Evidence
Cromwell Site	Near Marsing, Idaho	None
10-CN-1	Near Celebration Park	Faunal Remains
10-CN-5	Near Celebration Park	Faunal Remains
10-CN-6	Near Celebration Park	Faunal Remains
10-OE-240	10 Miles W of Swan Falls	Fishing Gear, Faunal Remains
10-AA-17	Near Swan Falls	Faunal Remains
10-AA-188	Near Swan Falls	Faunal Remains, Net Sinker
10-AA-306	Near Halverson Bar Road	Faunal Remains
10-EL-22	3 km E of King Hill	Faunal Remains
10-EL-110	Near King Hill Creek	Faunal Remains
10-EL-215	4 mi from Clover Creek	Faunal Remains
10-EL-216	4 mi from Clover Creek	Possible Weir

10-OE-269	15 km N of Grandview	Faunal Remains
10-OE-277	5 km downstream of Swan Falls	Possible Fish Trap
10-EL-294	Near Three Island Crossing	Faunal Remains w/ 3 Features
10-EL-392	2 Miles W of Grandview	Faunal Remains
10-EL-1367	Near Medbury Ferry	Faunal Remains
10-EL-1417	¼ Mile W of King Hill	Faunal Remains
10-GG-1	Below Bliss, Idaho	Faunal Remains
10-GG-176	Hagerman Fish Hatchery	None
10-GG-191	Near Billingsley Creek	Faunal Remains
10-GG-278	Above head of Kanaka Falls	Faunal Remains
10-GG-312	Island, below Kanaka Falls	Fish Weir, Faunal Remains
10-GG-332	Below Malad River	River Cobble Alignment
10-TF-352	Opposite of Bliss Site on south bank	Faunal Remains

<u>Summary of Archaeological Evidence Along the Middle Snake River</u>

Faunal remains of fish species are the most common type of evidence for fishing in the sample of sites. However, a survey of the assemblages reveals few specimens in most sites, and even at Three Island Crossing (10-EL-294), where more than 19,000 specimens were documented during the 1986-1987 excavations by the Boise State University Archaeology Field School, the minimum number of individuals (MNI) is approximately 300. Subsequent excavations failed to expand that number in any significant way (2008 and 2018 excavations found no identifiable fish remains) (Eastman 2011; Wardle 2018).

The lack of fish remains at sites within the study area could be due to other factors: fish remains do not preserve well (Lubinski 1996) and often exhibit limited evidence of butchering (Willis et al. 2008). Experimental butchering, though, suggests that fish bones should exhibit more evidence of cutting. This discrepancy could occur because samples of bones present in the archaeological record are of the type that prehistoric people avoided cutting or that estimates of the number of naturally-deposited fish bones in archaeological contexts are low (Willis et al. 2008). The presence of fish remains could be attributed to natural deaths (Butler 1993). Even when faunal evidence is present, fishing and some amount of processing could have been done at a location different from the location of deposition (Lubinski and Partlow 2012).

Few pieces of fishing technology have been recovered in southwest Idaho, which includes some net sinkers (e.g., Higby Cave) (Plew 1998), rock weirs, two short-term storage pits at Three Island Crossing (Gould and Plew 2001), and a cache of fishing gear (Figure 2.2) that includes harpoon points, net sinkers, a hook, matting, and line

(Schellbach 1967). The latter two instances of storage and fishing gear are the only two examples of their kind found in southwest Idaho (Plew 2016). This is not surprising, considering that archaeological sites in the region are characterized by expedient toolkits that are similar in form, regardless of site function (Gould and Plew 1996). Absence of fishing toolkits could reflect a preservation bias since most gear components are organic (Yu and Cook 2015).

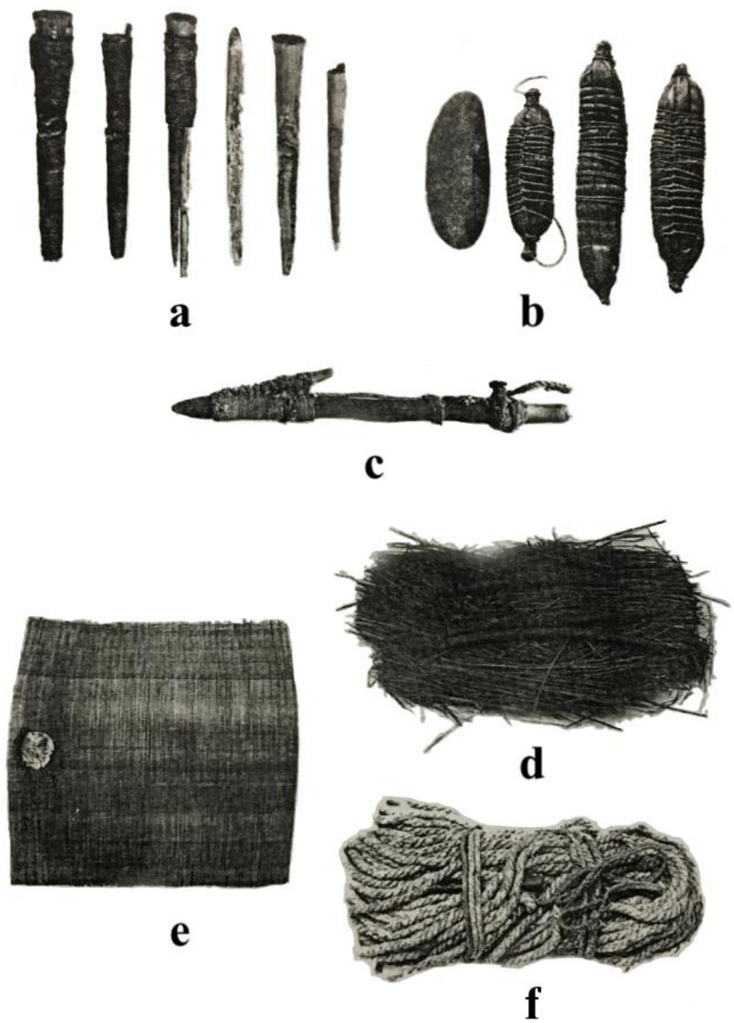

Figure 2.2 Sample of fishing gear found at Schellbach Cave: a, Harpoon points; b, Net sinkers; c, Fishhook; d, Bundle with wooden spear; e, Matting; f, Fishing line (from Schellbach 1967)

Had fishing been a focus at these locations, residential mobility would have decreased to some extent, but there is no evidence for this in the archaeological record. Most sites are ephemeral and typical of a foraging residential pattern (Plew and Guinn 2015) described in the Binford mobility continuum (Binford 1980). Archaeological sites reflecting a foraging mobility pattern will exhibit "low visibility" with little accumulation of debris, camps not located relative to previous use (i.e., little reuse of locations), and few smaller logistical camps because such foraging occurs close to the central base camp (Binford 1980: 7). The one exception would be groups in an arid environment that are "tethered" (Taylor 1964) to isolated and discretely placed water sources (not the case on the Snake River Plain). Also, high residential mobility is suggested in most sites along the Middle Snake River when applying Kelly's index of residential mobility (2001), which infers mobility based on 14 dimensions of lithic assemblages. The indicators in addition to lithic assemblages, such as ceramics, also suggest high levels of residential mobility (Roberts 2015).

When reviewed in detail (Appendix D), the evidence from archaeological sites along the Middle Snake River offers little to support the claim that fishing was the primary function at these locations, even when factoring in preservation bias.

The Ethnographic Evidence

Ethnographic data can be of use to archaeological problems as a means to address gaps in archaeological knowledge (Yu 2015: 1-3) by using frames of reference: environmental data linked to locations of modern weather stations and projections of probable hunter-gatherer behaviors in response to those environmental conditions (Binford 2001: 3). A degree of caution is necessary due to the fact that ethnographic data are not exact analogies of the past (Kelly 1996). Ethnographies are often misleading even as representations of the ethnographic present. The context of data recording (e.g., direct observation, informants, government records, etc.), the research strategy of the investigator, the questions asked, and the historical context at the time of research can all influence the quality of data collected during ethnographic research. It follows that frames of reference based on ethnographic data are only as accurate as the input data.

With these caveats in place, the ethnographic setting of the region can be used to inform archaeological expectations. Historic accounts, ethnographic reports, and models of subsistence gleaned from ethnographic and environmental data contribute to this goal.

Historic Inhabitants of the Study Area

The Northern Shoshone and Northern Paiute were the primary historic inhabitants of the western Snake River Plain in southern Idaho. The primary ethnographies (Murphy and Murphy 1960; Steward 1938), indicate that these groups differed in language but were relatively similar in socio-political and economic organization. The Northern Shoshone included the Boise, Bruneau, and Weiser subgroups (Murphy and Murphy 1960; Steward 1938). The Northern Paiute included the Payette, Weiser, and Bannock subgroups (Liljeblad 1957). The Bannock subgroup consisted of mounted hunters who by the 18th century had moved east near Fort Hall (Liljeblad 1957); this subgroup is not used as ethnographic reference points in this study.

Ethnographic Sources

The socio-political organization of groups that inhabited the western Snake River Plain was characterized by small aggregates of nuclear families, no band chiefs, no warfare, few horses, and temporary aggregation with other groups to engage in tasks such as the construction and monitoring of fishing technology (Steward 1938). For example, a dam or weir might be built by four or five families under the guidance of a *kuwedagwani*, or fishing director (Steward 1938: 169). The fishing director would be responsible for returning to the traps to collect and distribute fish, keeping a greater share for himself (Steward 1938: 169). Steward uses the masculine pronoun when describing fishing directors but doesn't exclude females from descriptions of dam or weir construction.

Steward describes villages that acted as winter encampments below Twin Falls (Steward 1938: 165). These were scattered, as far away as six miles from the river and dispersed across the landscape. Each would have been small, encompassing about three families, and transporting food back to encampments positioned near cached salmon (Steward 1938: 165). The problem with this ethnographic portrait of encampment near the Snake River, other than its brevity at less than 200 words, is that it suggests a collector subsistence pattern (Binford 1980). First, use of the term "village" suggests a more complex socio-political organization than that described in the ethnographic sources (Plew 2016). Second, this portrait likely simplifies probable varied responses to fluctuating environmental conditions each winter. Other than this described winter aggregation, the economic life of these historic inhabitants was more a general foraging strategy that moved people seasonally to key resources (e.g., camas at Camas Prairie in July) (Steward 1938: 167).

Jack Sargent Harris' work on the White Knife Shoshoni of northern Nevada, a group that utilized the Snake River for salmon in summers and had socio-political and economic patterns similar to those of the Northern Shoshone (Steward 1938), offers a glimpse of food procurement strategies typical of groups in the region. *Tosawi* ^{hi}, or

White Knife Shoshoni, seemed to practice a generalized foraging pattern in response to a limited subsistence spectrum amid a semi-arid landscape. Labor was divided by sex: men hunted and fished; women gathered and did some hunting and fishing near camp (Harris 1940). Men constructed fish nets, traps, bows, arrows, and flint artifacts, whereas women spent much of the day making basketry and pottery (Harris 1940).

The names of Western Shoshonean groups reflected the food sources that were predominant in their diet (e.g., squirrel eaters, salmon eaters, pine nut eaters, etc.) (Harris 1940). Harris argues that these were not permanent appellations, because seasonal shifts in camps brought new prey to focus on, along with new names for the groups. One group might be known as the pine nut eaters in one part of the landscape, but salmon eaters in another (Harris 1940). Europeans' assumption that appellations were permanent betrayed the diversity of subsistence strategies that shifted seasonally (Harris 1940).

Fishing was undoubtedly a significant part of the diet of groups in the region during the 19th century. Steward suggests that groups coordinated their seasonal rounds to time with the runs of anadromous salmon and trout species (Steward 1938: 168). Examples of this include groups that wintered on the Snake River, positioning themselves for spring salmon runs in March or April, as well as groups that wintered at Camas prairie moving to the river for the same reason when winter abated (Steward 1938: 167).

Small streams were fished, especially in summer, but through holes in ice as well in winter along spots where wood was plentiful for fuel. In summer, groups would travel up these tributaries to fish, as well as to procure roots and berries (Steward 1938: 168). Salmon could be taken in these smaller streams, as well as smaller resident fish species such as suckers or trout (Steward 1938: 168).

Ethnographic sources contain detailed descriptions of the type of fishing gear utilized by groups on the Snake River. Lowie (1909) points to spears, nets, and weirs as the primary fishing technology used by the Northern Shoshone. Spears consisted of a long pole with a two and half inches long bone gig (Lowie 1909). Dams of stone or brush were also used in small streams where fish were funneled into areas that were watched at night by torch light (Lowie 1909; Wyeth 1851). Many of the elements, or techno-units, (*sensu* Oswalt 1976) of technologies described in ethnographies are not of durable materials and are rarely found in archaeological contexts due to poor preservation. Most techno-units that comprise the Schellbach (1967) collection (e.g., matting and line) will not preserve; furthermore, the most durable element most likely to preserve in its original form (i.e., net sinker) is often difficult to identify because many of them are indistinguishable from natural rocks (Plew 1998) and other types of anchors (Lyons 2015: 122).

Ethnographic sources also highlight that certain locations on the Snake River were valued as productive fisheries. Steward identifies Upper and Lower Salmon Falls near Hagerman as offering the best fishing (Steward 1938: 167). The fish would have been netted at the bottom of the falls, as well as caught with dams, weirs, and hooks (Steward 1938: 167). Murphy and Murphy (1960) identify the three islands near Glenns Ferry as shallow depths where weirs would have been used. Small creeks would have also been ideal locations for basket traps (Murphy and Murphy 1960: 322).

Salmon runs did not extend above Shoshone Falls and there were few coveted fishing areas on the Middle Snake River (Murphy and Murphy 1960). Even when salmon runs consisted of greater numbers of salmon, the fish could not be caught at any point on a river that was too deep and wide at most points for weirs or spears to be used (Steward 1938). Harris (1940) also claims that the White Knife Shoshoni chose specific spots to set traps and nets during their summer fishing.

These decisions would have been vital due to the time constraints of salmon runs. Harris (1940) notes that fishing areas on the Snake River were usually depleted within 10 days. As Gould and Plew (1996) note, the only quantitative assessment of the productivity of fish pre-dam salmon runs is Barton Evermann's (1896) record of the Liberty Millet fishery below Upper Salmon Falls. Two men harvested and weighed their daily catch from October 2 to November 1, 1894 using a small boat and a seine that was 4.3 m deep in its center, 3 m deep in its wings, and stretched for 98.8 m (Gould and Plew 1996: 67). The days that produced more than 200 kg of fish were within a period of two to 2.5 weeks, suggesting that fish runs were temporally compressed to even shorter spans than the two months noted in most ethnographic sources (Gould and Plew 1996).

Because of this temporal and spatial compression, groups did vie for control of specific locations, though the concept of property applied only to fishing gear, rather than to locations. White Knife groups held rights to areas only in the sense that they would have been known to use an area in the summer, never to the exclusion of other groups (Harris 1940). There is also mention in Harris (1940) of some form of economic insurance, or reciprocity, whereby groups helped neighbors whose fisheries had been less productive. Murphy and Murphy (1960: 322) cite one such example of a fish weir on the Bruneau River that was shared with visiting Fort Hall Bannock groups.

The system of fishing locations on the Middle Snake River, as described ethnographically, is one where, although fisheries may not have been tremendously productive, there was competition constrained by time and space and locations that were more valuable than others.

The ethnographic present is not a direct indication of how individuals were behaving during the Late Archaic. For example, more people were moving onto the landscape, which may have affected prey choice, causing people to pursue previously ignored lower ranked resources. Ethnographies are too often interpreted as exact records (Kelly 1996) but can be influenced by the methods and theoretical framework of the ethnographer, the spatial and temporal distance between informants and behaviors of interest to the ethnographer, and the fact that most peoples during this time period were under significant pressures from sharing the landscape with European immigrants. For example, Reservation-era ethnographies describe the Uintah Utes as obtaining their primary subsistence from fishing in the Green River in the Middle Rocky Mountains (Lubinski 2000). A significant shift occurred 100-300 years ago, with an increase in fishing represented by faunal remains, fish hooks and notched pebbles interpreted as net weights (Lubinski 2000). A similar phenomenon might have occurred in the Middle Snake River. Ethnographic accounts like Steward’s (1938) are interpreting a specific moment in time that doesn’t necessarily represent the foraging patterns before the Historic Period.

Early Historical Accounts

Historical accounts, as compiled in Murphy and Murphy’s (1960) description of the Middle Snake River from American Falls to the Bruneau river, paint a picture different from that recounted to ethnographers by informants. These accounts do not mention cached salmon but instead describe groups “who have to struggle hard for a livelihood, even though it is the prime of the fishing season in the Country" (Stuart 1935: 108). This description comes from August 12, 1812. The fall Chinook run, which arrives in the Middle Snake between late September and early December (Reiser 1998), would be the final chance to cache for winter.

The Wyeth party documented a group of 120 foragers with fresh salmon catches (a group large enough to conduct a significant fishing operation), but there is no mention of drying for storage (Wyeth 1899: 163). Another source, Talbot (1931: 56), writes, "it seems that there is a monopoly of the fisheries on the Snake River." After Bannock groups exploit fisheries, groups on foot "gather up the leavings of their richer and more powerful brethren" (Talbot 1931). These sources suggest that, whatever the extent of fishing or caching fish, certain points on the river were prized as more productive fisheries.

Projections of Hunter-Gatherer Subsistence in the Region

One way to inform hypotheses and expectations is to make projections from available and relevant data, "frames of reference" (Binford 2001), and those projections of what groups of hunter-gatherers are expected to do in specific environmental conditions can inform hypotheses that are testable with available archaeological data (Binford 2001). The projections fit specific conditions around weather stations, where many of the environmental variables of interest have been recorded for decades.

Projections using a clipped area of the northern Great Basin and western Snake River Plain (Figure 2.3), with data from 42 weather stations within the latitude range of 41.3 to 43.5 degrees and within the longitude range of -113.5 to -117.9 degrees (Appendix C) project hunting and gathering as making up a greater proportion of the subsistence strategy than hunting or gathering in the western Snake River Plain, which is consistent with archaeological data in the region that suggests a seasonal foraging pattern that utilized multiple resources during the Late Archaic (Plew 2016). According to projections from Binford's North American database, the predominant subsistence strategy for the western Snake River Plain and northern Great Basin should be terrestrial hunting (40/42 locations). None of these locations are projected to be inhabited by hunter-gatherers that specialize in fishing (Figure 2.4).

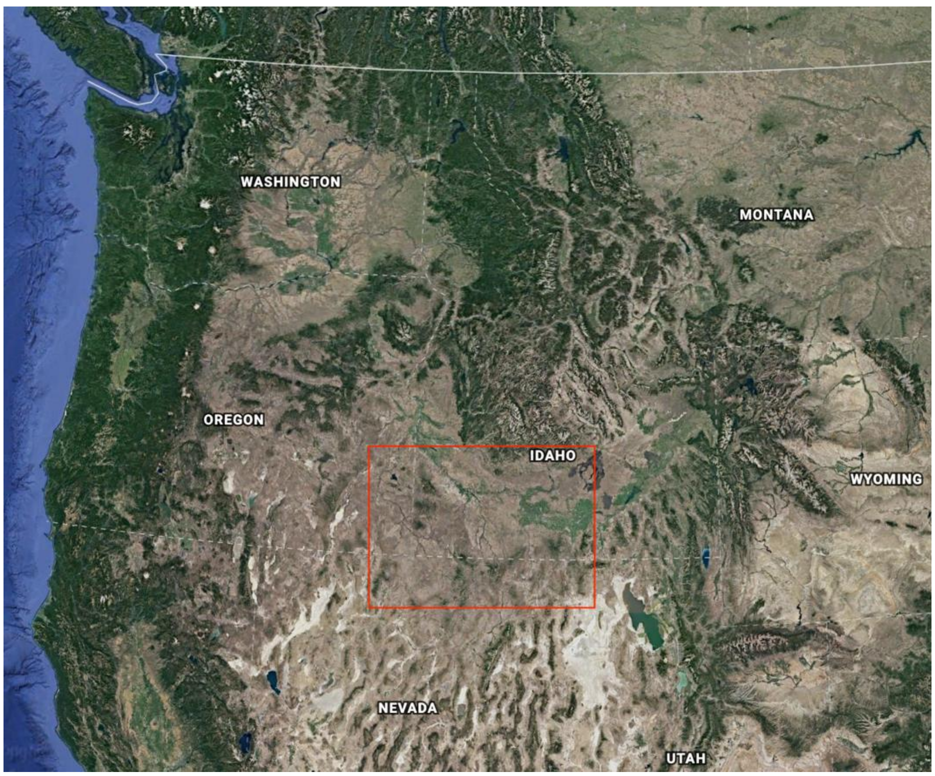

Figure 2.3 Clipped area of northern Great Basin and western Snake River Plain

Table 2.2 Key of Binford Database Variables Used (Binford and Johnson 2014)

Code	Description
WHUNTP	Expected percentage of hunting using ethnographically known hunter-gatherer cases.
WGATHP	Expected percentage of gathering using ethnographically known hunter-gatherer cases.
WFISHP	Expected percentage of fishing using ethnographically known hunter-gatherer cases.
UPHUNTP	Expected percentage of hunting (when population density is less than 9.1 persons/km2) using ethnographically known hunter-gatherer cases.
UPGATHP	Expected percentage of gathering (when population density is less than 9.1 persons/km^2) using ethnographically known hunter-gatherer cases.
UPFISHP	Expected percentage of fishing (when population density is less than 9.1 persons/km^2) using ethnographically known hunter-gatherer cases.
EXNOMOV1	Projected number of residential moves per year, scaled for subsistence type, for groups with year-round camp to camp mobility pattern.
WATD	Measure of water deficit, or aridity. If amount of water evaporated or transpired in the atmosphere is less than potential evapotranspiration, then the rainfall was less than what could have been evaporated from solar radiation.
ELEV	Elevation (meters above sea level).
CRR	Calculated real rainfall (mm/year).
NAGP	Net Above Ground Productivity: measure of new cell life added to a habitat as a result of photosynthesis and growth (gm/m^2).

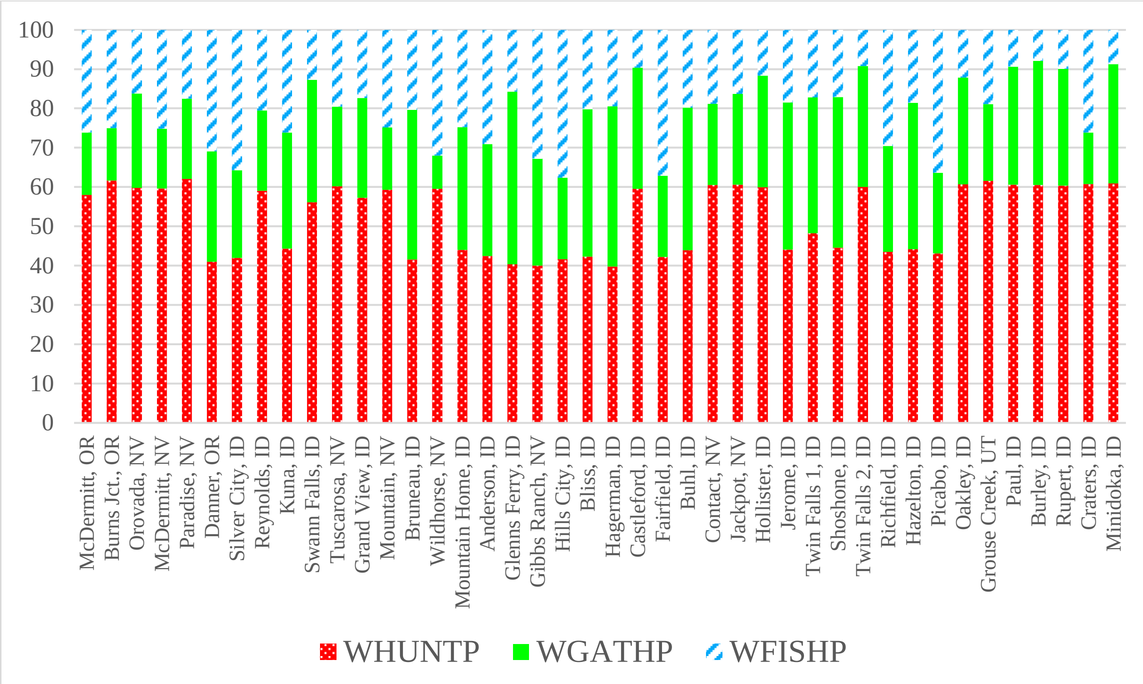

Figure 2.4 Projected percentage of hunting (red), gathering (green), and fishing (blue) within 42 local environments in the western Snake River Plain and northern Great Basin

Hunter-gatherers in the region are also projected to increase their dependence on fishing as elevation increases (Figure 2.5). Lower elevation river valleys are projected to have a diet composed of ca. 20% or less fishing. In fact, gathering is projected to make up a slightly greater proportion of subsistence at two locations: Glenns Ferry and Hagerman.

If fishing on the river system were a large portion of the diet, it would also be expected that less arid local environments would be projected to have a greater emphasis on fishing, and perhaps decreased mobility. This is projected to some extent for Idaho cases where there is a positive relationship between WATD (a measure of aridity) and number of residential moves per year for groups with year-round camp to camp mobility patterns. Two outliers (Glenns Ferry and Hagerman) have high aridity and ca. ten expected residential moves per year (Figure 2.6).

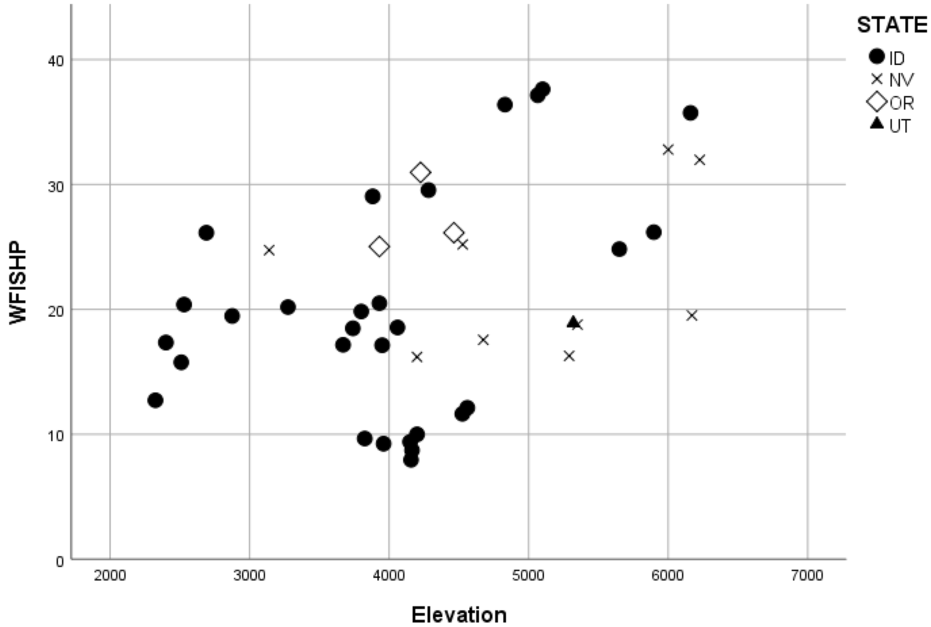

Figure 2.5 Projected expected percentage of packed fishing plotted against elevation

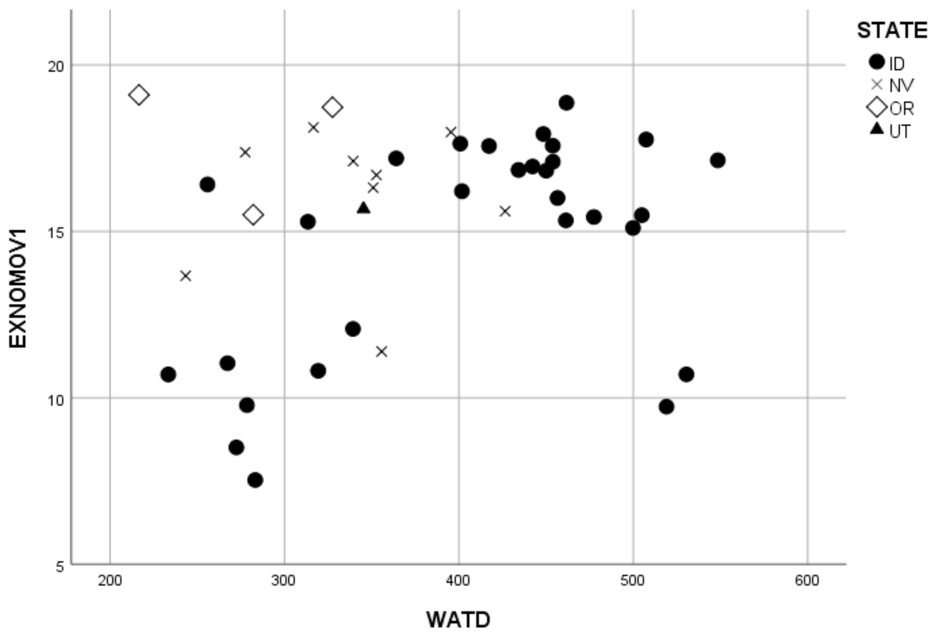

Figure 2.6 Projected number of residential moves per year for groups with year-round camp to camp mobility pattern plotted against water deficit, or aridity

Another tool for modelling expected resource diversity is the Simpson Diversity Index (1949), originally used to measure biodiversity. This tool can be repurposed for measuring the diversity of subsistence type. If general foraging predominates in an area with access to all three types of food, then there should be a higher index of diversity (e.g., more evenly distributed) between the three types of food procurement.

Using the 42 weather stations and projections of hunter-gatherer behavior (Appendix B), a mean value for WGATHP, WHUNTP, and WFISHP [expected percentage of subsistence type (gathering, hunting, and fishing) using ethnographically known hunter-gatherer cases] is established for the region and then calculated for level of diversity among the subsistence strategies. The Index of Diversity (1-D) for groups is 0.61 (Figure 2.7). Additionally, the concept of packed vs. unpacked refers to the population density of groups (Binford 2001). As population increases and groups become more packed, they may influence the behavior of their unpacked neighbors. For unpacked groups, the Index of Diversity was slightly higher at 0.63. Population packing is not projected to increase emphasis on any given subsistence type.

$$D = \frac{(WHUNTP)^2 + (WGATHP)^2 + (WFISHP)^2}{10{,}000}$$

$$D = \frac{(52.18)^2 + (26.80)^2 + (21.02)^2}{10{,}000}$$

$$D = 0.39$$

$$1-D = 0.61$$

Figure 2.7 Simpson Diversity Index of subsistence activities in study area based on packed subsistence projections

This suggests that subsistence diversity is relatively high among hunter-gatherer groups in these 42 local environments (represented by modern weather stations). This score can be thought of on a scale of 1-10, with 10 being high diversity. Hunting is the one subsistence activity that is expected to make up a greater percentage of the total in the region.

These frames of reference aid in interpreting historical and ethnographic sources and help inform expectations of the archaeological record as to questions asked, data used, and construction of hypotheses. To summarize, fishing certainly is projected to be part of the economic strategy of historic inhabitants on the western Snake River Plain. Ethnographic sources suggest that prehistoric groups timed movements to the appearance of seasonal anadromous fish spawning. Prehistoric groups also were aware that variability in the configuration of the river influenced the level of productivity of fisheries. Groups vied for superior locations, aggregated to exploit these at certain times, and engaged in reciprocity. Archaeological expectations include signatures of aggregation such as some short-term storage features, greater site size, longer ranges of occupation, and specialized technology.

Were There "Fishing Sites" on the Western Snake River Plain?

In the early to mid-20th century, archaeology in southern Idaho sought to provide evidence for the accounts of fishing villages that appear in Steward's (1938) ethnography. Long-term winter encampments that allowed subgroups to conduct logistical foraging trips would certainly leave archaeological signatures of some kind. These might include signatures of low residential mobility, high frequencies of fish remains, tool assemblages which contain fishing technology, evidence of storage, or sites with multiple occupational levels. These signatures should be present at sites within six miles of the Snake River (Steward's limit).

If the ethnographies are viewed without skepticism, the quest becomes explaining why archaeological evidence does not suggest winter encampments that survived upon caches of salmon. Reasons for the discrepancy have included inadequate methods for collecting faunal remains and an overreliance on conceptual frameworks from Jennings' (1957) Great Basin work (Meatte 1990: 67). The former has proved irrelevant after nearly three decades of employing 1/8th inch mesh screens (Plew 2016), which have increased the number of faunal remains collected but failed to increase these to numbers indicative of large-scale anadromous fish exploitation.

The latter critique has proved even less rigorous, since the idea that the Snake River Plain should fit within the conceptual framework of either the Great Basin or the Columbia Plateau ignores the various environmental conditions of the Middle Snake River that differ from both neighboring regions. In terms of fishing, though, the Great Basin framework is more useful because there is yet no archaeological evidence to suggest that groups engaged in the intensification of salmon like Columbia Plateau groups. Furthermore, some northern Great Basin groups migrated seasonally to the Middle Snake River (e.g., the White Knife Shoshoni) (Harris 1940).

Fishing was undoubtedly a part of the foraging spectrum of Late Archaic groups of aboriginal people that seasonally inhabited parts of the western Snake River Plain in Idaho. However, the extent of fishing, (i.e., its scale and degree of importance within the diet of foragers), has long been a point of debate within the archaeology of the region. The traditional view, based on many assumptions drawn from ethnographic sources (e.g., Harris 1940; Steward 1938), argued that Late Archaic aboriginal groups had begun to engage in salmon intensification, long-term winter storage of returns from fall Chinook runs, and a degree of settled life along the river during the winter months (Pavesic and Meatte 1980). In no way simplifying the argument of this position, the archaeological evidence cited to support this argument was merely the presence of anadromous, non-anadromous, and unidentified fish remains in archaeological sites throughout southwest Idaho (Meatte 1990: 66-67).

The archaeological and ethnographic evidence suggests that fishing was part of the subsistence spectrum of Late Archaic foragers in the western Snake River Plain, but it was not the primary resource. There question now evolves toward understanding how river configuration would have influenced foraging decisions as groups increasingly foraged near the Snake River during the growing aridity of the Late Archaic.

CHAPTER THREE: VARIABILITY IN THE MIDDLE SNAKE RIVER FLUVIAL SYSTEM

Fluvial systems are open ones with both internal variables (e.g., soil type, slope angle, channel depth, or vegetation) and external variables (e.g., climate, tectonics, or human activity), characterized by a constant state of feedback between those variables (Charlton 2008). Systems theory models, while far from accurately recording the complex systems they represent, are a useful heuristic for discerning relevant interactions as a part of the system of interest. The aims of this chapter are: 1) to outline the fluvial geomorphology of river systems in regard to the two physiographic features of interest: islands and localized narrows 2) to explore how much variation in the configuration of the Middle Snake River is expected to have taken place over the 1,500 years of the study time period, and 3) to explore how the river's configuration has changed since the construction of modern dams. The last of these is crucial in understanding how much of the modern configuration can be said to correlate with dynamic human behavioral processes that existed in the past as inferred from static archaeological remains that exist in the present.

Understanding the variability in the creation and alteration of these physiographic features can aid in attempts to infer landscape conditions that Late Archaic foragers would have been required to adapt to when choosing where to place camps when seasonally occupying the Middle Snake River and the surrounding landscape, which was significantly less productive than even more arid nearby locations (Figure 3.1). Low rainfall should relate to low plant productivity, but locations on the Snake River Plain have lower projected NAGP than areas with lower annual rainfall.

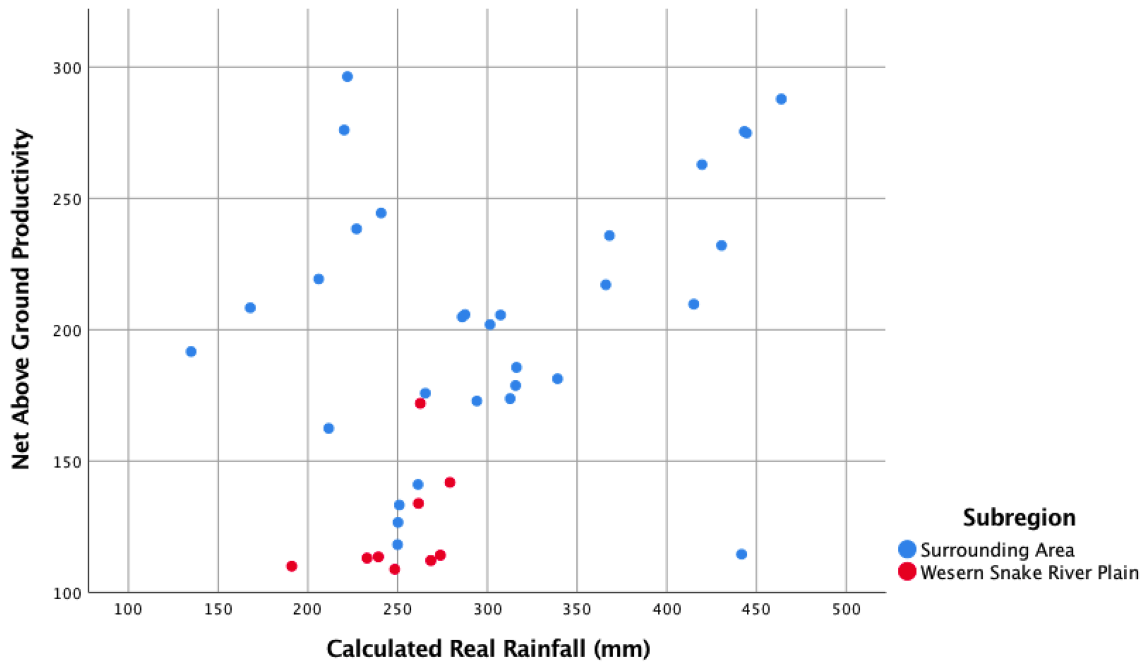

Figure 3.1 The relationship between annual rainfall and primary productivity

Changes in a river's configuration could have been gradual, over millennia, or rapid, such as paleoseismic events that are within the timescale of archaeology (see Plew and Guinn 2015). Rapid changes would have had considerable effects on human foragers who utilized Snake River resources, halting the ability of salmon to reach the middle and upper stretches of the Snake River, altering river channels and flows, and potentially changing areas in which fish were traditionally expected even after runs resumed. Archaeological reconstructions of past lifeways must consider these changes and how they might alter the inferences gleaned from the static archaeological record.

Archaeology must also consider the rapid changes that occurred to river systems after traditional foraging lifeways were abandoned. These changes might not have affected foraging peoples but did affect how the archaeological record is presently preserved, found, and interpreted.

Dam construction during the 20th century on the Middle Snake River in southern Idaho was one such example of this post-foraging change. While dams notably halted the migration of salmon up the Snake River and into its tributaries to the north and south (Plew and Guinn 2015), this had little effect on extant foraging groups. Few groups of people, if any, were engaging in traditional lifeways along the river by this time. The memory of those lifeways remained, as evident by the stories of informants told to ethnographers such as Steward (1938) and the use of traditional weirs and spears on the Duck Valley Indian Reservation in 2015 when Chinook salmon were released into the Owyhee River to run for the first time in 87 years since the last Chinook run occurred in 1928, which were halted by the construction of dams on the Owyhee and Snake rivers (Harrison 2015).

This chapter concludes with a brief outline of the range of aquatic species in the Middle Snake River available to human foragers; and the life history, behavior and ideal spawning habitat of those aquatic species.

Fluvial Geomorphology and Variability in Islands and Localized Narrows

Flow Levels

Seasonal and annual variation in stream flow levels are of particular importance in understanding the change over time of location, size and morphology of islands and localized narrows. Formation, maintenance, and alteration of these physiographic features are sensitive to changes in flow levels.

Flow levels instantaneously influence river depth, alter channel morphology through deposition of sediment (Mueller and Pitlick 2013), create suitable spawning areas for anadromous and resident fish species (Knapp et al. 1998; Simpson and Wallace 1982), and affect dissolved oxygen levels (Webb et al. 2008) and water temperature (Blakey 1966; Smith and Lavis 1975). The extent to which flows influence sediment buildup and change channel morphology is difficult to measure, and build-up of sediment is rarely measured in conjunction with precipitation (Mueller and Pitlick 2013). Also, accumulation of sediment will depend on local variables such as basin lithology, relief ratio, hillslope angle, drainage density, and mean annual precipitation (Mueller and Pitlick 2013), all of which vary east to west along the Middle Snake River. Over time, though, buildup of sediment will change channel morphology.

Amount of riverine vegetation, another variable linked to climatic trends, can also influence channel morphology through flow resistance, bank strength, bar sedimentation, formation of log jams and concave-bank bench deposition (Hickin 1984; Johnson et al. 1995). Depth, riverine vegetation and the force of flows in depositing sediment are the three main contributors to configuring a channel morphology. All three are direct effects of climatic cycles.

Flows also directly affect water temperature, an important condition for the life history, behavior, and nutritional value of aquatic species. Temperature is perhaps the most obvious, and in many ways the most important parameter in determining water quality (Blakey 1966). Higher temperatures during migratory runs can increase energetic expenditures (Plumb 2018), but species also have optimal temperature ranges for spawning. Optimal temperatures for an adult chinook salmon are around 16.5°C; and fish that migrate too early or too late will likely die due to exhausting all energy reserves (Plumb 2018). The Middle Snake River currently has monthly temperatures that are ideal for chinooks during a 5 to 7-month period, which covers the three migratory runs. For example, water temperatures in the Snake River near King Hill, Idaho (Figure 3.2) average around 15°C from April to September, with a spike in July (Figure 3.3).

Figure 3.2 Location of Hydrological Unit Code 17050101 near King Hill, Idaho (Google Earth, accessed January 10, 2019)

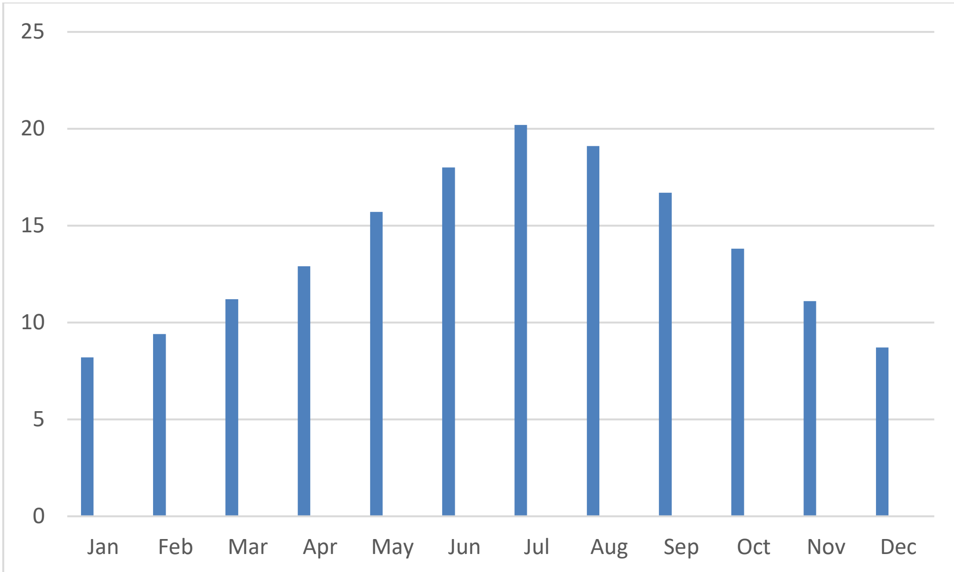

Figure 3.3 Mean of monthly temperatures (1996-2018) of Snake River near King Hill, Idaho (USGS National Water Information System 2018)

Chinook salmon have an energy expenditure between 3 and 4.5 kilojoules/gram at the time of death, compared to 5.2 to 12.1 kilojoules/gram energy expenditure at the beginning of a migration (Plumb 2018). In addition to migration run and spawning, egg hatching is directly influenced by water temperatures. Steelhead eggs usually hatch when water temperatures are approximately 10°C after an incubation of about 50 days (Grabowski 2015). There is no variable more consequential to the success of a migratory spawning run than water temperature.

Flows can directly influence water temperature and thus salmon energy expenditures and the timing of spawning. Higher flows have increased thermal capacity and faster travel time, making them less sensitive to atmospheric influence (Smith and Lavis 1975). Conversely, lower flows reduce thermal capacity and speed, thus increasing water temperatures, which can affect dissolved oxygen levels (Webb et al. 2008) and spawning timing (Simpson and Wallace 1982). Low flows can also allow ground seepage to reduce temperatures in some cases (Smith and Lavis 1975).

Climate cycles that would have influenced the Middle Snake River fluvial system have been inferred from tree ring chronologies taken from the region of the river's headwaters in western Wyoming. A 415-year reconstruction of the stream flow of the Upper Snake River revealed that drastic changes to the flow occurred in the past, most notably in the presence of a 30-year low flow period in the mid-1600's (Wise 2010). The study reconstructed stream flows by sampling tree ring chronologies that correlated with available data on stream flows from the historic period of 1911-2006 and modelling the centuries that preceded data collection (Wise 2010). River systems vary from year to year and can have decades-long alterations in one of the variables within the system, which can have far-reaching effects on the entire system. The 415-year period of Wise's (2010) study revealed many other periods of low flow which ranged from 2-7 years long, including six periods of six years or longer. Flow levels in the Middle Snake relative to the Upper Snake would have had the additional influence of tributaries and groundwater seepage, both products of snowfall levels (Geological Survey (U.S.) and Kjelstrom 1986).

Flow levels at the Snake River near King Hill in the nearly 40 recorded years before the construction of nearby dams reflect this variation. Looking at just three months (May, July, and September), there is high variation in flow levels. May and July have wide ranges of means. For May, the mean cfs was 12,327 with a standard deviation of 5,949.66. For July, the mean cfs was 8,951 with a standard deviation of 3,677.93. The high standard deviation reflects more variation in temperatures, whereas the lower standard deviation of September (mean=8,417, SD=1,684.99) represents more clustering toward the mean and less variation, as is visible in Figure 3.4.

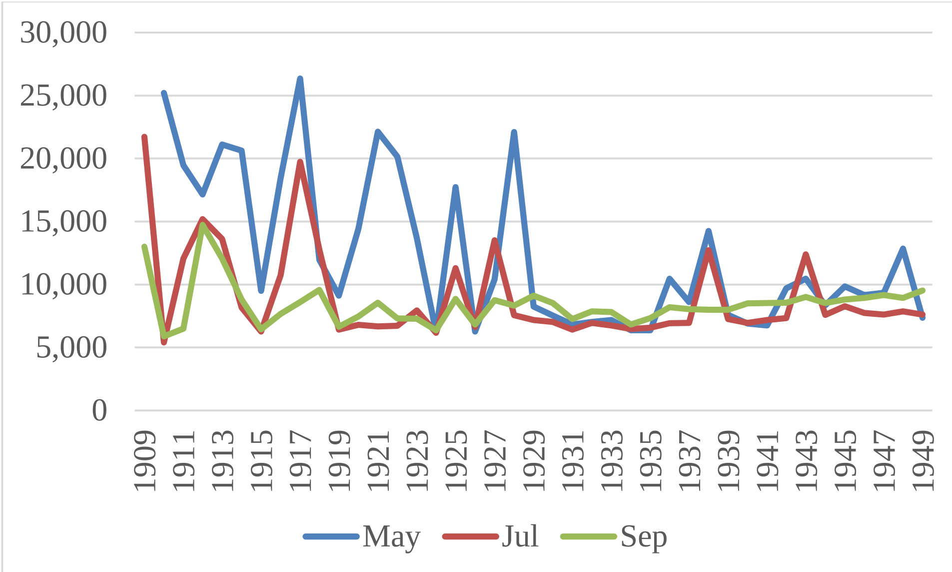

Figure 3.4 Monthly mean discharge (cfs) of Snake River at King Hill for May, July and September (1909-1949) (USGS National Water Information System 2018)

The form of islands is particularly dependent on flow regimes. Fluvial islands, like those on the Middle Snake River, are the result of high energy processes like floods, glaciation, or avulsion, and are unstable and highly variable over geologic time scales (Osterkamp 1998). Unlike other islands, fluvial islands surrounded by a river channel are less permanent, and their form can vary seasonally, annually, and instantaneously due to events like landslides or floods. However, it has been noted that dynamic fluvial zones around islands are beneficial to terrestrial plants and animals by providing a wide range of riparian habitats and high species diversity (Osterkamp 1998; Stanford et al. 1996). They also offer protection from predation on the island, which leads to high bioproductivity.

Islands can form in numerous ways, with the most rapid channel alteration occurring in the event of avulsion, recession of floods, or the deposition of new mass in the form of debris from a landslide (Osterkamp 1998). The life of an island is a balance between continual erosion and deposition. Flow levels, though, will significantly alter the form of an island. On the Middle Snake River, this is evident in maps of Dolman Island before the construction of dams (Figure 3.5) and after (Figure 3.6), as shown in a 1903 Government Land Office map and a 2017 USGS 7.5 Quad map.

Most of the islands on the Snake River may have formed about 15,000 years ago and many of the islands are more than one kilometer long (Osterkamp 1998). The most common formation process for present-day islands was rapid evacuation of sediment associated with relict islands that are elongate and may not have been flooded over since formation at the time of the Bonneville Flood (Osterkamp 1998). There is variation in form, though. Many islands, typically the smaller ones, are not relic islands, but regime islands which are more subject to erosion by floods and channel migration (Osterkamp 1998).

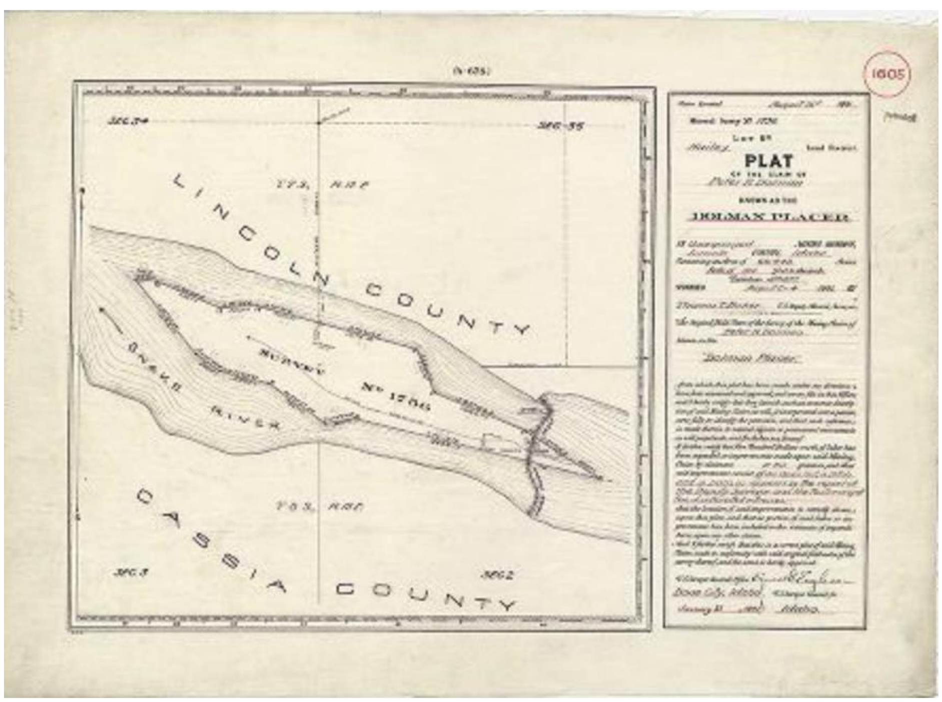

Figure 3.5 Map of Dolman Island in 1903

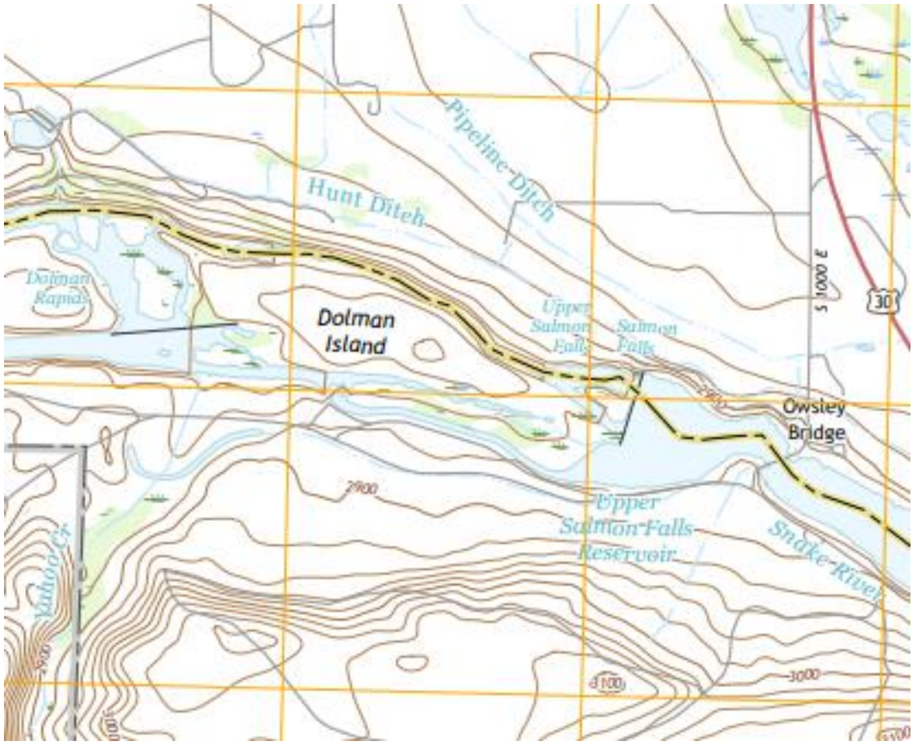

Figure 3.6 Map of Dolman Island in 2017

At the time scale of this study (1,500 years, or about 10% of the life history of most islands on the Middle Snake River), most alterations to the form of islands and to the dependent elements they influence within the configuration of the river are related to flows, geological intrusions, and changes in vegetation. The variation in landscape features can have significant influence on the selection pressure of salmonids (Micheletti et al. 2018). Paleoseismic events can shape the configuration of islands and localized narrows by dramatically altering the landscape through geologic obstructions, changes in flow levels, and increases in sediment discharges (Plew and Guinn 2015). Earthquakes can increase groundwater discharge and river flows (Borah Peak in 1983); fire erosion can lead to sediment discharges because of smooth soil surfaces; and landslides can obstruct migratory runs instantaneously (Plew and Guinn 2015: 58-61).

The Effect of Dams

Dams have significant impacts on river configuration; understanding those impacts and how they shape rivers as they exist today is essential to making inferences about past river configuration and past human behavioral responses. The most consequential impact is the erosion of downstream channels (Csiki and Rhoads 2010) and the accumulation of sediments upstream within an impoundment (artificial lakes) (Csiki and Rhoads 2010). Slow-moving waters will affect temperature and temperature gradients (Smith and Lavis 1975; Webb et al. 2008), and original channels are drowned in sediment (Pizzuto 2002). The dams that cover the study area would have had profound effects on the flow and temperature of the Snake River (Table 3.1). Even by 1906, when Robert Lowie came to Idaho to do ethnography on the Shoshone, the river would have been completely altered by the dam at Swann Falls (1901).

Table 3.1 Dams within the study area (U.S. Army Corps of Engineers 2003)

Dam	Height	Year Completed	Owner
Lower Salmon	16 m	1949	Idaho Power Co.
Bliss	43 m	1950	Idaho Power Co.
C.J. Strike	35 m	1952	Idaho Power Co.
Swann Falls	25 m	1901	Idaho Power Co.

King Hill is downstream of Lower Salmon Falls Dam (1949) and of Bliss Dam (1950) and would have begun experiencing the effect of the dams on streamflow by 1950 (Figure 3.7). Two trends are visible: a far greater discharge before the construction of dams was completed and less monthly variation afterward.

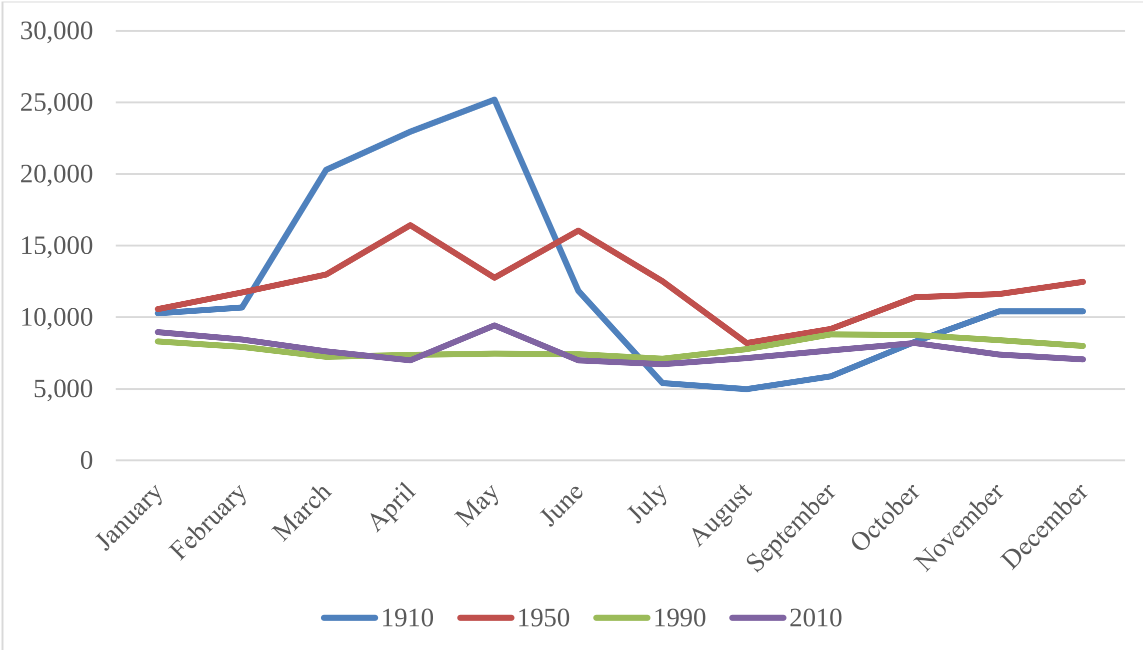

Figure 3.7 Monthly mean cfs (cubic feet/sec) discharge of Snake River near King Hill, Idaho (USGS National Water Information System 2018)

Aquatic Species as Prey

River Configuration and Prey Choice

River configuration can affect prey choices by influencing prey population numbers through variables like water temperature and suitable spawning locations (Blakey 1966; Webb et al. 2008), the protein and fat content of fish species (Plew 1983), and the spatial distribution of prey at moments in time (Grabowski 2015; Lyons 2015). The last of these influences the optimality of prey by either reducing search time or lowering the cost of manufacture and maintenance of fishing technology by making the simplest technologies (e.g., spears) practical. Locations with high variation in flows leads to more spatial aggregation of fish when flows are at low levels.

It is estimated that 65 species of resident, migratory, and anadromous fish species inhabit the Columbia River Basin (Grabowski 2015: 13). The life histories and behaviors of these species vary, but Pacific anadromous species have particularly variable life histories due to complexity of such histories as tied to two different habitats. Anadromous species have an advantage over resident species in the ability to feed in the ocean and reach large adult sizes, such as sturgeon that are hundreds of pounds or a typical chinook salmon of thirty pounds (NOAA Fisheries 2018). Juvenile fish leave freshwater spawning grounds and migrate to the ocean where they acquire more than 90% of their adult weight (Grabowski 2015). They then return inland and don’t eat as they migrate.

All anadromous species have temperature ranges within which they will spawn (Grabowski 2015). In addition, some species, like chinook salmon, have evolved low inter-annual variability in seasonal runs to adapt to average flow and temperature conditions over longer periods of time, and so as to avoid responding each year to highly variable flow and temperature changes (O’Malley and Banks 2008). Flows can influence resident species as well. Resident fish species that spawn early in spring (like rainbow trout) are more negatively affected by early spring floods than by summer floods (Pearsons 1994).

Latitude also influences migratory runs due to the proximate mechanisms that initiate migrations. One possible proximate mechanism, C*lock* genes, influence circadian rhythm and have been shown to be related to day length in mice, *Drosophila* and zebrafish (O’Malley and Banks 2008). In Chinook salmon populations on the west coast of North America, the frequency of alleles of these *Clock* genes change with latitude, likely in response to varying lengths of day (O’Malley and Banks 2008). The habitat of the North Pacific Ocean can be thought of as three latitudinal zones based on water temperatures and daylight that affect anadromous species: above 60° N, 45°- 65° N, and below 45° N (Schalk 1977). Anadromous species at southern mid-latitudes, where water temperature varies to a great degree, have short winter spawning seasons (Schalk 1977). At the lowest latitudes, anadromous species also face increased competition from other ocean species. For a region like the Middle Snake River, given over a thousand-mile journey from the coast for anadromous fish not eating on the journey, the nutritional content of species will be significantly reduced by the time runs reach Shoshone Falls (Idler and Clemens 1959; Plew 1983).

<u>Aquatic Prey Choices in the Middle Snake River</u>

The inclusion of the following species is based on references in historical or ethnographic sources or presence within faunal assemblages of archaeological sites in the region. The focus on anadromous species (e.g., Pavesic and Meatte 1980; Pitkin 2010; Plew 1983) stems from the fact that they are mentioned in ethnographies as being influential (Murphy and Murphy 1960; 322; Steward 1938: 165) and a somewhat predictable resource due to timing of spawning runs (Simpson and Wallace 1982). However, other resources were likely consumed. These include resident fish species, freshwater mussels, and aquatic plants. A full consideration of the potential resource base beyond salmon has been rare. An example is Plew's (1997) assessment of the white sturgeon (*Acipenser transmontanous*) and its variance in catch ratios, handling time, and caloric values depending on variables like water temperature. The goal of expanding on the subject of which resources may have drawn foragers to specific locations on the river is not to argue that resident trout, mussels, or cattail are higher ranking prey than salmon. The inclusion works from the assumption that groups were opportunistic and would have been aware of the behavioral patterns of aquatic species that included, but was not limited to, salmon. Additionally, there is little evidence that salmon were a primary resource at any of the 25 sites used in this study sample (Chapter 2; Appendix D). If aquatic resources influenced camp placement, they likely did so as considerations of supplemental resources within a general foraging pattern and therefore all available aquatic resources should be accounted for as possible prey.

Anadromous Fish

The geographic distribution of anadromous fish species is not completely understood, inasmuch as geological and climatological events can alter the course of streams (Plew and Guinn 2015; Simpson and Wallace 1982). However, each of the anadromous species listed has a historical geographic distribution that includes the Middle Snake River and its tributaries, and their size and spawning run times vary (Table 3.2). The following are brief descriptions of the variables that influence the profitability of these species as resources for human foragers.

Table 3.2 Characteristics of anadromous fish migrations in the western Snake River Basin (NOAA Fisheries 2018; Simpson and Wallace 1982; U.S. Fish and Wildlife Service 2018).

Species	Size	Spawning Run
Chinook salmon (*Oncorhynchus tshawytscha*)	3 feet; 30 pounds	Spring, Summer, Fall
Green sturgeon (*Acipenser medirostris*)	4.5-6.5 feet; Up to 350 pounds	May-June
White sturgeon (*Acipenser transmontanus*)	5-6.5 feet; Up to 400 pounds	May-June
Sockeye salmon (*Oncorhynchus nerka*)	1.5-2.5 feet; 4-15 pounds	May-August
Steelhead trout (*Oncorhynchus mykiss*)	Up to 45 inches and 55 pounds	March-June
Pacific lamprey (*Entosphenus tridentatus*)	16-21 inches; 1 pound	May-September

Chinook Salmon

Adult chinook salmon would have entered the Middle Snake River by late May, June, and early July; two more runs occurred in the summer and early fall around late September and October (Simpson and Wallace 1982). Spawning occurs 2-3 weeks after the fish reach the spawning location of a gravel river bed where they dig out nests, or redds (NOAA Fisheries 2018; Simpson and Wallace 1982). Chinook runs would have been abundant when entering the Lower Columbia. Archaeological evidence in the Lower Columbia suggests that fish remains were similar in frequency to those of mammals and birds (Butler and Martin 2013), and runs may have included as many as 16,000 individual salmon (Grabowski 2015: 26).

As noted, numerous variables would have made chinook salmon a less profitable resource by the time these populations reached the Middle Snake River (Plew 1983; Plew and Guinn 2015; Schalk 1977). Adult chinook salmon are typically 30 pounds but can grow to as large as 129 pounds (NOAA Fisheries 2018). Considering what is seen in male sockeye salmon migrating 1,000 km up the Fraser River (71.6-91% fat loss; 31-42% protein loss; and 1293-1398 total caloric expenditures) (Idler and Clemens 1959), it is reasonable to assume similarly significant losses can be expected in Chinook migrations to the Middle Snake River (Plew 1983).

Steelhead Trout

The steelhead trout is the anadromous form of the rainbow trout and once had a range similar to the Chinook salmon (Simpson and Wallace 1982). The spawning run of steelhead trout occurs between March and June in small streams where gravel riffles are abundant (NOAA Fisheries 2018; Simpson and Wallace 1982). Size ranges for trout are highly variable; sizes can reach 55 pounds (NOAA Fisheries 2018), though the largest documented steelhead in Idaho is only 30 pounds, caught in the Clearwater River near Lewiston in 1973 (Simpson and Wallace 1982: 87).

Sockeye Salmon

Sockeye salmon runs would have also reached the Middle Snake River between May and August, with spawning usually occurring in September (Simpson and Wallace 1982). Sockeye usually spend two years in freshwater and two years in saltwater, but a residual population, known as kokankee, remain in freshwater and spawn in freshwater at a smaller size (Simpson and Wallace 1982). Both versions of sockeye spawn in gravel bars along lake shores. In Idaho this includes Payette, Redfish and Alturas lakes (Simpson and Wallace 1982). Spawning locations and timing are relatively stable, but during some years there is unexplained variation in spawning location with entire populations spawning in a new location. The range of Sockeye is limited to the tributaries of the lakes where spawning occurred and is not as widespread as the range of Chinook and Steelhead in the Middle Snake River (Reiser 1998).

Sturgeon

White Sturgeon, *Acipenser transmontanus*, can complete their entire life cycle in freshwater, unlike the Green Sturgeon, *Acipenser medirostris*, which merely spawns in freshwater (Markle 2016). Both species are some of the largest freshwater fish in the region and in the world. White sturgeon can be as large as 816 kg, while Green Sturgeon can weigh up to 159 kg (Markle 2016). White sturgeon spawn in May and June in fast currents near rocky bottoms (i.e., rapids) (Simpson and Wallace 1982).

Pacific Lamprey

While often overlooked, the historic range of Pacific lamprey included the Middle Snake River, though they have only been observed in Idaho on one occasion in the modern era since the construction of Hells Canyon Dam (Grabowski 2015). The one sighting was a small number of 8-inch specimens that were found as parasites on a trout in Pend Oreille Lake in 1967 (Simpson and Wallace 1982). Adult lampreys usually enter freshwater from May to September but do not spawn until the following spring at locations of sandy gravel riverbeds (Simpson and Wallace 1982). They then return to sea to live a life of parasitism, while some small populations remain in freshwater as parasites of fresh water fish (Simpson and Wallace 1982). To wherever steelhead and chinook migrated, lampreys would have migrated. It is well documented that many native peoples harvested migrating Pacific lamprey in the Lower Columbia (Jones 2015; Grabowski 2015). However, the relative profitability of a typical, one-pound lamprey that has migrated inland to the Middle Snake River is less clear, although the adults did continue to eat between beginning migration in the summer and spawning the following fall. Because Pacific lamprey are less well studied than salmon, many aspects of their life history are not well known (Grabowski 2015).

Resident Fish

Resident fish species have the potential to be spatially and temporally predictable in the same manner as anadromous fish species (Lyons 2015). The spawning timing and location of many species is predictable; they may congregate in great numbers; and their feeding locations are somewhat consistent. *Prosopium williamsoni* (mountain whitefish), for instance, which are found primarily in cold mountain streams and lakes but also have a range on the Middle Snake River and its tributaries (Simpson and Wallace 1982), congregate in great numbers to spawn during late October and early November (Lyons 2015). As Lyons notes, the numbers of these species can be high, with the Idaho State Game and Fish Commission allowing 50 pounds of mountain whitefish harvest in the fall of 1939 (Lyons 2015; Sims 1999).

Sucker species, such as *Catostomus coumbianus* (bridgelip sucker) and *Catostomus macrocheilus* (largescale sucker), while small, bony and unpalatable, typically spawn in late spring and early summer in shallow edges of rivers and lakes and could have been prey choices in the absence of more profitable resources (Markle 2016).

In addition, many trout species like *Oncorhynchus mykiss newberryi* (redband trout) and *Salmo trutta* (brown trout) had historic ranges that included the Middle Snake River and had predictable spawning locations in gravel beds of rivers (Markle 2016; Simpson and Wallace 1982). Similar to that of many salmonids, the diet of trout consists of aquatic insects and other small fish (Simpson and Wallace 1982).

There is great difficulty in predicting congregations of resident species. Unlike anadromous species, there are no “runs” by which populations of such fish must pass through certain locations. Descriptions of resident fish spawning locations are generic (e.g., “gravel river beds”) and there is more variability in spawning timing. In certain cases, with sufficient ethnographic context, it may be possible to differentiate between the archaeological signatures that suggest harvesting of resident fisheries, like Lyons’ (2015) predictions of Pend Oreille resident fisheries; however, the toolkit on the Middle Snake River is multi-functional and doesn’t lend itself to identifying signatures of fishing of resident species.

However, for groups engaged in a general foraging pattern that varied seasonally and was based on the available resources, it is likely that groups utilized resident fish species as prey. There is ethnographic evidence for suckers being fished in the Owyhee tributary (Steward 1938: 168). There is also archaeological evidence of utilizing resident species (e.g., mountain whitefish remains at 10-CN-1 and catostomid remains at 10-AA-188). Alhough resident species may not have been as abundant or predictable as anadromous species, any level of predictability would be factored into decisions of where to situate camps; and resident species spawning locations would have been influenced by river configuration in the same way that anadromous species spawning locations were affected.

Other Prey

Other aquatic prey that would have been possible prey choices include freshwater shrimp (Plew and Weaver 2001), aquatic plants like Typhaceae cattail species, and freshwater mussels. The last of these, freshwater mussels, are found in most of the archaeological sites in the study sample. Two species are represented: the western ridged mussel (*Gonidea angulate*) and the western pearlshell (*Margaritifera falcata*) (Plew and Willson 2013). The western pearlshell is common in archaeological sites throughout the Pacific Northwest. They were usually harvested during late spring through fall, a time when chinook, sockeye and salmon were being harvested as well (Jones 2015). In addition to being harvested at the same time, the western pearlshell and main salmon species with range that includes the Middle Snake River were likely harvested in similar locations. The preferred habitat of the western pearlshell is hatural rapids of rivers and streams (Jones 2015). Near Hagerman, salmon were taken below Upper and Lower Salmon Falls with nets in the spring and spears in the pools at the bottom of the falls in mid-summer (Steward 1938: 167). Rapids exist within range of the falls. Like many parts of the Columbia Plateau, fishing and mussel collecting on the Middle Snake River were not mutually exclusive (Jones 2015) but often overlapped both spatially and temporally. Mussel collecting sites might even predate significant salmon harvests: the Middle Archaic Kueney Site south of Twin Falls produced thousands of mussels and had a range of deposits between 3758 ± 151 B.P. and 2977 ± 115 B.P. (Plew and Woods 1985).

One final consideration is that aquatic prey may not be conditioning camp locations in any way. However, the effect of river configuration on settlement decisions can be conditioned by other factors such as terrestrial game, rich riparian environments, and mobility. Many terrestrial game species are drawn to riparian environments, and localized narrows and islands offer locations where larger game can cross the river. Mule deer (*Odocoileus hemionus hemionus*) make winter habitat decisions that offer adequate forage, protection from predators and weather, and conservation of energy (Smith et al. 2015). They typically choose ranges at lower elevations with south-facing slopes and moderate to high canopy cover (Smith et al. 2015). The north bank of the Middle Snake River offers all three.

Similarly, locations of possible river crossings (such as Three Island Crossing) offer foraging patches on either side of the river, doubling the area of riparian habitat for foraging from a central place (*sensu* Orians and Pearson 1979). Whether human foragers were drawn to locations where river configuration made terrestrial and aquatic resources more profitable, or allowed movement across the river, the question of how that relationship varied over time is a useful starting point before further investigations unravel the complicated spectrum of foraging decisions that responded to local conditions, including the configuration of the river.

CHAPTER FOUR: RESEARCH DESIGN AND METHODS

The methodological framework of this project attempts to answer two of the three research questions (page 11-12) from a deductive approach that predicts site location if related to physiographic features of the Middle Snake River and the duration of occupations at specific locations if the configuration is relatively stable over time. Informed by the behavior and life history of aquatic resources and historical changes in the configuration of the Middle Snake River, two hypotheses are proposed as answers to the following research questions presented in Chapter 1:

- *Do archaeological site locations correlate with these physiographic features in proportion to the whole study area? Or are some physiographic features (i.e., islands) ubiquitous and causing a Type I error (rejecting a null hypothesis when the evidence suggests it should not be rejected)?*
- *Were these locations repeatedly used by Late Archaic foragers?*

Hypotheses One: Expectations and Methods

<u>Hypothesis One: The Middle Snake River configuration influenced the positioning of camp locations.</u>

The hypothesis proposes that groups considered locations of potentially productive fisheries when choosing foraging locations adjacent to the Middle Snake River (Table 4.1). The null hypothesis is that a generalized foraging pattern was not influenced by river configuration and that fishing was a secondary concern in decisions about foraging. If the hypothesis is supported, it does not suggest that fishing was the primary subsistence strategy (an assertion that would contradict ethnographic projections and archaeological evidence), but that the variation in the configuration of the river influenced decisions of location and timing. This general foraging pattern would include fish but not necessarily in the numbers that would support village life and winter caching of salmon (Pavesic 1978). Other aspects of the riparian zone may have conditioned mobility (e.g., shellfish, aquatic plants, waterfowl, terrestrial game crossings, riparian vegetation used as fuel, etc.).

Table 4.1 Hypothesis One: The Middle Snake River configuration influenced the positioning of camp locations.

Hypothesis 1	**Expectations**	**Measurement Variables**
Camps were positioned adjacent to potentially productive fisheries or productive riparian zones.	Archaeological site locations correlate with islands and minimum channel width on the modern Middle Snake River before dam construction.	Archaeological site location; Proportion of sites within 2 km radius zones around each of the features; Proportion of land area within same zones.

The expectation is that archaeological site location will correlate with specific features on the river because of the theoretical expectations previously outlined. Archaeological site locations should be situated near features that cut search time for aquatic resources and allow implementation of ethnographically documented fishing technology.

The analysis created a predictive map of sites based on the independent variables of fish behavior and river conditions (e.g., spawning aggregation, flow levels, etc.). Using ArcGIS Pro, a series of data layers were superimposed onto two base maps of the study area. United States Geological Survey (USGS) 7.5-minute quad maps were used as the first base map. The USGS quad maps show a pre-dam river channel, but another layer of Government Land Office (GLO) historical maps was placed over the reservoirs to identify a more detailed pre-dam configuration. GLO maps are much more accurate for identifying pre-dam configurations. GLO maps can be found online (glorecords.blm.gov), with maps as early as this example of a survey from May, 1893, at the location where the C.J. Strike dam would be built in the 20th century (Figure 4.1).

In most cases, the USGS quad maps accurately portrayed the earliest documentation of islands. However, some of the earliest GLO maps (from the 1890's) were useful in identifying locations where the channel funneled. For example, at Lower Salmon Falls Dam the minimum channel width for the 20-km section was situated just below the dam, and this was only visible on a map from an 1884 survey (U.S. Bureau of Land Management 2018).

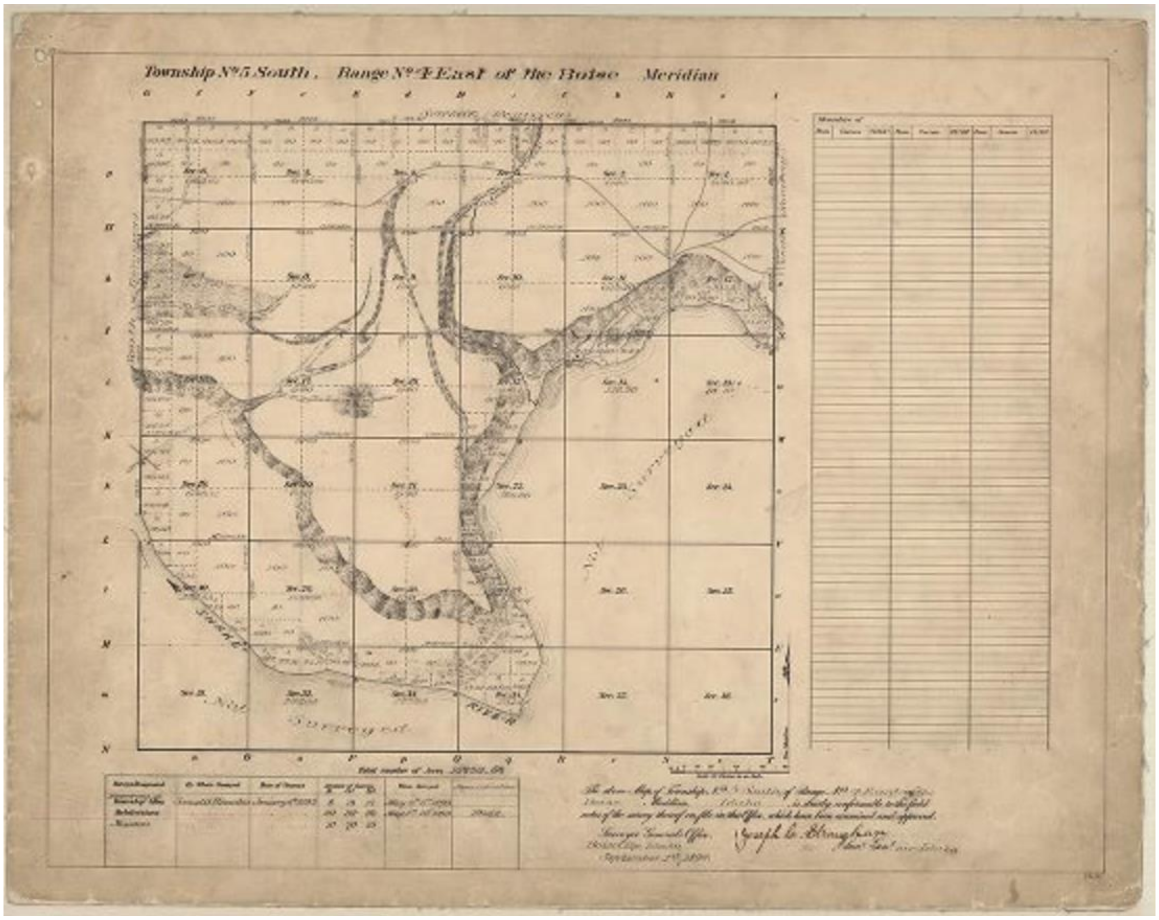

Figure 4.1 Map of 1893 survey of Township 5S, Range 4E in southern Idaho

A data layer of the river course with a 2-km buffer on either side was superimposed onto the base maps. Two kilometers was estimated as the distance foragers would travel for transporting fish. While this may in fact be an underestimate, since a foraging radius typically extends 6-10 km from a residential base (Kelly 2013), it is a number that encompasses Pitkin's (2010) categories of adjacent (within 2 km) and immediate (within 1 km). It also is not far from Steward's (1938) estimate that Owens Valley Paiute foraging trips rarely exceeded 3.6 km one-way, which seems a reasonable substitute for the Snake River Plain, for which Steward provides no estimate. If caches of salmon were being transported, the distance would likely have been similar to what is seen among the Western Mono in the southern Sierra Nevada – an average of 3.4 km one-way trip from settlements to caches (Morgan 2008). Therefore, a buffer of 2 km (consistent with Pitkin's study) is reasonable based on the fact that data taken from two similar environmental contexts is only 1.4-1.6 km greater (rather than differing by 4-8 km when compared to general worldwide estimates).

Zones with a 2-km radius were established around each occurrence of an island longer than 100 meters and of the minimum channel width for every 20-km section of the river beginning at the western boundary of the study area (Table 4.2). The latter of these is based on the fact that Piktin (2010) designates minimum channel width as the average of the minimum width of every 1 km extending 10 km upstream and downstream from each archaeological site. These physiographic features (i.e., islands and points at which the channel funnels) within the river configuration potentially increase the productivity of fisheries (either by reducing search time or allowing the utilization of nets, spears, weirs with their optimal river conditions). This created two categories: land within zones around the physiographic features and land within the study area but not within those zones (Figure 4.2).

Table 4.2 River features and requirements for inclusion in analysis

River Feature	Requirements for Inclusion
Islands	>100 m long
Funneled Channel	Minimum channel width within 20 km long sections

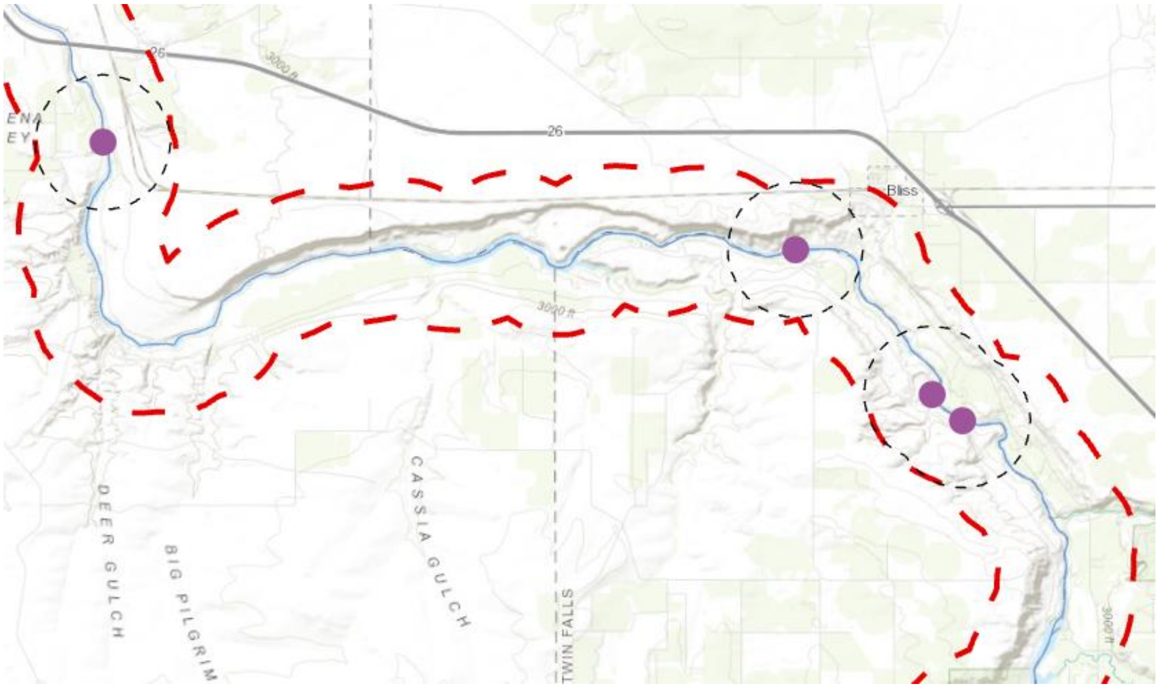

Figure 4.2 Example of zones around islands (purple dots) and 4 km wide study area (red dashes)

A sample of 25 archaeological sites near the Snake River from Shoshone Falls to the border of Oregon was selected and compiled based on site location (Appendix B). One site, 10-WN-469, originally listed as "Middle Snake River" in the Pitkin (2010: 67) study, lies north of the geographic scope of this analysis and was removed. Sites were selected based on their being situated within 2 km of either side of the Middle Snake River and having evidence of Late Archaic occupations based primarily on projectile types, presence of pottery, and radiocarbon dating. Although the presence or absence of evidence of fishing is noted in the site descriptions listed in Appendix D, this characteristic was not used in selecting sites.

Using IBM SPSS Statistics, a binomial test was conducted to assess whether the proportion of land area within 2 km zones around the physiographic features was similar to the proportion of sites within those same zones (relative to total land area within the study area or total number of sites within the study area) For example, if land within zones is .05 proportion of total land within the study area, then H_0: p=.05, H_a: p>.05 (where p=proportion of archaeological sites within zones around river features).

Statistical analysis of the first hypothesis (Binomial Test of Proportions) hinges on the assumption that it is more reasonable to compare the relationship between site location and physiographic feature within the context of the entire stretch of river rather than note which physiographic features happen to be near sites.

Hypothesis Two: Expectations and Methods

<u>Hypothesis Two: The Middle Snake River configuration influenced the duration of re-occupation of camp locations.</u>

The premise that archaeological site location and river configuration are related leads to the hypothesis that certain locations would have been repeatedly used, as is suggested in Harris (1940), Steward (1938) and Murphy and Murphy (1960), where groups were aware of better fisheries, had preferred locales, cached equipment, and built semi-permanent structures like weirs. The expectation is that sites near areas of potentially productive fisheries will have longer ranges of occupation than sites farther from those areas (Table 4.3). If those productive areas, as seen today, were somewhat consistent over the last 2,000 years, then there should be longer ranges of occupation near those areas than seen in archaeological sites not near those physiographic features. However, if those physiographic features change frequently because of changes over time in the configuration of the river, then it would be expected that ranges of occupations would be similar between sites near areas with islands and minimum channel width and sites not near these physiographic features on the river configuration right before construction of dams (ca. 1890’s). In other words, if the ranges are skewed toward more sites near the features in the late 19th century configuration, the variation in configuration was not great enough over time to change preferences in locations. This presumes good preservation of sites and a good representation of sites that are not underwater.

Table 4.3 Hypothesis Two: The Middle Snake River configuration influenced the duration of re-occupation of camp locations.

Hypothesis 2	**Expectations**	**Measurement Variables**
A changing configuration altered the locations of potentially productive fisheries or productive riparian zones, reducing occupational length.	Sites near modern islands and funneled channel locations have a similar range of occupations to sites not near the features.	Mean range of radiocarbon dates for each site; Categorical variable of inside or outside of 2 km radius zones around each of the features.

A smaller sample of archaeological sites on the western Snake River Plain with radiocarbon-dated specimens was split into two categories: sites within the zones around physiographic features and those outside the zones. The mean range of dates (number between earliest and latest) was taken for each site. A non-parametric Mann-Whitney test compared the means of the two samples to test whether, on average, sites near the features had similar occupation ranges to sites not near the features.

CHAPTER FIVE: RESULTS

Site Location and Physiographic Features

Islands

Islands are a ubiquitous physiographic feature of the Middle Snake River's configuration. Just over half of the study's land area (56.7%) was within 2 km of an island. There are 178 islands that are at least 100 m long within a river course that spanned 669.6 km. The distribution of the islands is not homogeneous across the river. Within the 20 km sections that were used to select minimum channel width, the mean number of islands is 5.24, or one island every 3.82 km (Figure 5.1). This is a pattern that existed at least in the 1890's and remains the same today.

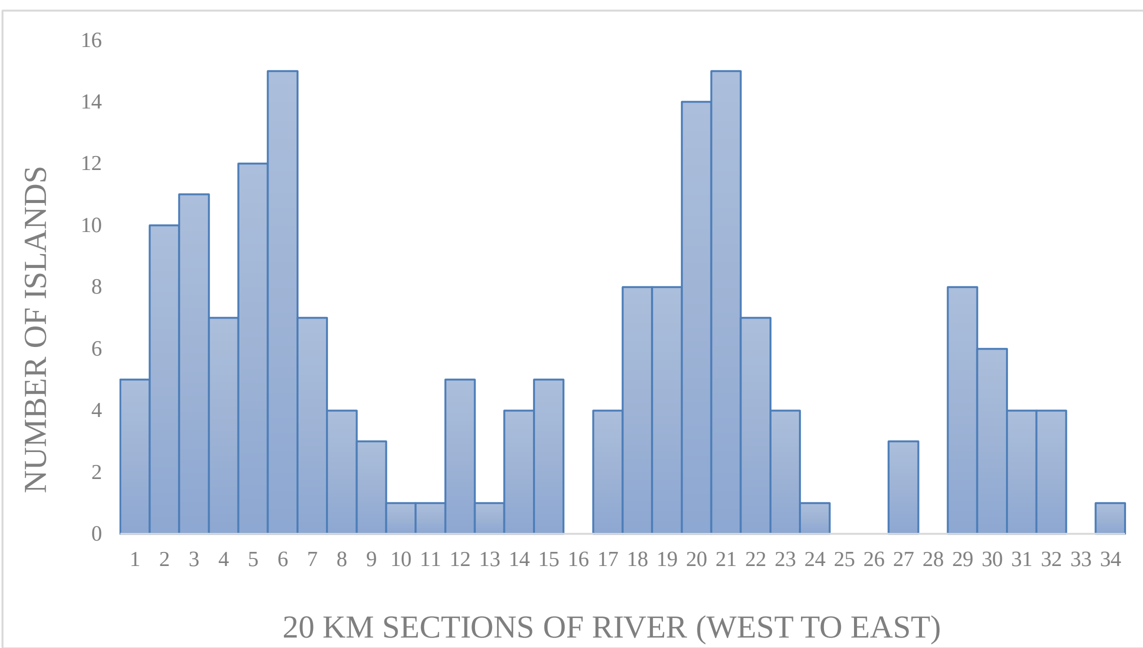

Figure 5.1 Bar graph of island distribution in Middle Snake River configuration (7=Celebration Park, 22=Three Island, 27=Bliss, 34=Shoshone Falls)

There are more islands in the western half of the study area than in the eastern half. If every section upstream of Three Island Crossing were omitted from the study area, the mean number of islands per 20 km section would increase to 6.68, or one island every 2.99 km.

The following hypothesis was proposed: that the proportion of sites within zones would be greater than the proportion of land area within zones. The null hypothesis (H_0: Proportion of Sites = .567) would suggest that the placement of archaeological sites was likely to have been random. The alternate hypothesis (H_a: Proportion of Sites > .567) would suggest that the placement of archaeological sites occurred near islands to a greater extent than would be expected if the placement were random. The results from the geospatial analysis are outlined in Table 5.1, and maps of the analysis can be found in Appendix A (Figures A.1-A.10).

Table 5.1 Results of geospatial analysis of islands

Length of river in study area	669.6 km
Total study area (with 4 km wide buffer)	1814.15 km^2
Number of Archaeological Sites in Sample	25
Number of Islands >100 m long	178
Area of Total Land Within Island Zones	1,029.22 km^2
Number of Archaeological Sites Within Island Zones	16

A binomial test of proportions suggests that the null hypothesis can be rejected. The proportion of sites within zones around islands was 0.64, greater than the expected proportion if site placement were random (0.567). However, the proportion of sites within zones around islands is only slightly greater (+7.3%) than expected if site placement were random.

Locations of Minimum Channel Width (MCW)

There were 34 sections of the river, each 20 km long, except for the final section near Shoshone Falls, which was 9 km. The total area of land across the study area that was within 2 km of a section's MCW was 412.61 km^2, or 22.7%. The number of sites within zones surrounding locations of MCW was 11.

The following hypothesis was proposed: that the proportion of sites within zones would be greater than the proportion of land area within zones. The null hypothesis (H_0: Proportion of Sites = .227) would suggest that the placement of archaeological sites was likely to have been random. The alternate hypothesis (H_a: Proportion of Sites > .227) would suggest that the placement of archaeological sites were near locations of MCW to a greater extent than would be expected if the placement were random. The results from the geospatial analysis are outlined in Table 5.2 and maps of the analysis can be found in Appendix B (Figures B.1-B.11).

Table 5.2 Results of geospatial analysis of MCW

Length of river in study area	669.6 km
Total study area (with 4 km wide buffer)	1814.15 km^2
Number of Archaeological Sites in Sample	25
Area of Total Land Within MCW Channel Zones	412.61 km^2
Number of Archaeological Sites Within MCW Zones	11

A binomial test of proportions suggests that the null hypothesis can be rejected. The proportion of sites within zones around locations of MCW was 0.44, greater than the expected proportion if site placement were random (0.227). This is a much stronger relationship than that between camp locations and islands. The proportion of sites within zones around locations of MCW is nearly double the proportion expected if site placement were random.

Variation in Physiographic Features and the Duration of Site Use

<u>Mean Radiocarbon Ranges in Relation to Islands</u>

The mean radiocarbon ranges between sites within 2 km of an island and sites not within 2 km of an island are not significantly different when analyzed using a non-parametric Mann-Whitney Test (U=8, p=.874) (Figure 5.2). Sites near islands were not occupied for a significantly longer time than sites not near islands. The ranges of occupation for single component sites were listed as 100-year ranges to capture the possible timeframe of occupation.

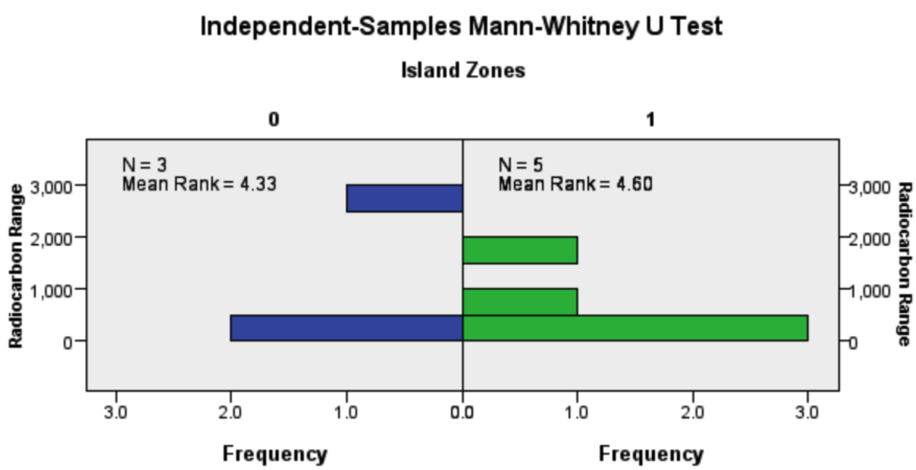

Figure 5.2 The mean radiocarbon range across archaeological sites (0=sites not within 2km of an island, 1=sites within 2 km of an island)

<u>Mean Radiocarbon Ranges in Relation to MCW</u>

The mean radiocarbon ranges between sites within 2 km of a location of MCW and sites not within 2 km of a location of MCW are not significantly different when analyzed using a non-parametric Mann-Whitney Test (U=11, p=.266) (Figure 5.3). Sites near locations of MCW were not occupied for a significantly longer period of time than the sites not near locations of MCW. The same sample of eight sites from the previous analysis was used.

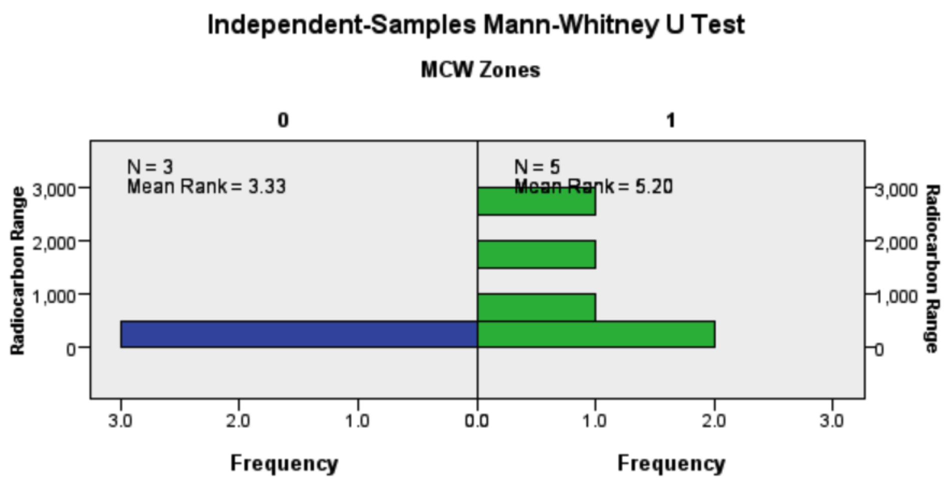

Figure 5.3 The mean radiocarbon range across archaeological sites (0=sites not within 2km of a MCW, 1=sites within 2 km of a MCW)

In both cases, the null hypothesis, that sites near the physiographic features would have average duration of re-occupation similar to that of sites not near the physiographic features, cannot be rejected. Sites near both islands and locations of funneled channels (the minimum channel width) are related to archaeological site placement, but this was a relationship characterized by variability. Thus, site placement is conditioned by physiographic features, but site use is more complicated and varies over time.

CHAPTER SIX: DISCUSSION AND CONCLUSION

Discussion

As outlined in Chapter 2, river configuration is characterized by variability. The results of this study support the proposal that the variability inherent in river configuration would have made any relationship between archaeological site placement and physiographic features of the river one that varied significantly during the last 1,500-2,000 years.

Both islands and localized narrows correlate with camp site placement, but islands are situated throughout most of the study area. Islands would be ubiquitous if the distance a forager would likely travel is raised from the 2-km range to Steward's (1938) 3.6 km range or Kelly's (2013) 6-10 global average range. Furthermore, the binomial test of proportions barely exceeds the .567 proportion expected if site placement is random. Factors such as the range of the buffer around islands, the size and composition of the archaeological sample, and the length and width of the study area could alter a result this close.

These results are more ambiguous than those of the study conducted eight years ago (Pitkin 2010). That study noted types of physiographic features near sites with fishing evidence. By surveying the entire Middle Snake River for islands, this study identified features where archaeological sites are expected and tested for a correlation within the context of the entire landscape. This ensures that sections of the river where sites are not located are included in the analysis. Otherwise, noting what is situated near a site could lead to meaningless observations such as a correlation between sites and water.

The much stronger correlation occurred between archaeological site location and minimum channel width. These locations are mentioned in ethnographic sources as being linked to productive fishing, and many of the minimum channel width locations corresponded with falls and rapids. These are also locations where spearfishing would have been productive (a likely behavior when considering the multifunctional nature of the toolkit found throughout the western Snake River Plain). This correlation also potentially speaks to areas where facilities could have been placed (e.g., traps, weirs, etc.). The parsimonious explanation for why no other caches of fishing gear have been found, like those recovered at Schellbach Cave (Schellbach 1967), is that simple fishing strategies would have been more productive. In addition to considerations of fishing technology, it is likely that other factors influenced foraging decisions. Deer and human crossings are never going to be at the widest or deepest point of a river.

If one predicts that a general foraging pattern that moves people to resources occurred during the Late Archaic, as other archaeological analyses suggest, then it is reasonable to expect that groups that utilized the Middle Snake River on a seasonal basis considered river configuration not solely relative to fish but to a spectrum of potential prey. It is also worth considering the relationship between islands and MCW that is not explicit in the design of this study. Many of the narrow points on the river course are on the peripheries of islands. It is possible that islands are simply more MCW locations that are drawing human actors because of the potential for game crossings and access to patches on either side of the river. Furthermore, islands themselves are very productive environments with higher rates of species diversity relative to riparian environments. Locations of MCW not associated with islands will be more stable over time but funneling on the peripheries of islands offers all of the benefits of any MCW location with the added benefits of productive vegetation and shelter that deer seek during winter months.

The possibility for repeated use of the same locations (that correlate with physiographic features of the modern configuration just before dam construction) is fleshed out by this study in several ways: 1) cataloguing of the events that would have altered river configuration 2) review of historically known flow variation 3) statistical analysis of mean durations of occupation at sites that correlate with the physiographic features. The former two approaches (Chapter 3) reveal a spectrum of variables that influence river configuration. The statistical analysis (Chapter 5) suggests that people did not use the sites that correlate with physiographic features of the river ca. 1890 any longer than the sites positioned elsewhere. This means that either sites do not actually correlate with physiographic features (Type I error) or that there is variation over time in the spatial distribution of the physiographic features. Flows and depths in one century, or decade, or year, will vary because of a variety of causes – altering the size of islands and the points on the river where the channel width is at its minimum relative to nearby points.

The result that archaeological sites correlate with some physiographic features is expected. It confirmed to some extent the results of Pitkin (2010: 110), although the relationship between site location and islands is not as strong as was found in the 2010 study. The value of this reassessment has been to elucidate factors that would have changed those physiographic features over time. The islands and channels as measured in this study and in the 2010 study are not static features that exist today unchanged. Over the 1,500 to 2,000 years of the time period that is the focus of this study, the characteristics of the river's configuration would have changed constantly.

Other Factors and Future Studies

A number of factors could influence the results of this study and possible improvements that future expansions of the archaeological dataset might allow. First, it is possible that other features are worth examining. Rapids and falls were certainly productive fisheries, but these overlapped with many of the MCW locations as defined by this study. Confluences, where many anadromous and resident species spawn, are another possibly significant physiographic feature. Although Pitkin found no correlation between confluences on the Middle Snake River and archaeological site locations, it may be worth testing under the new design that compares proportions.

Second, the size of the sample of sites with radiocarbon data could be increased. Most of the 25 sites used in this sample have no radiocarbon-dated specimens. A broader sample might aid in avoiding a non-parametric comparison of means, if distributional assumptions are met, and instead allow use of an independent t-test that would give a clearer comparison of the mean occupation ranges of the sites within zones and those outside. There would be considerable value in expanding the study to include all known archaeological sites that have been recorded as part of cultural resource management surveys. This could include sites that are up to 10 km away from the river.

Finally, it must be noted that many of the archaeological sites adjacent to the river may have been destroyed by the river over time. This can create a bias in the sample.

Conclusion

There is a significant relationship between archaeological site location and physiographic features of the Middle Snake River, though the width of the river channel seems to have a stronger influence over groups' decisions of where to camp during the Late Archaic period than does the presence of islands. The proportion of archaeological sites within zones near locations of minimum channel width is .44, much higher than the .227 expected if site placement were random. The proportion of the same archaeological sites within zones near islands is .64, only slightly above the .567 expected if site placement were random. Furthermore, islands are pervasive across the section of the Snake River that flows through southwest Idaho. These results are expected and support the findings of Pitkin (2010), but the presence of islands may not be a viable prediction of foraging locations and of current archaeological evidence. The correlation between islands and archaeological sites, less strong in this new study, is possibly a side effect of sites mapping onto funneled channels (which are sometimes created by islands).

It has also been shown that river configuration is highly variable, influenced by climate cycles, geological events, variability in flows, and human intervention. Not only does this have implications for studies that attempt to infer past conditions before dams (e.g., this study), but also for the scale and frequency of alterations throughout prehistory and subsequent impact to human foragers. Within the categories of zones near physiographic features and land within the study area but beyond those same zones, the archaeological sites with radiocarbon-dated specimens suggest no difference between the range of re-occupation for sites within zones and sites beyond the zones. This could mean that the correlations found in this study and those of its predecessor are non-existent or lacking some other variable that is influencing site placement. If site placement and physiographic feature are correlated, then the variability in river configuration can be said to have altered that relationship over time. The locations that ethnographies suggest were claimed by specific groups would not necessarily have been consistent over two millennia. Understanding variability in river configuration is a useful starting point for framing new research questions about the variability in foraging decisions that would have been necessary on the western Snake River Plain.

The variability in river configuration at locations that correlate with prehistoric human foraging adds to the mosaic of few fish remains at archaeological sites in the region, absence of fishing technology documented outside of a few weirs, net sinkers and the cache at Schellbach Cave, and the lack of evidence for storage and bulk processing of salmon. This suggests that these archaeological sites do not represent “fishing sites” and that when fishing was a part of the foraging spectrum, its profitability would have varied seasonally and annually by flows, geomorphological changes, and in relation to other resources.

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APPENDIX A

Maps of ArcGIS Analysis of the Relationship Between Islands and Archaeological Sites

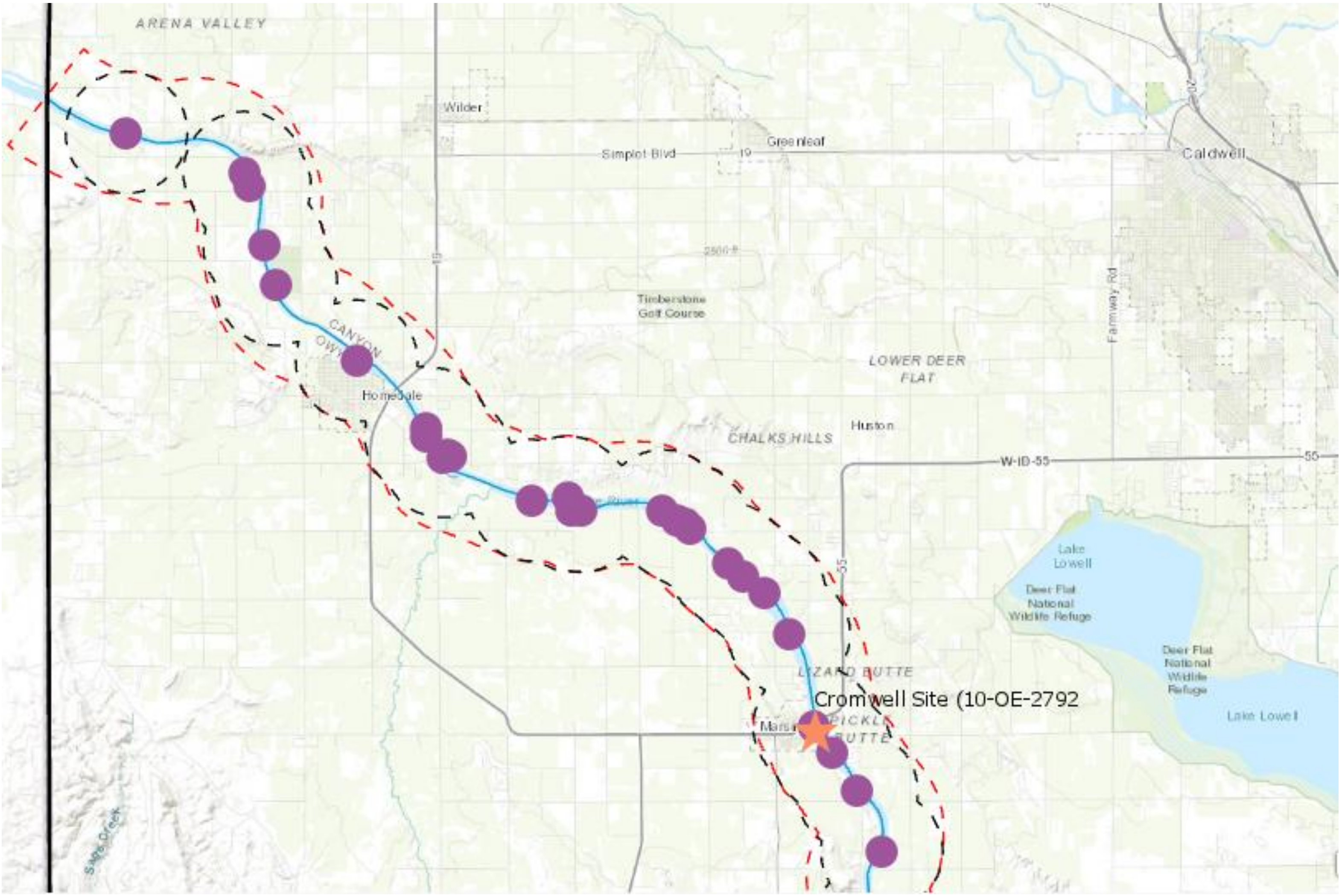

Figure A.1 Map of Island Analysis (Oregon Border to Marsing)

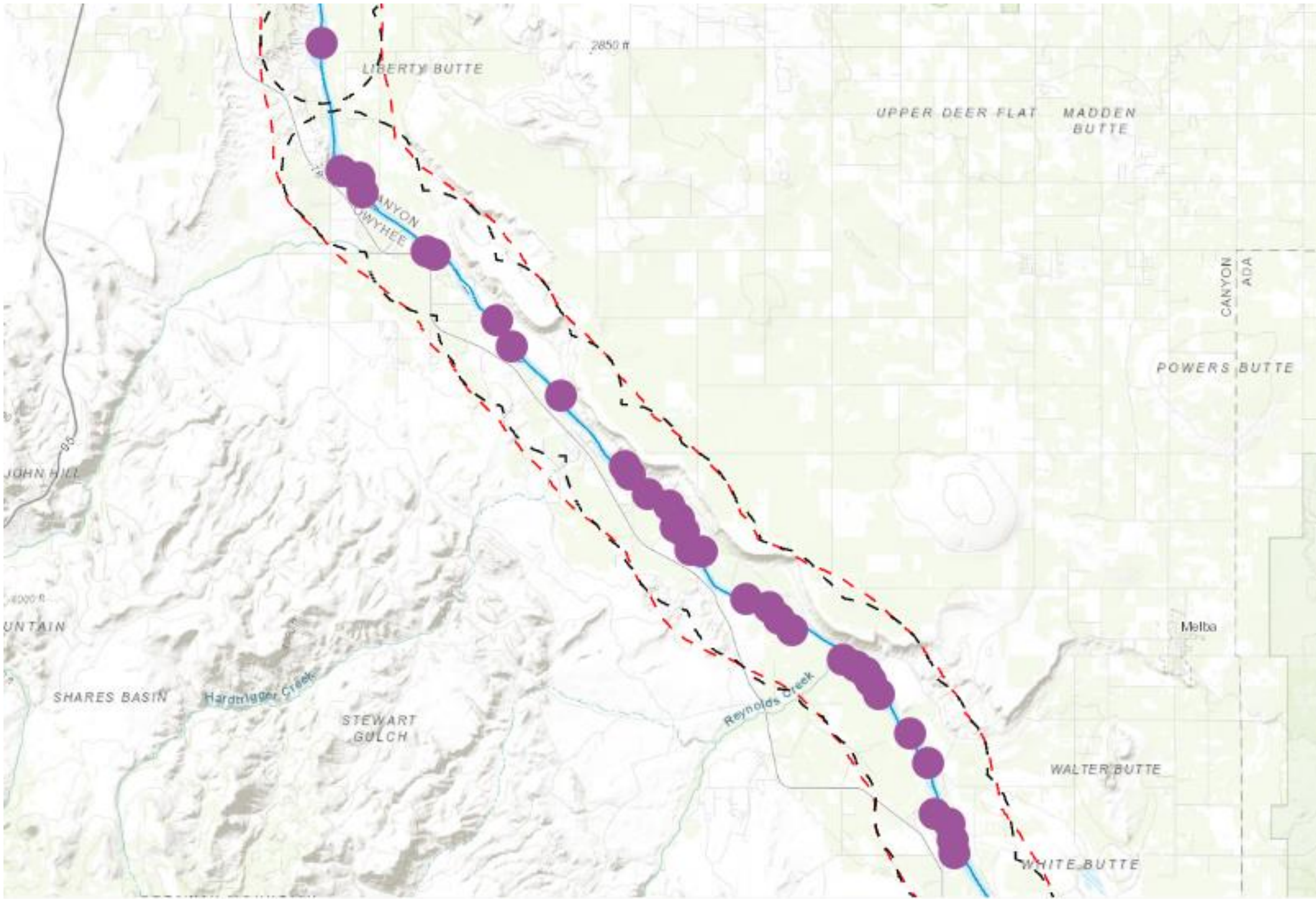

Figure A.2 Map of Island Analysis (Marsing to White Butte)

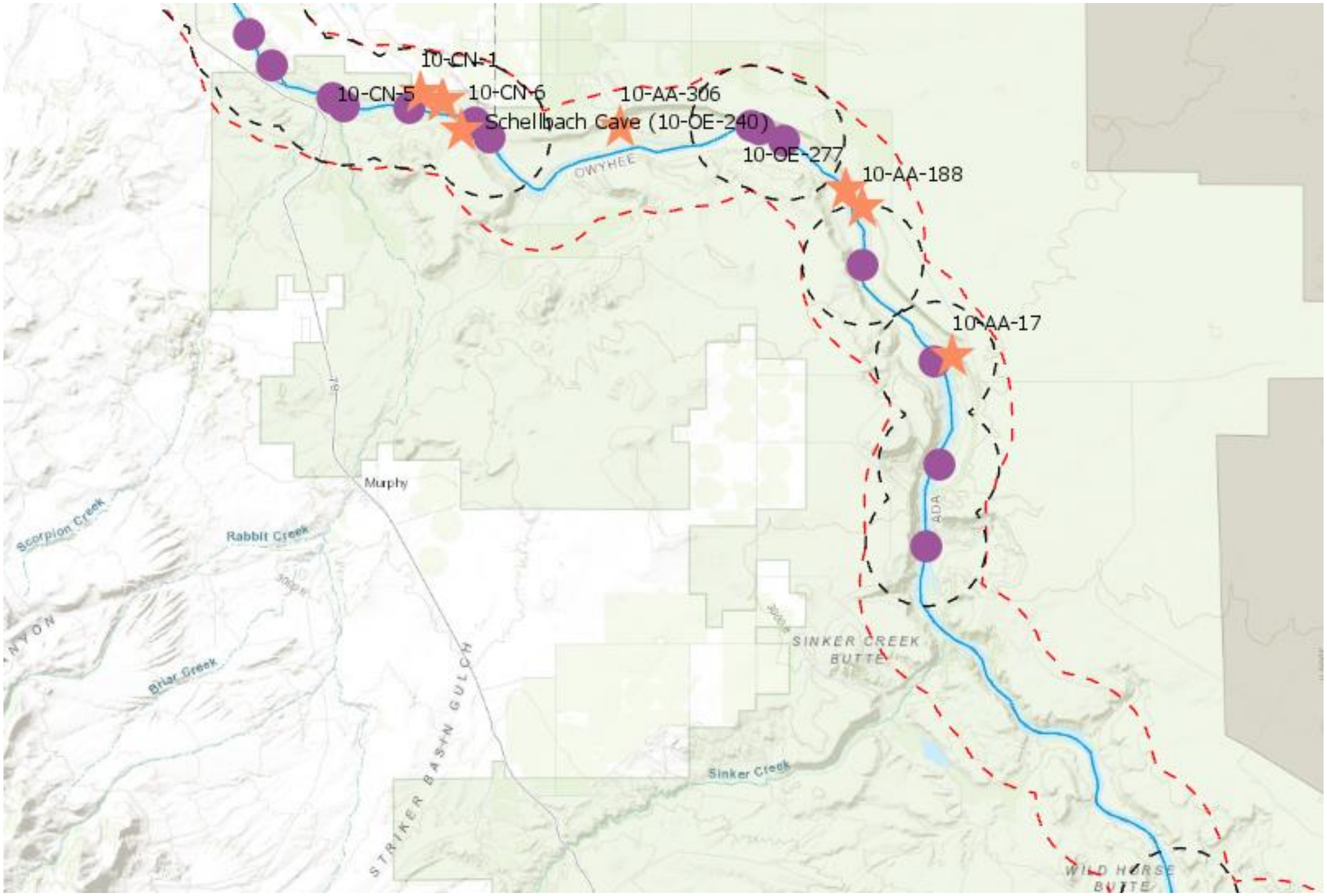

Figure A.3 Map of Island Analysis (Celebration Park to Wild Horse Butte)

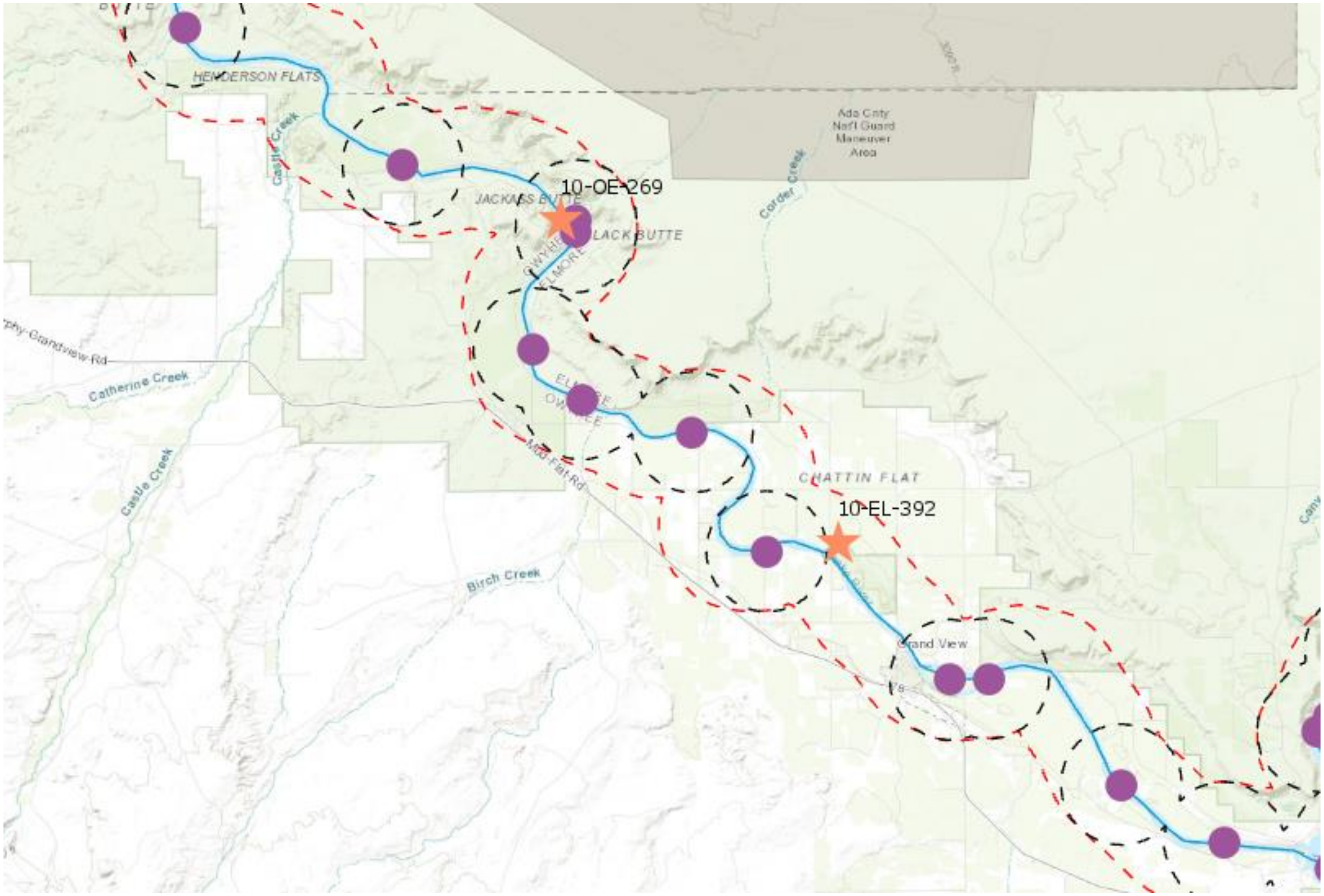

Figure A.4 Map of Island Analysis (Henderson Flats to C.J. Strike Reservoir)

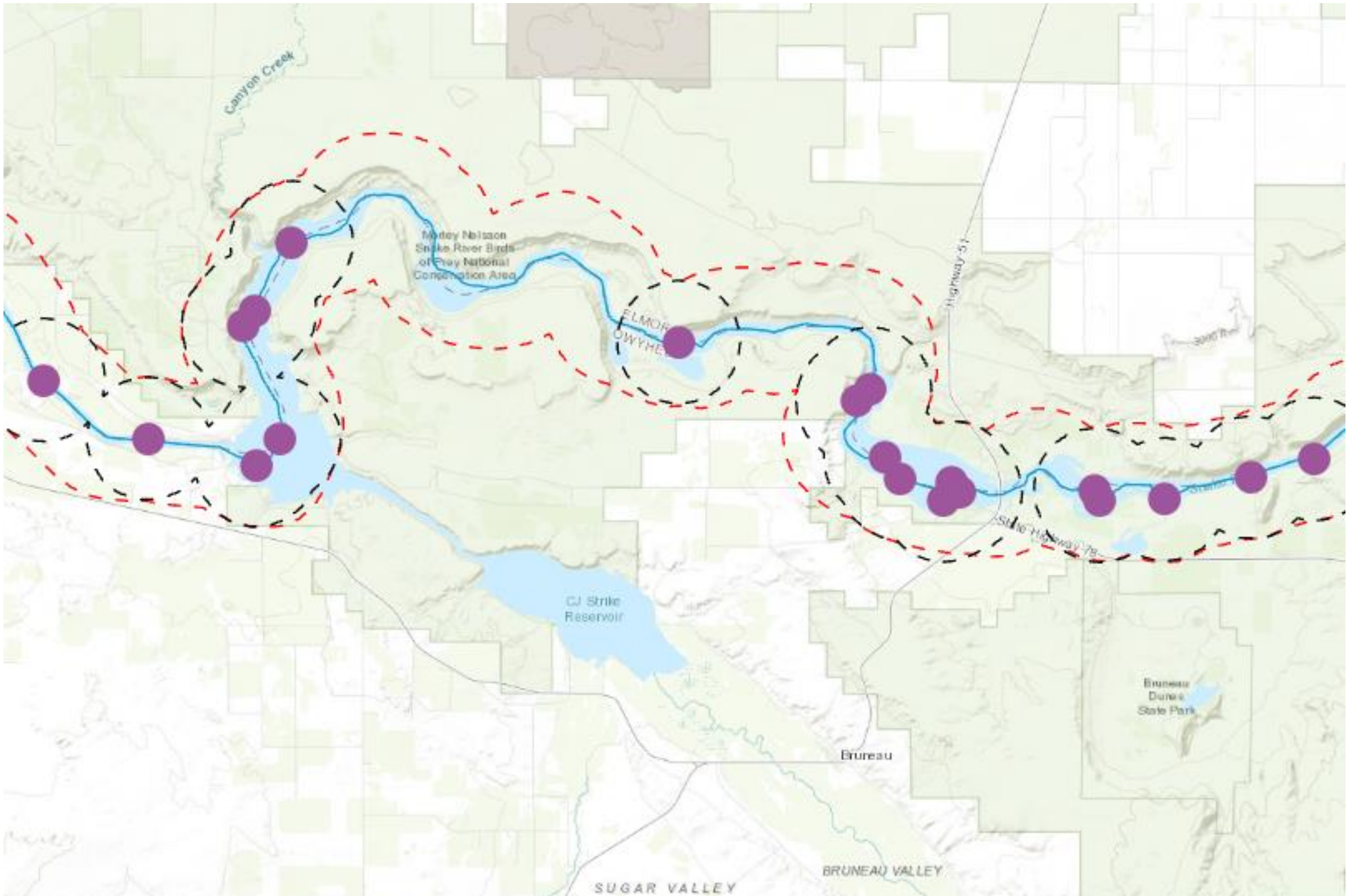

Figure A.5 Map of Island Analysis (C.J. Strike Reservoir)

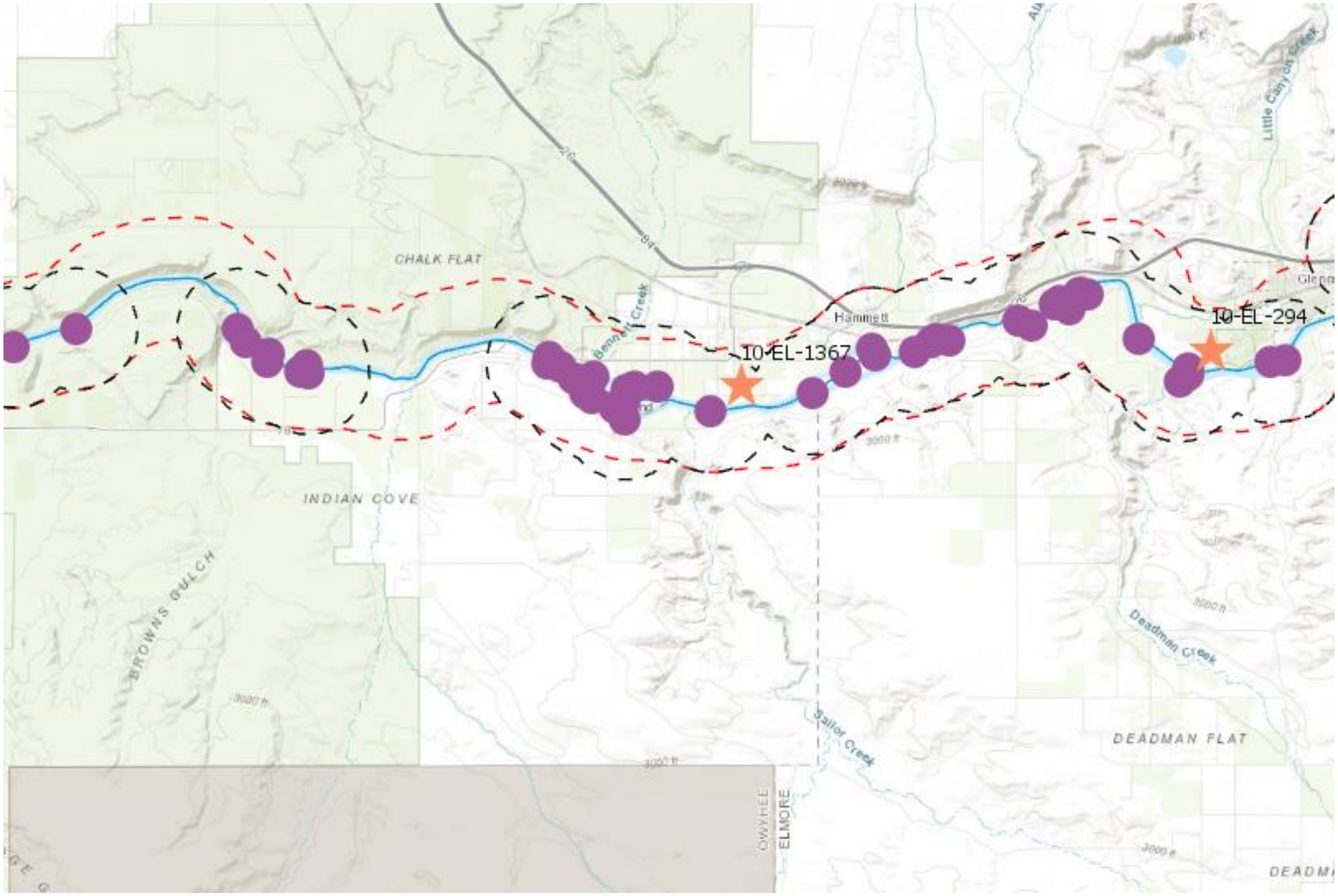

Figure A.6 Map of Island Analysis (Chalk Flat to Three Island Crossing)

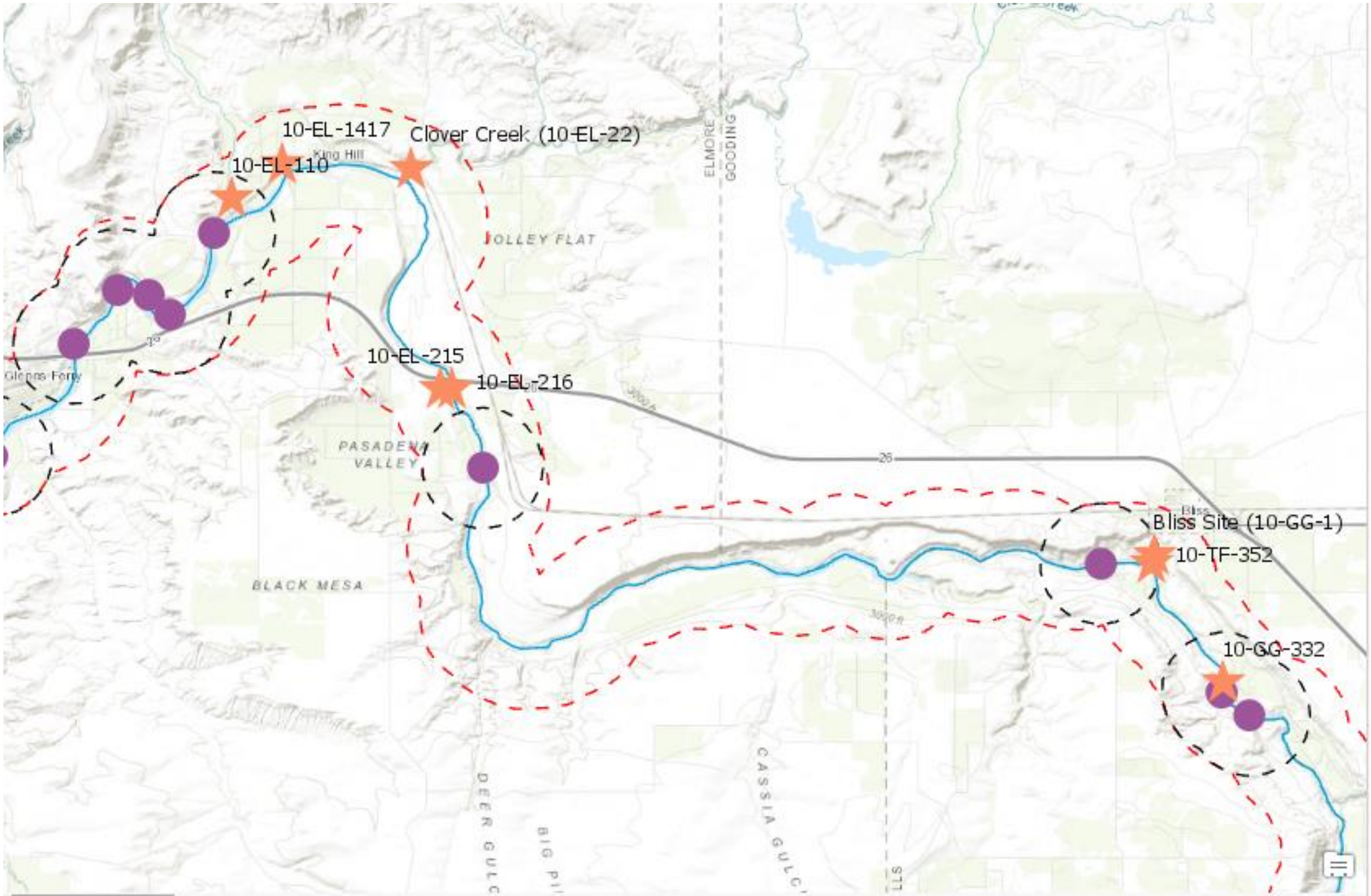

Figure A.7 **Map of Island Analysis (Glenns Ferry to Bliss)**

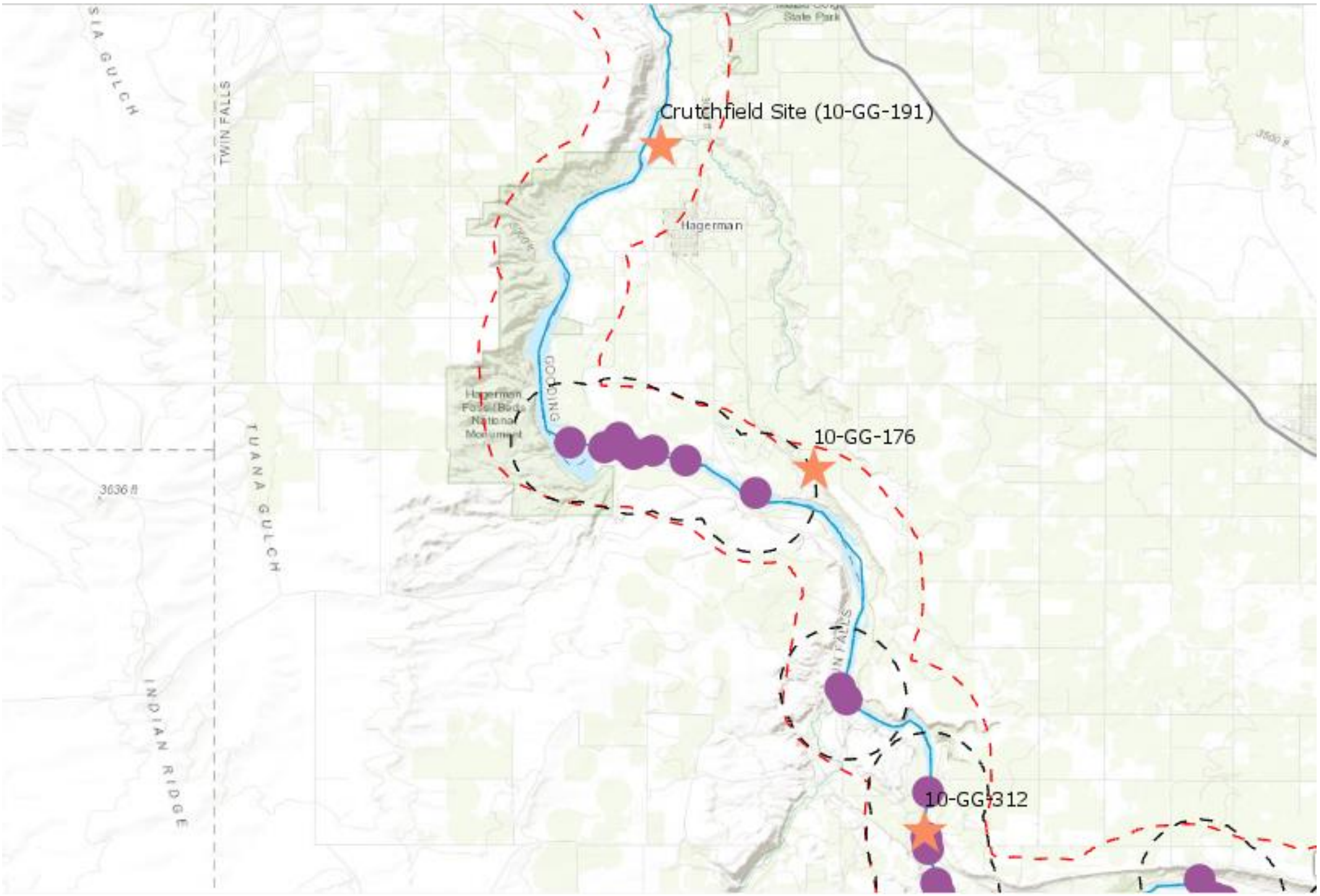

Figure A.8 Map of Island Analysis (Hagerman Valley)

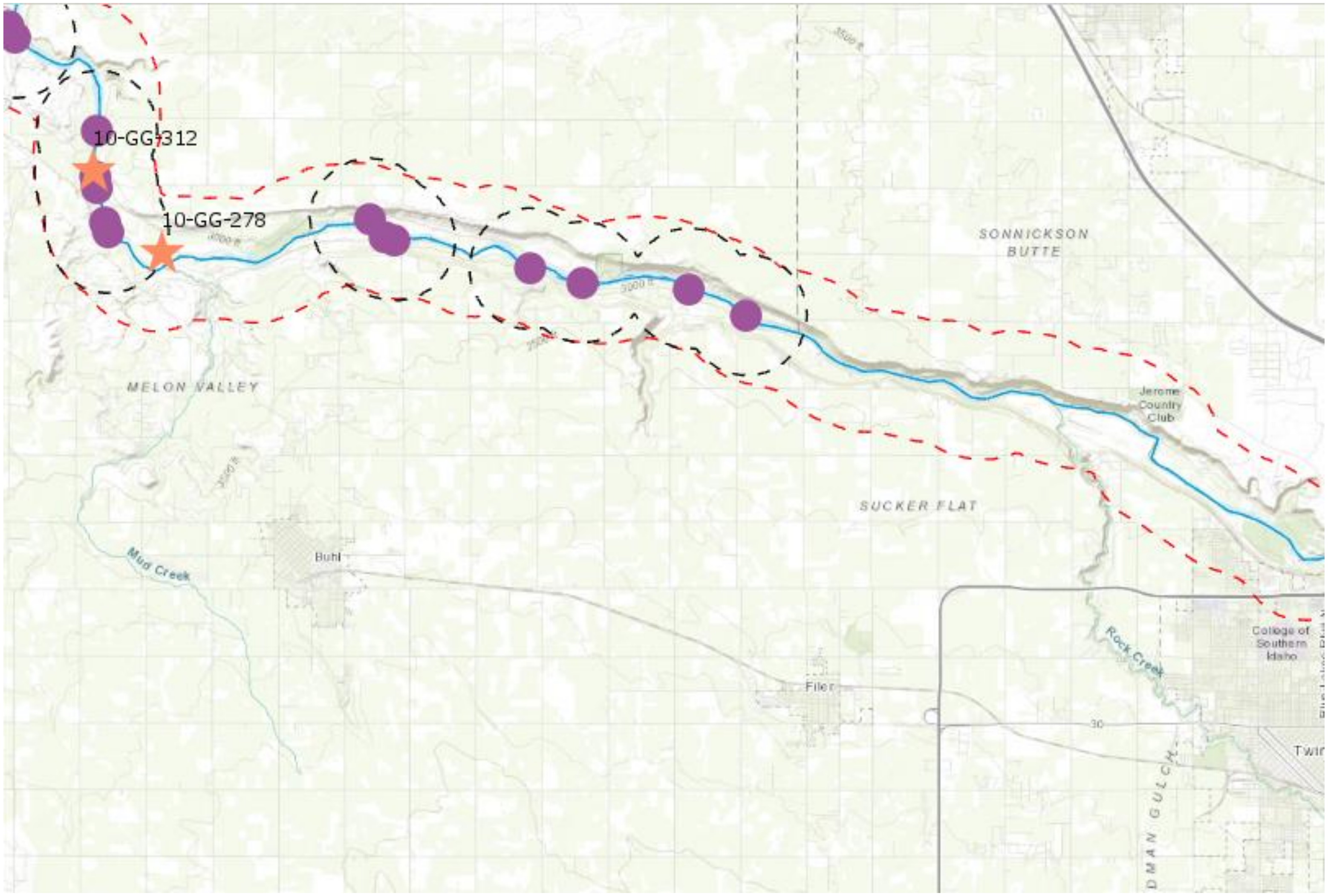

Figure A.9 Map of Island Analysis (Melon Valley)

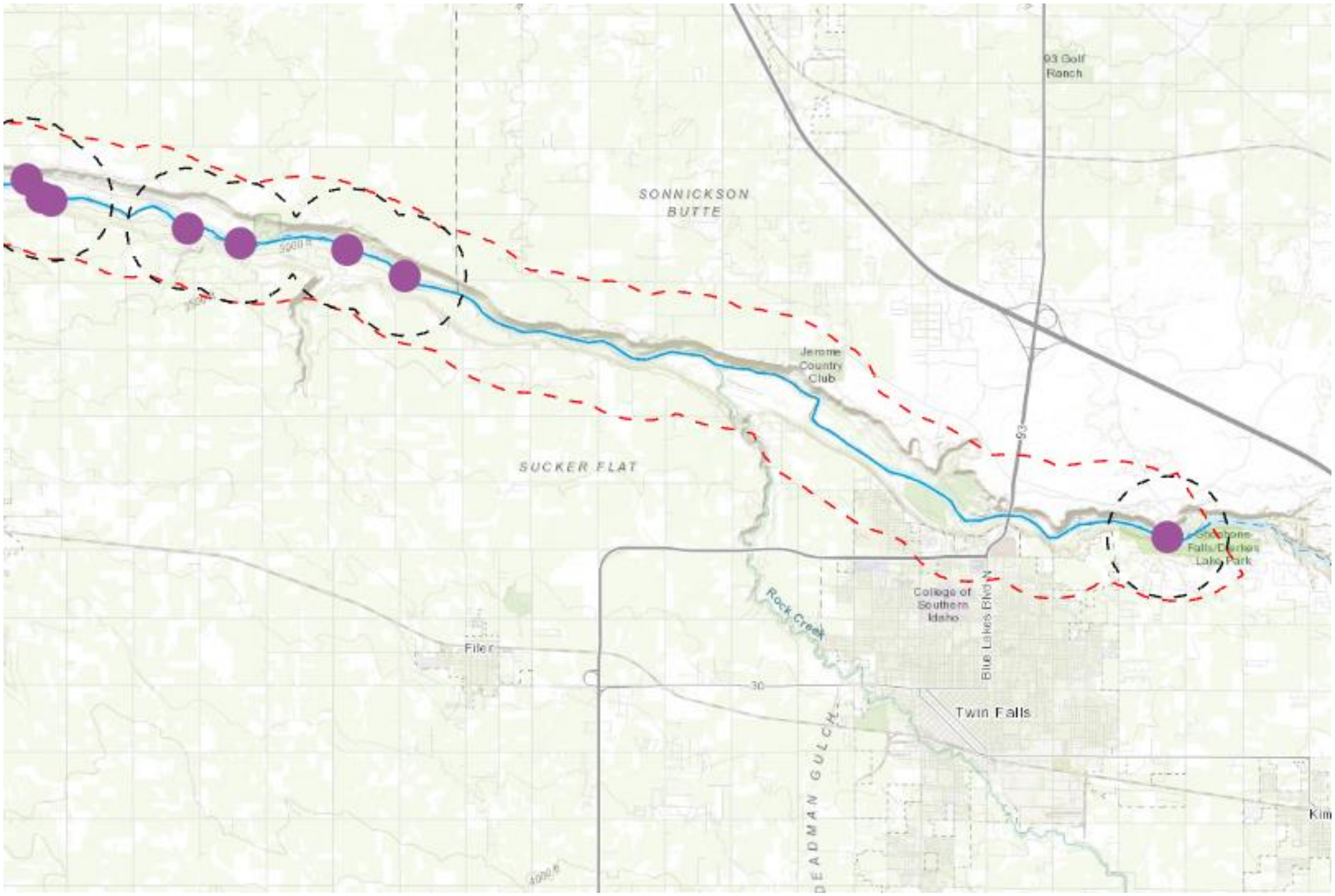

Figure A.10   Map of Island Analysis (Shoshone Falls)

APPENDIX B

Maps of ArcGIS Analysis of the Relationship Between Minimum Channel Width (MCW) and Archaeological Sites

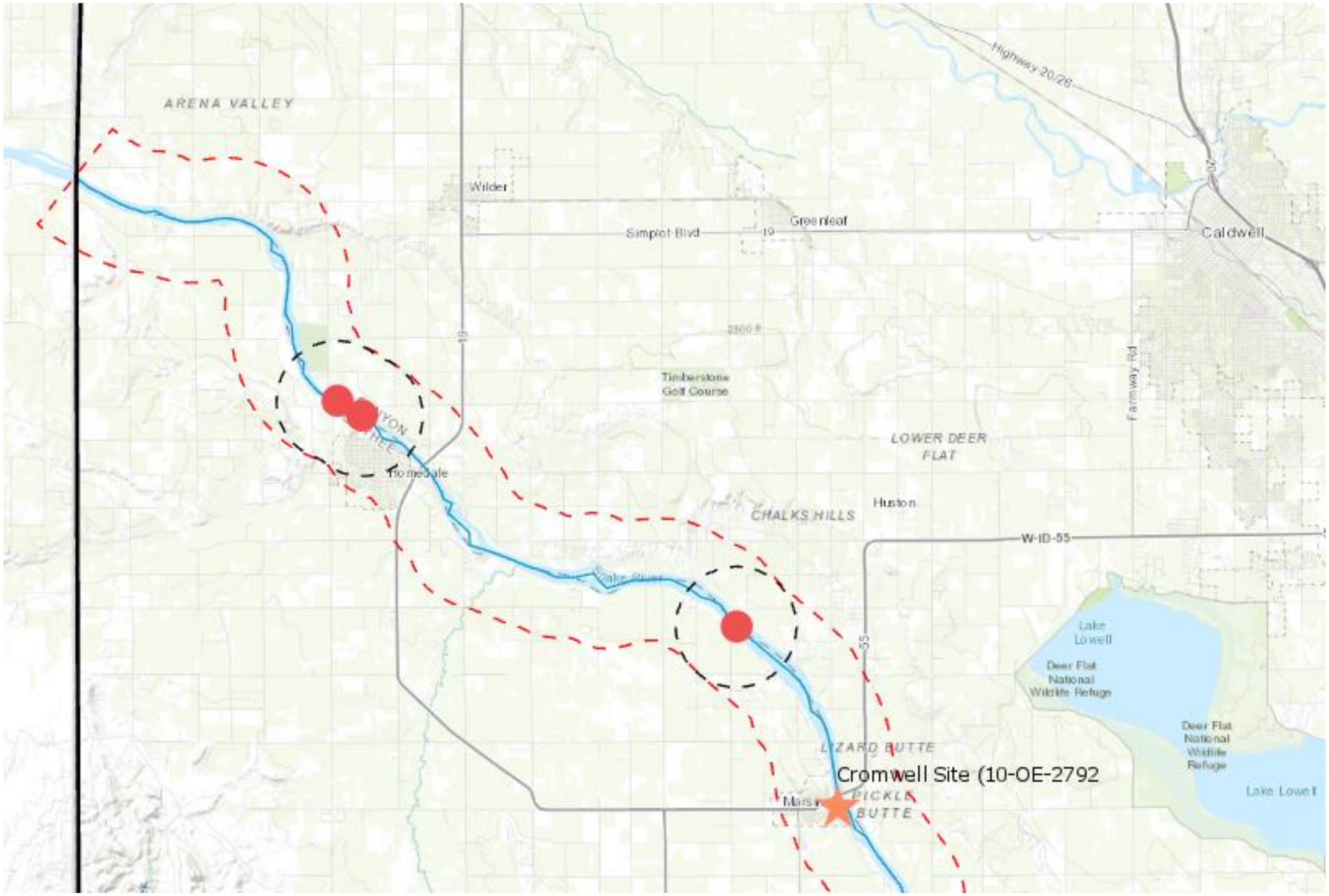

Figure B.1 Map of MCW Analysis (Oregon Border to Marsing)

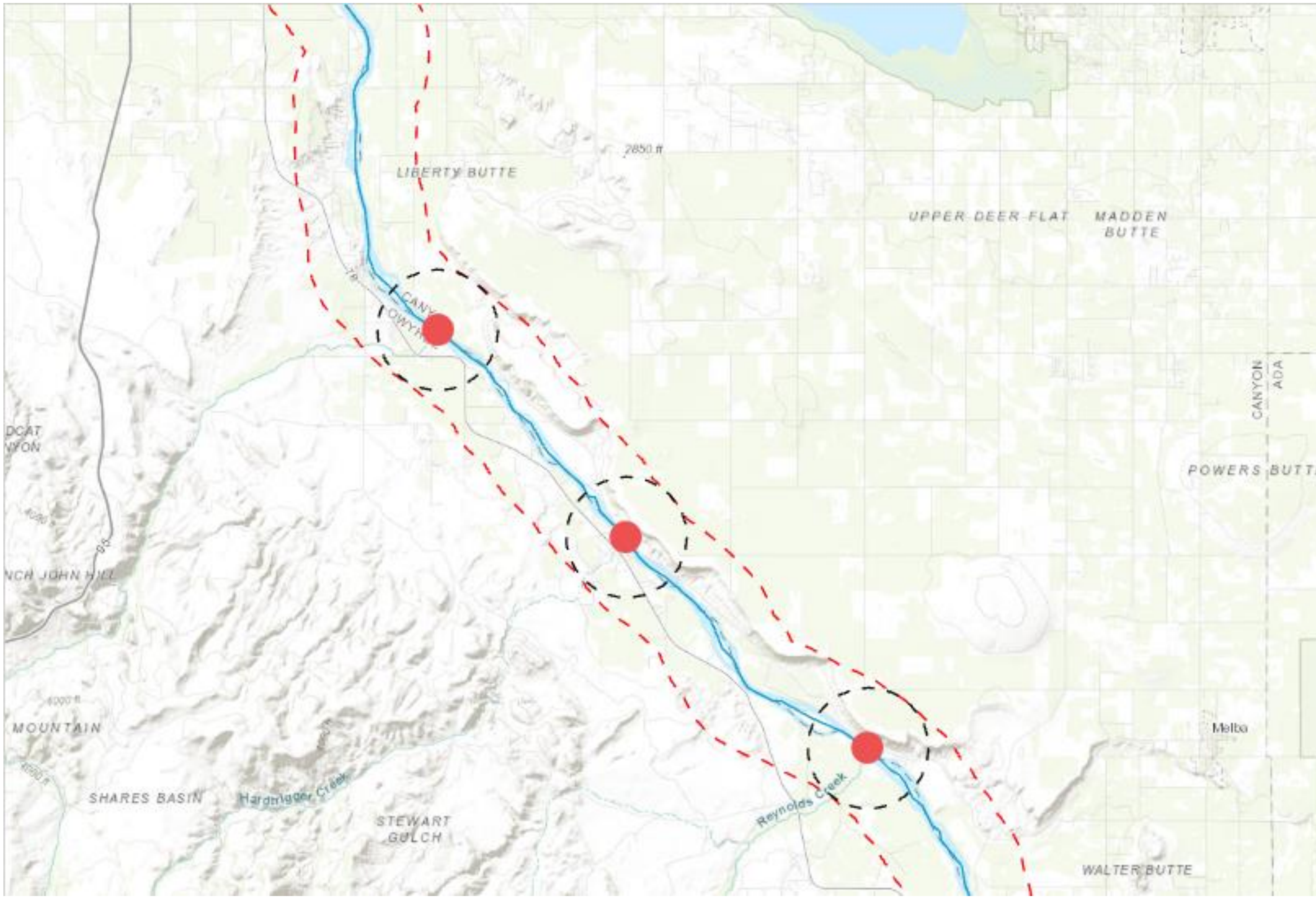

Figure B.2 Map of MCW Analysis (Marsing to White Butte)

Figure B.3 Map of MCW Analysis (Celebration Park to Wild Horse Butte)

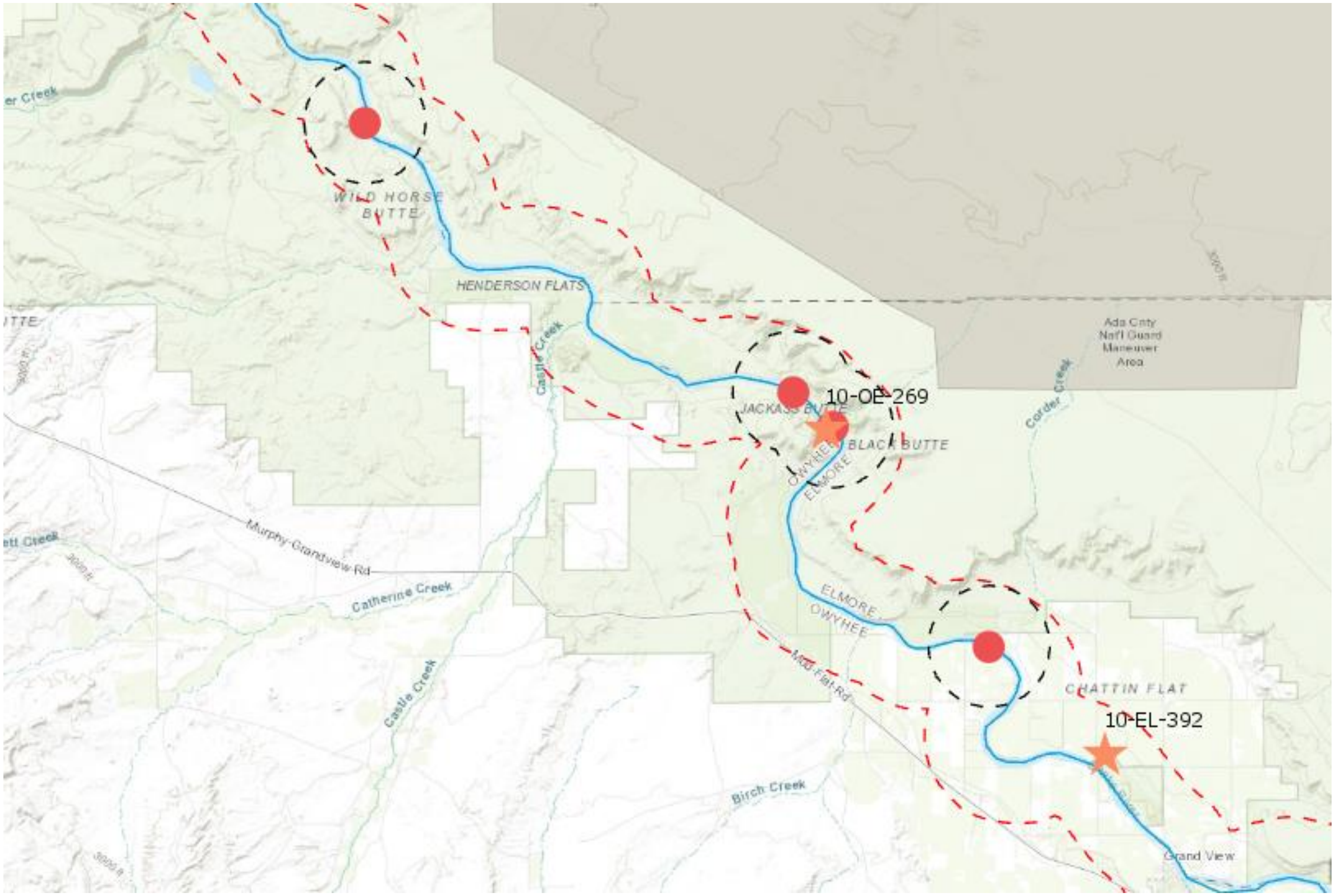

Figure B.4 Map of MCW Analysis (Henderson Flats to C.J. Strike Reservoir)

Figure B.5 Map of MCW Analysis (C.J. Strike Reservoir)

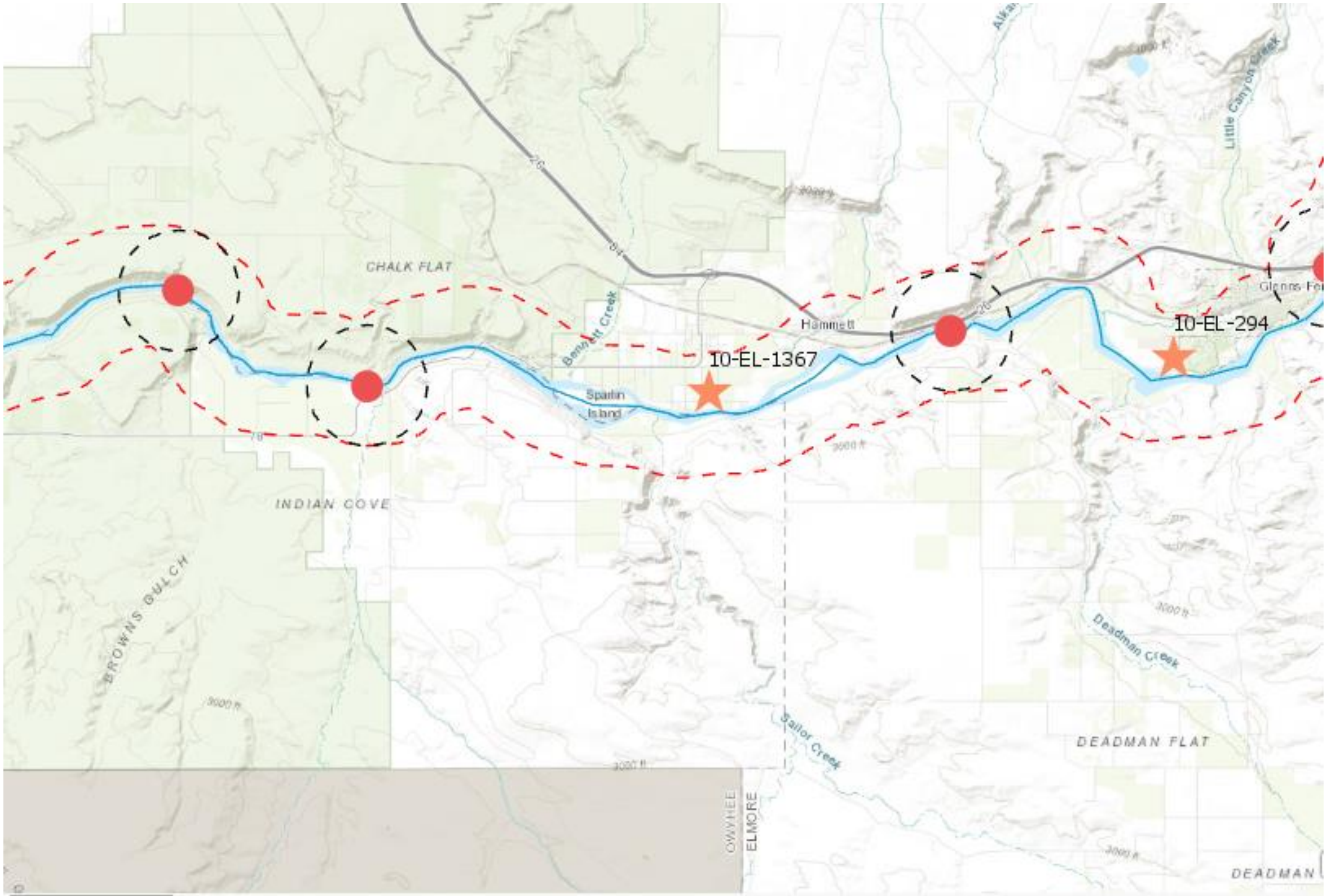

Figure B.6 Map of MCW Analysis (Chalk Flat to Three Island Crossing)

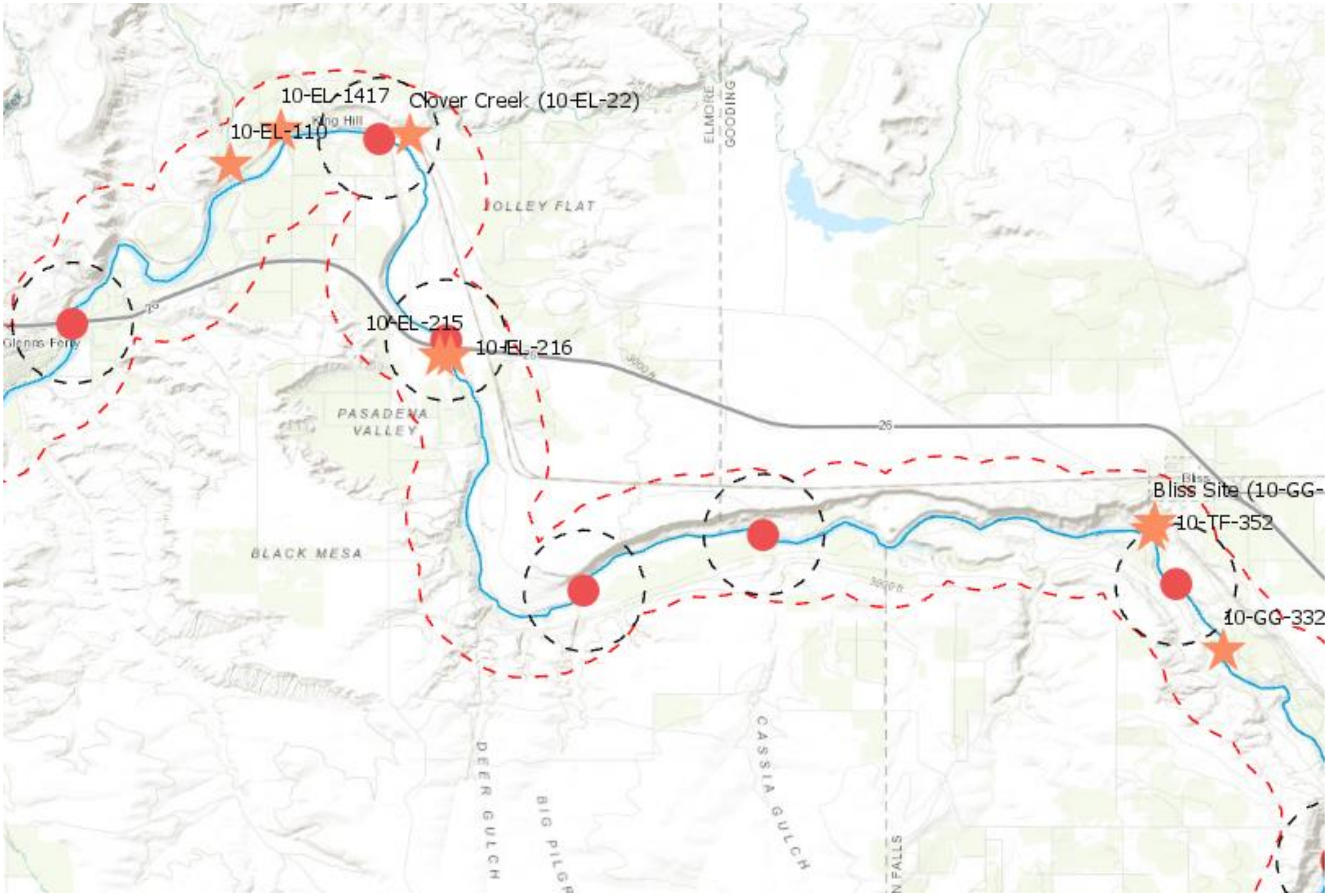

Figure B.7 Map of MCW Analysis (Glenns Ferry to Bliss)

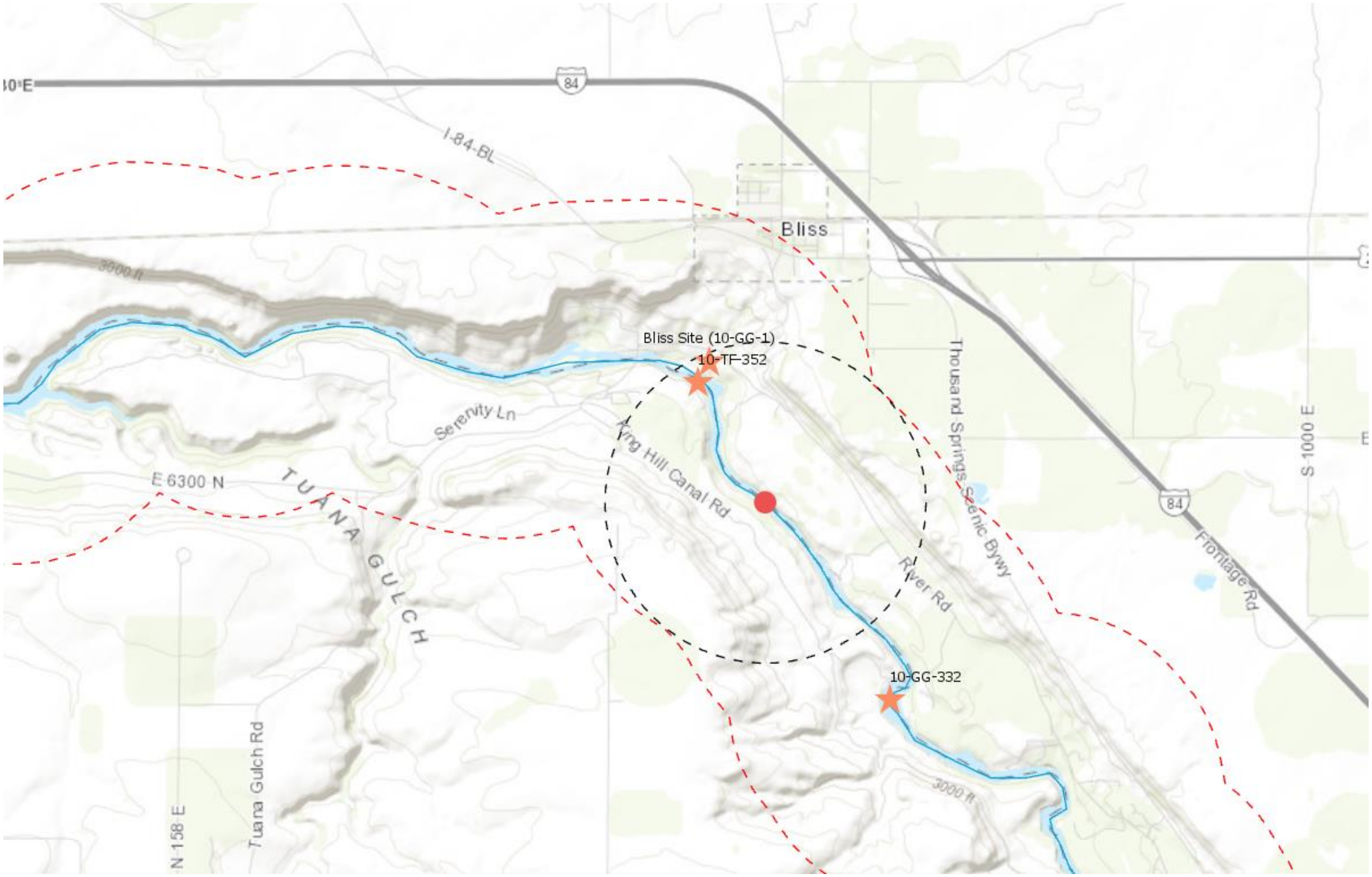

Figure B.8 Map of MCW Analysis (Bliss Site)

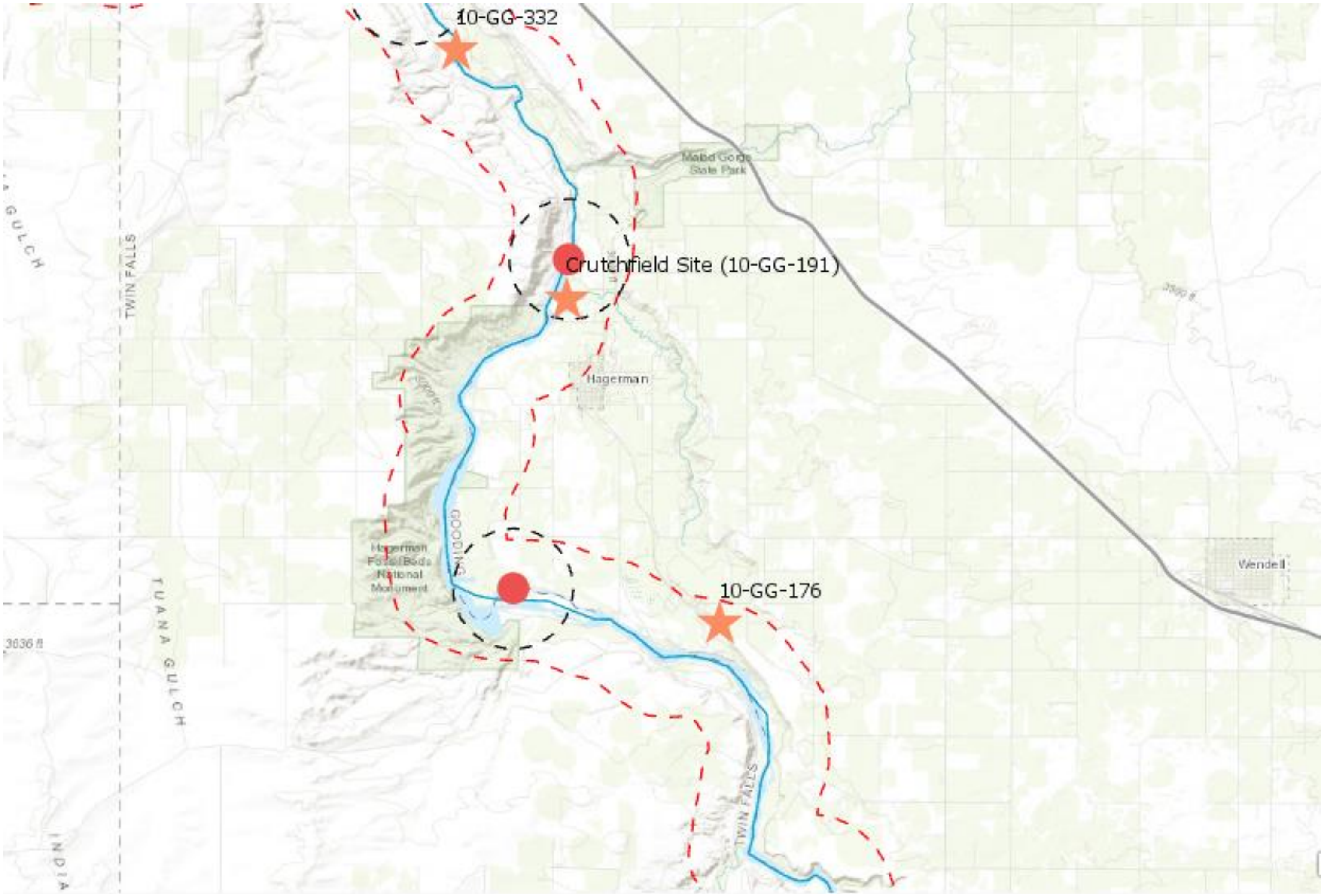

Figure B.9 Map of MCW Analysis (Hagerman Valley)

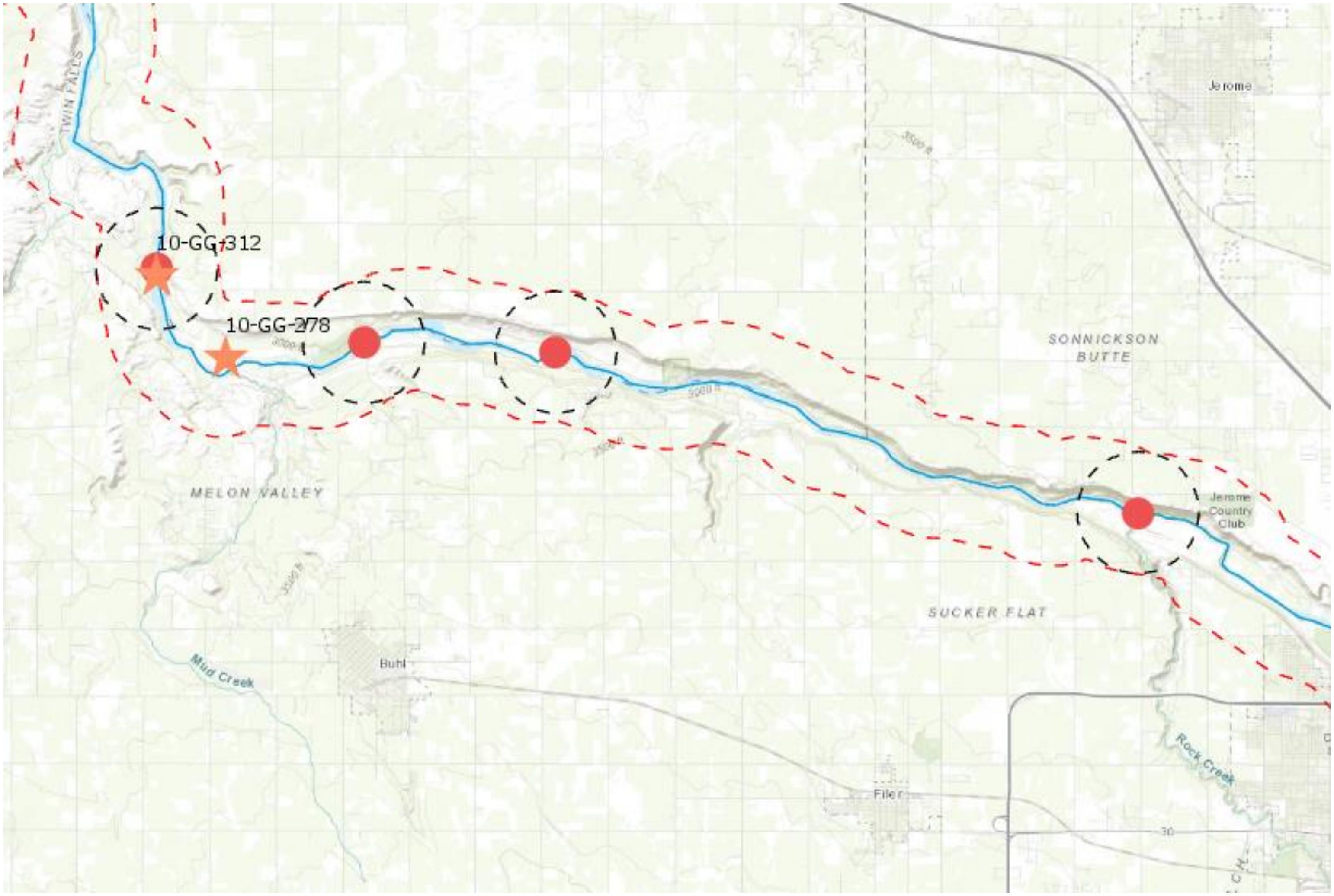

Figure B.10 Map of MCW Analysis (Melon Valley)

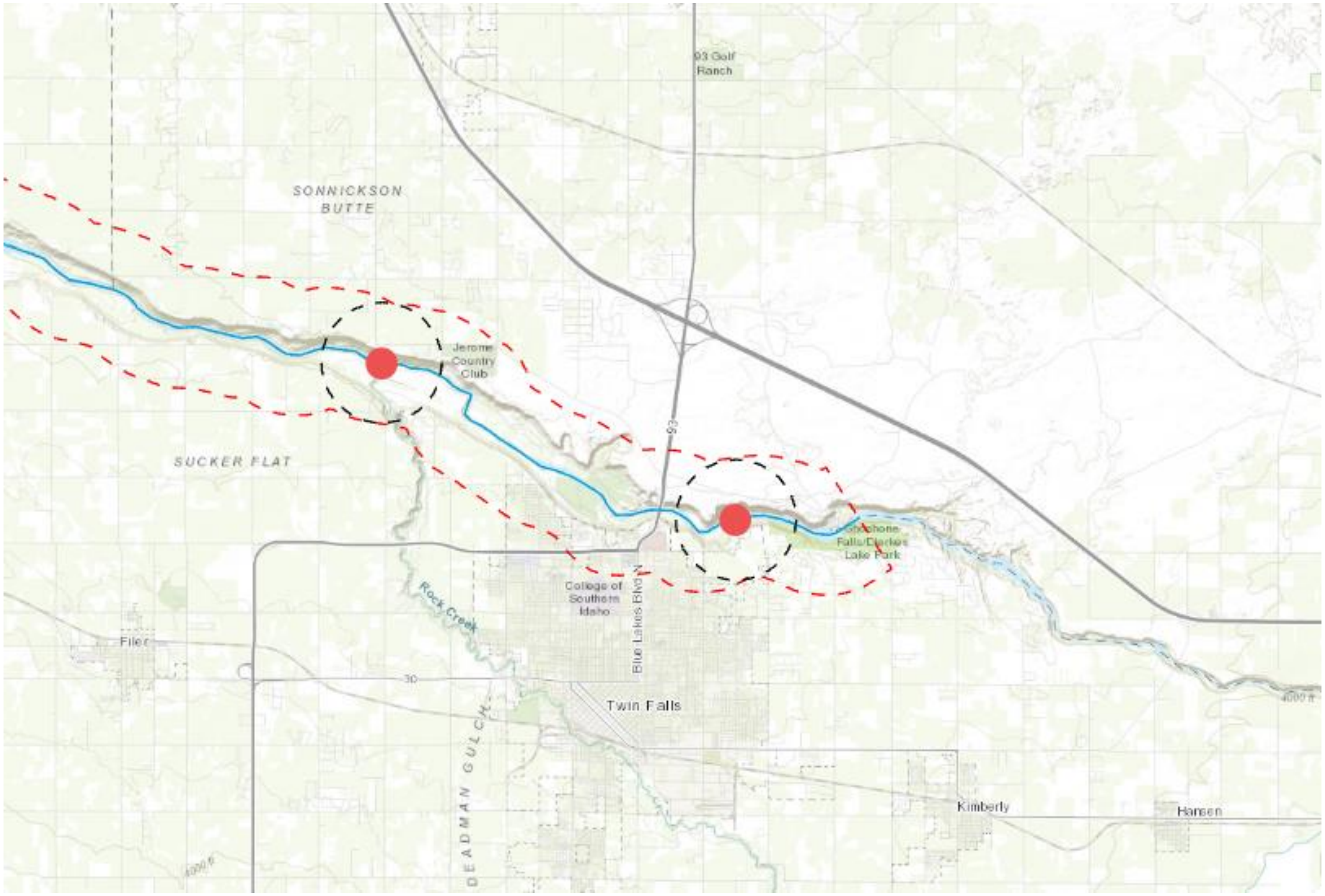

Figure B.11 Map of MCW Analysis (Shoshone Falls)

APPENDIX C

Ethnographic Projections of the Western Snake River Plain and Northern Great Basin

Table C.1 Data from Binford's North American Database

STATION	WHUNTP	WGATHP	WFISHP	UPHUNTP	UPGATHP	UPFISHP	EXNOMOV1	WATD
McDermitt, OR	57.97305	15.89098	26.13596	49.81906	26.75632	23.42463	15.50141	282.0597
Burns Junction, OR	61.64644	13.32425	25.02931	56.66874	25.78224	17.54903	19.10339	216.5765
Orovada, NV	59.80092	24.00488	16.19421	49.10884	34.01218	16.87898	17.9829	395.4517
McDermitt, NV	59.58319	15.2179	25.19891	52.88735	28.34766	18.76499	17.37894	277.5021
Paradise, NV	62.06261	20.37682	17.56057	49.6406	30.51128	19.84812	17.11337	339.4391
Danner, OR	41.01707	28.01803	30.96491	58.26788	28.61441	13.11771	18.73265	327.499
Silver City, ID	41.92663	22.34089	35.73248	45.66187	24.98155	29.35658	10.70125	233.3842
Reynolds, ID	59.02817	20.48134	20.49049	51.58965	27.38391	21.02644	15.29078	313.4163
Kuna, ID	44.30804	29.55737	26.13459	51.8165	30.6185	17.56501	16.20666	401.7666

STATION	WHUNTP	WGATHP	WFISHP	UPHUNTP	UPGATHP	UPFISHP	EXNOMOV 1	WATD
Swann Falls, ID	56.0962	31.18559	12.7182	49.41238	36.24782	14.3398	17.76104	507.3264
Tuscarosa, NV	60.16297	20.32018	19.51686	49.74978	31.37793	18.87229	18.12306	316.5713
Grand View, ID	57.28776	25.36527	17.34697	51.33652	34.46701	14.19647	17.92762	448.4093
Mountain, NV	59.30904	15.86745	24.82352	50.84437	27.25867	21.89696	16.41006	255.8552
Bruneau, ID	41.56407	38.05168	20.38425	49.5987	37.76601	12.63529	17.13695	548.4254
Wildhorse, NV	59.56278	8.467555	31.96967	46.19591	26.23162	27.57247	13.66703	243.3355
Mountain Home, ID	44.017	31.23964	24.74336	48.64842	32.45292	18.89866	15.60574	426.5052
Anderson, ID	42.43259	28.52125	29.04616	45.41077	26.95783	27.6314	10.81276	319.3137
Glenns Ferry, ID	40.32931	43.90819	15.76251	47.13825	37.31059	15.55116	9.733684	519.0237

STATION	WHUNTP	WGATHP	WFISHP	UPHUNTP	UPGATHP	UPFISHP	EXNOMOV 1	WATD
Gibbs Ranch, NV	39.97138	27.23596	32.79266	40.9378	31.23712	27.82509	11.39354	355.7553
Hill City, ID	41.60962	20.76653	37.62385	40.31237	24.74508	34.94254	8.51036	272.4052
Bliss, ID	42.31949	37.49593	20.18458	44.4442	36.55384	19.00196	15.10381	499.8018
Hagerman, ID	39.74297	40.78336	19.47367	48.45057	37.55998	13.98944	10.70483	530.4467
Castleford, ID	59.56244	30.7804	9.657165	48.53745	34.16416	17.2984	17.57481	453.7863
Fairfield, ID	42.17454	20.67858	37.14688	39.48678	24.94519	35.56803	7.529651	283.2222
Buhl, ID	43.92704	36.24207	19.83089	45.80815	35.11623	19.07562	16.00422	456.5586
Contact, NV	60.50119	20.71458	18.78423	53.0777	30.88799	16.03431	16.6936	352.73
Jackpot, NV	60.61932	23.10218	16.2785	51.06136	30.75111	18.18753	16.31498	350.8442

STATION	WHUNTP	WGATHP	WFISHP	UPHUNTP	UPGATHP	UPFISHP	EXNOMOV 1	WATD
Hollister, ID	59.95297	28.41151	11.63552	52.644	31.75173	15.60428	17.63729	400.7907
Jerome, ID	44.05422	37.46354	18.48224	44.95033	35.67812	19.37155	15.43399	477.3771
Twin Falls 1, ID	48.25716	34.58061	17.16223	47.75481	34.42716	17.81802	16.95077	442.2279
Shoshone, ID	44.52514	38.34675	17.12811	43.39442	36.77698	19.8286	15.48698	504.864
Twin Falls 2, ID	60.0232	30.72935	9.247457	48.3517	34.39442	17.25388	17.09276	453.8699
Richfield, ID	43.51678	26.93474	29.54848	45.34191	27.86668	26.79141	12.07148	339.265
Hazelton, ID	44.11973	37.32809	18.55218	45.00787	35.17372	19.8184	15.33021	461.3323
Picabo, ID	43.11882	20.48855	36.39263	43.22159	25.1163	31.66211	9.779838	278.4638
Oakley, ID	60.70907	27.17344	12.11749	53.94035	29.71936	16.34029	17.19589	364.0557

STATION	WHUNTP	WGATHP	WFISHP	UPHUNTP	UPGATHP	UPFISHP	EXNOMOV 1	WATD
Grouse Creek, UT	61.56484	19.52545	18.90972	51.40747	29.81621	18.77632	15.67524	345.2901
Paul, ID	60.55186	30.05899	9.389149	47.95983	33.66268	18.37749	16.84682	434.1931
Burley, ID	60.51391	31.53505	7.95104	51.16563	34.58028	14.25409	18.86445	461.6786
Rupert, ID	60.31642	29.6928	9.990781	49.77958	32.57194	17.64849	17.56709	417.2471
Craters of the Moon, ID	60.75731	13.0641	26.17859	47.20212	25.23614	27.56174	11.03993	267.3296
Minidoka, ID	60.885	30.39343	8.721562	47.32415	34.15869	18.51716	16.82345	450.0162
SAMPLE MEAN	**52.17624**	**26.80155**	**21.0222**	**48.4609**	**31.28499**	**20.25411**	**15.20989**	**381.5574**

APPENDIX D

Middle Snake River Archaeological Site Descriptions

10-CN-1

The site is located on the western edge of the Birds of Prey National Conservation Area, 0.25 miles west of the historic Guffey Railroad Bridge on the north side of the Snake River (Sayer et al. 1999). Recovered items of relevance to this study included projectile points (for dating occupations) and faunal remains (for identifying activities). Of the 869 total faunal specimens, 168 were classified as fish which were recovered from all but 3 units (Sayer et al. 1999). The evidence for fishing is minimal, though. Osteological analysis showed that only 22% of the species represented in the assemblage were fish, with artiodactyl and small mammals making up a much greater percentage, 33% and 15% respectively (Sayer et al. 1999). The fish remains that are present are Salmonidae, but relatively small and likely whitefish or trout (Sayer et al. 1999). In addition, of the c. 2500 mussel shell or mussel shell fragments, only 13% are charred, compared to 77% of bone or bone fragments (Sayer et al. 1999).

The rationale for inclusion in this analysis, though, is restricted to its proximity to the river and the evidence of a Late Archaic occupation. The site includes Desert Side-Notched, Cottonwood Triangular and Rose Spring projectile points (n=11), which indicate a Late Archaic timeframe (Sayer et al. 1999). It is also possible that the site was utilized recently during the early 19th century due to the recovery of a pastel blue glass trade bead (Sayer et al. 1999).

10-CN-5

The site is located at Celebration Park east of the historic Guffey Railroad Bridge. Test excavations in 1997 revealed fish remains (n=24) that appear to be sucker and trout (Huter et al. 2000). Bliss and Rose Spring Side-Notched points, along with Shoshoni pottery, indicate Late Archaic occupations, though the site appears to consist of repeated occupations during the past 3,000 to 4,000 years (Plew 2016).

10-CN-6

The site is located 50 meters from 10-CN-5 on the north side of the Snake River (Plew 2016). Four seasons of field work produced 375 artifacts from a diverse range of functional categories and similar numbers of artifacts within each category: projectile points and projectile fragments (n=26), potsherd (n=37), modified flakes (n=27), bifaces (n=26), etc. (Plew et al. 2006). Like 10-CN-1 and 10-CN-5, the site suggests hunting, gathering, and fishing, as well as on-site processing (Plew 2016). The evidence for fishing was faunal remains (n=27) that represented a MNI of no more than nine individuals.

Late Archaic occupations are indicated by projectile point type (Desert Side-Notched and Rosegate), pottery sherds in the upper strata, and a radiocarbon date of 650 ± 40 B.P. (BETA-197310) from a small hearth (Plew 2016).

Schellbach Cave (10-OE-240)

The site lies within a cave near the Snake River Canyon on the south side of the river 10 miles downstream from Swan Falls Dam (Plew 2016). The 1929 excavation by Louis Schellbach, the first systematic excavation in Idaho, produced a cache of fishing gear that remains the most complete collection yet found in the region (Plew 2016). The gear includes fishing line, a wooden spear, matting, a fishhook, net sinkers, and harpoon points (Schellbach 1967). Whether this was a fishing station (Schellbach 1967), an “important” fishing station where salmon was cached (Pavesic et al. 1987: 25), or a site that served various functions, the presence of Late Archaic fishing technology and the location of the site are cause for its inclusion in the sample.

Cromwell Site (10-OE-2792)

The Cromwell site appears to have been a mussel-collecting station located on the Snake River near Marsing, Idaho. Along with mussels (n=500-600), all of which were of the species *Goneidea angulata*, an Eastgate point was documented (Huntley 1988). There was no evidence of fish remains or fishing gear of any kind.

10-AA-17

The site is located near Swan Falls in the Snake River Canyon. Twenty test units excavated between 1981 and 1983 produced 1,516 fish remains and four otoliths (Ames 1983). A Late Archaic structure, likely the remains of a burned wickiup, was situated at a depth of 150 to 170 centimeters with a 3-meter diameter and high concentrations of fire-cracked rock in association with macerated deer bones (Ames 1983). Based on radiocarbon samples, the dates of use of the structure range from 650 ± 60 B.P. (Beta-3901) to 2,310 ± 70 B.P. (TX-4509) (Ames 1983).

10-AA-188

The site is located on the north side of the Snake River nearly three miles downstream from Swan Falls Dam in the Birds of Prey National Conservation Area (Sayer et al. 1996). It lies in a small basalt rock shelter. Excavations in 1995 produced some evidence that fishing may have occurred. Fish remains of the Catostomidae, Cyprinidae, and Salmonidae families were recovered, accounting for six of the total number of identifiable fish remains (n-20) (Sayer et al. 1996: 47). A net sinker was also found at a depth of 40-50 cm (Sayer et al. 1996: 37).

Early occupations is suggested by two Humboldt Points recovered from a depth of 90-130 cm, but later occupations are assumed based on cultural material found at a more shallow depth and the projectile point types of nearby sites such as 10-AA-12 (e.g., Desert Side-Notched) and 10-AA-14 (e.g., Rosespring) (Sayer et al. 1996).

<u>10-AA-306</u>

The Midden Site (10-AA-306) is located near Halverson Bar Road south of Melba on the north side of the Snake River. A 1988 excavation (Willig 1989) produced evidence of salmon, non-salmon, and freshwater mussels. Further excavation in 1991 by Idaho State University expanded the horizontal size of the site, and both excavations identified five Late Archaic occupational zones (Plew 2016). The range of radiocarbon dates is from 270 ± 70 B.P. (WSU-3775) to 1770 ± 70 B.P. (WSU-3777); and projectile point types include seven Desert Side-Notched points and two Rosegate points (Plew 2016).

<u>Clover Creek Site (10-EL-22)</u>

The site is approximately 3 km east of King Hill, Idaho on a terrace 50 meters north of the Snake River and 200 meters east of the confluence of the Snake and Clover Creek (Plew and Gould 1990). The site was impacted by mining activity and pot hunting as evident from numerous potholes and historic debris at the time of the 1988 excavation (Plew 2016). The site had previously been identified as a possible major fishing site, as well as a Fremont occupation (Butler 1982), neither of which were supported by the 1988 excavation (Plew and Gould 1990). Only 22 specimens of fish remains were recovered in 1988 (Plew and Gould 1990); along with an unspecified but limited number reported by Delisio (1981).

The site suggests Late Archaic occupations based on five obsidian hydration readings that indicate occupations between A.D. 1013 ±36 years and A.D. 1187 ±31 (Plew and Gould 1990: 10). The material culture of pottery specimens and Late Archaic projectile point types, similar to that of other nearby sites, indicates such occupation as well (Plew and Gould 1990: 11).

10-EL-110

10-EL-110 lies on a terrace on the north side of the Snake River near King Hill Creek. A 2006 excavation by Boise State University Field School recovered fish remains (n=181) (Willson and Plew 2007). This included 175 caudal vertebrae, three thoracic vertebrae, four fragmentary head parts, and one otolith. The vertebrae, and otolith were salmonid, and the large size of vertebrae (1.2-1.7 cm diameter) suggests either Chinook salmon or large steelhead trout (Willson and Plew 2007). Remains of freshwater mussels were also recovered throughout the site.

A Late Archaic occupation is suggested by the presence of certain projectile point types (e.g., Desert Side-Notched) and of Shoshoni pottery sherds (Willson and Plew 2007).

10-EL-215

10-EL-215 is located on the south side of the Snake River on a large open terrace about four miles upstream from the Clover Creek Site (Plew and Willson 2013). A single salmon vertebra was recovered along with 182 freshwater mussel remains (Plew and Willson 2013). The primary activity seems to have been hunting deer (NISP=22) and rabbits (NISP=3), similar to nearby sites (Plew and Willson 2013). A Late Archaic occupation is suggested based on the presence of Desert Side-Notched points.

10-EL-216

The site is located to the east of 10-EL-215. Original excavations recovered a house pit feature, weirs, an Eastgate projectile point fragment, and pottery (Butler and Murphy 1982). A later excavation by the Boise State Archaeology Field School (Plew and Willson 2010) found that the housing feature was likely historical, though stacked rock features may have been associated with weirs or fishing traps (Pitkin 2010).

10-OE-269

Bonus Cove Ranch (10-OE-269) is located 15 km north of Grandview, Idaho on a steep embankment on the west side of the Snake River (Plew 2016). The site appears to have been mostly a fishing and mussel collecting site, with a 90-cm diameter feature associated with historic era activity (Yohe and Neitzel 1999). Nearly 57.9 g of mussel were recovered, including both *Margaritifera falcata* (MNI=1) and *Goneidea angulate* (MNI=3); as well as fragments of fish bones and five otoliths identified as Chinook salmon (Plew 2016). Bliss points place the site within a Late Archaic time period, regardless of radiocarbon data from a mussel shell which suggested a date of 3630 ± 70 B.P. (Beta-75710) (Yohe and Neitzel 1999).

10-OE-277

The site is located 5 km downstream from Swann Falls on a terrace on the west bank of the Snake River. The site is included in this study based on the presence of Late Archaic small side-notched projectile points and a possible fish wall in the river that is 20 meters long (Murphy 1977). Pitkin (2010) notes the presence of rapids adjacent to the site.

<u>10-EL-294</u>

Three Island Crossing is situated on the north side of the Snake River near the Three Island Oregon Trail crossing. Original excavations in 1986 and 1987 identified two major activity areas (Plew 2016). This site contains the largest number of individual fish remains, with over 19,000 documented (Gould and Plew 1996). These included Chinook salmon (*Oncorhynchus tshawytscha*), suckers (*Catostomus columbianus*), squawfish *(Ptychocheilus oregonensis*), and sturgeon (*Acipenser transmontanus*). Subsequent excavations in 2009, 2013, and 2018 have found further faunal evidence, but most of the cultural material is clustered in the two main areas that were originally excavated in the late 1980's (Eastman 2011; Wardle 2018).

Two storage pits were documented: Features 7a and 7b, as was Feature 5, a residential structure of particular interest; though no drying or storing facilities were documented (Gould and Plew 1996). Similarly, no fishing gear was documented.

Radiocarbon dates (e.g., 970 ± 330 B.P. (TX-5723), 970 ± 60 B.P. (TX-5724)), as well as pottery, place the occupations within the Late Archaic (Plew 2016). Projectile point types included Desert Side-Notched, Eastgate, Rose Spring, Cottonwood, and Bliss (Plew 2016).

<u>10-EL-392</u>

The site is located two miles west of Grandview, Idaho on the north side of the river. The evidence for use of fish as a resource included 101 fish remains (Plew 2016). In addition, 1200 mussels shell fragments were recovered. As with many other sites in the sample, a Late Archaic time frame is suggested by the presence of pottery sherds and projectile point types that include Desert Side-Notched, Rose Spring, and Eastgate (Plew 2016)

Medbury Site (10-EL-1367)

The site is located southeast of Hammett, Idaho and northeast of the old Medbury Ferry Crossing, on a terrace 40 m north of the Snake River (Plew and Willson 2005). Based on fish remains, a minimum number of individuals was established for salmon (N=22) and castomids (N=1) (Plew and Willson 2005). The presence of 12 Intermountain Gray Ware ceramic specimens and 4 Desert Side-Notched projectile points suggests a Late Archaic occupation (Plew and Willson 2005).

10-EL-1417

The Swenson site (10-EL-1417) is located on a terrace on the north side of the river near King Hill, Idaho. The evidence for fishing includes faunal remains which are probably salmon based on the size ranges of caudal vertebrae (Plew 2016). A Late Archaic occupation is suggested by the documentation of pottery sherds and projectile point types, as well as by a radiocarbon date obtained from a composite bone sample taken from the lower level of the 2016 excavation: 590 ± 30 B.P. (Beta-476562) (VanWassenhove et al. 2018).

Bliss (10-GG-1)

The Bliss site is located in the Eastern Hagerman Valley on a large terrace below the town of Bliss on the north side of the river and was excavated in 1980 as part of a proposed dam project (Plew 1981). Three of the four cultural components are Late Archaic and the fourth is Protohistoric (mid-17th century) (Plew 1981). The 1980 excavation recovered 528 fish remains, 95% of which are salmonid (Plew 1981).

Radiocarbon dates range from 1140 ± 120 B.P. (RL-1500) to 300 ± 110 B.P. (RL-1498) (Plew 1981). Further evidence of the time frame of occupations includes pottery (n=421) and Rosegate, Desert Side-Notched, and Elko projectile points. Some Early Archaic types found in the assemblage could possibly be knives which resemble Early Archaic types (Plew 2016).

10-GG-176

The site is located at the Hagerman National Fish Hatchery along Riley Creek and was excavated as part of an expansion of the hatchery in 1979 (Plew 2016). The test units produced 14 features (including rock features, red stained earth, a shell lens, and a storage pit with mortars), Shoshoni Ware pottery and Rosegate projectile points (Pavesic and Meatte 1980). However, no fish remains, fishing gear, or fish processing facilities were recovered (Pavesic and Meatte 1980). Further excavations in 1980 and 1981 by Eastern Washington University found one possible salmon vertebra and more evidence of Late Archaic projectile types (i.e., Desert Side-Notched (Landis and Lothson 1983)).

The authors of the report on the original 1979 excavation argued that some features represented living surfaces consistent with the prehistoric village hypothesis that hinged on the focus of storage of salmon. However, the material culture and faunal remains suggest a short-term use of the location for a variety of purposes (Plew 2016); no further housing structures were found during the later excavations by Eastern Washington University (Landis and Lothson 1983).

Crutchfield Site (10-GG-191)

The site is located on Billingsley Creek in the northeastern corner of the Hagerman Valley. It is the only site in the Hagerman Valley to have evidence of Early to

Late Archaic occupations (Plew 2016). The most recent assemblage includes a number of notched net weights (n=15), perforated net weights (n=3) and fish remains (NISP=7) (Murphey and Crutchfield 1985). The projectile point types documented include Desert Side-Notched, Eastgate, and Bliss, which supports a Late Archiac time frame for the most recent occupation.

10-GG-278

The site is located just above the head of Kanaka Rapids. Test excavations in 1983 showed minimal evidence for fishing, with only three individual fish remains documented (two trout and one minnow) (Butler and Murphey 1983). Evidence for a Late Archaic occupation relies on the presence of Rose Spring projectile points.

10-GG-312

The site is located on an island 5 km upstream of Salmon Falls Creek. At the southern point of the island is a stone fish weir that protrudes west into the river channel (Murphey 1985). A Late Archaic occupation is suggested by the presence of pottery and Desert Side-Notched projectile points (Murphey 1985).

10-GG-332

The site is located on an island that is positioned 4 km downstream of Malad River. The site consists of an alignment of river cobbles that may have been used as a trap for fish (Miss and Campbell 1988). There is no evidence to establish a date for construction or use of the trap, but the site remains in the sample due to its use in Pitkin's (2010) study.

<u>10-TF-352</u>

The site is located opposite the Bliss site on the south side of the Snake River. The site may be contemporaneous with the Late Archaic occupations at Bliss (Plew 2016). Evidence for fishing included 65 salmonid and 4 castomid remains (Plew 1981). The evidence for its occupational time frame includes the presence of pottery sherds (n=16) and projectile point types typical of Late Archaic sites (e.g., Eastgate, Rosegate, and small side-notched points) (Plew 1981).