CHAPTER 2
UPPER COLUMBIA RIVER LITHIC TECHNOLOGY AND PREHISTORIC FISHING IN THE INTERMOUNTAIN WEST

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ABSTRACT
Prehistoric North American fishing is usually inferred from fish remains. Identifying durable lithic tools would increase our sample size of fishing sites but the diversity of fish processing lithic tool forms makes them difficult to identify archaeologically. The apparent lack of fishing tools in sites compared to abundant ethnographic references has been attributed to intensification of Native fishing activity resulting from Euro-American colonization. This study uses ethnographic data and known fishing tools from Kettle Falls on the Upper Columbia River to identify regular, archaeologically observable characteristics germane to all fish processing tools. We conclude that certain characteristics of fishing tools can be predicted, but multifunctionality blurs diagnostic characteristics. Investigating Native American fishing intensification in response to resource pressure from Euro-American immigration will require evidence for terrestrial hunting and gathering as well as aquatic resources.

DISCERNING FISHING ACTIVITY IN THE ARCHAEOLOGICAL RECORD
Prehistoric fishing activity is usually inferred from anatomical remains of fish (bones and other anatomical structures such as otoliths [Belcher 2009; Butler and O' Connor 2004; Cressman et al. 1960; Graesch 2007; Prentiss et al. 2012]) and, if the depositional environment allows, remains of fish procurement technology (e.g., hook-and-line, nets and sinkers, weirs, and dams [Lindström 1996; Lyons, in press; Lubinski 2000]).

Relative frequencies of these largely organic items are often used to infer changes in the proportion of fish in the diet. However, depositional environments of western rivers are characterized by acidic soil, erosion, wave action, currents, and dynamic stream and terrace structural morphology. These influence the attrition rate of organic materials and can result in under-representation in the archaeological record (Cannon 1996; Chance et al. 1977; Graesch 2007). In larger rivers, deterioration of archaeological organics has been accelerated by dam construction and reservoir operations.

Relying primarily on organic fish remains to infer past human behavior, cultural systems, and cultural evolution can lead to conflicting or ambiguous conclusions. For example, salmonid remains at Snake River archaeological sites have been used to argue a strong focus on salmon at odds with ethnographic reports (Plew and Guinn, in press). On the other hand, in Northern California the scarcity of archaeological salmonid remains is cited as evidence that ethnographic record overstates the importance of salmon (Gobaleta et al. 2004). On the Upper Columbia River Plateau, gaps in deposition of fish bone have been used to propose cycles of abandonment and re-population by ethnically distinct peoples (Chance and Chance 1985; Pouley 2008).

Regarding fishing in mountain settings, Lubinski (2000) says the paucity of archaeological evidence for fishing on the Green River in Wyoming is representative of the Rocky Mountains region as a whole. He concludes that the disjuncture between frequent reports of fishing in the ethnographic record of the Intermountain West and the lack of archaeological fish remains is real, not just a preservation issue (p. 163).

This may be an historical pattern associated with post-Contact disruptions to subsistence and mobility that necessitated increased focus on aquatic resources although sampling, preservation, and cultural change are still contributing factors to the lack of archaeological evidence for fishing (p. 164, also see Bogstie 2012). This conundrum is also present in the archaeological and
ethnographic record of the Upper Truckee River in the Sierras (Lindström 1996). But does this problem arise because archaeologists aren’t recognizing most fishing tools in the archaeological record?

The technology of fish procurement (e.g. hooks, netting or line, fish spear points, weirs, baskets, dams, and traps) does tend to be underrepresented archaeologically. Most fishing tools are organic, therefore much of what we know about their form and the functional requirements comes directly from ethnographic reports. Stone net sinkers do preserve well, but indicate little more than the fact that nets were used. Stone tools used to butcher fish and prepare them for storage are likely to preserve in the archaeological record, but the diversity of forms of the North American West (discussed in detail below), presents archaeologists with a real diagnostic challenge.

In addition, ethnographic reports of fish processing tools being used for hide processing and other tasks makes clearcut connections between morphology and function even more elusive (Chen, personal communication; Gould and Plew 1996; Plew and Guinn, in press; Graesch 2007). This supports Odell’s argument that functional requirements of stone tools may play out in morphologically variable, but equally valid ways in different settings (1981).

Techniques for identifying use wear and trace residues of lipids and proteins on tools (cf. Butler and O’Connor 2004; Hardy and Moncel 2011) offer some hope for identifying fishing archaeologically. However, the information obtained with these techniques has its limits. Post-depositional processes, washing, and other laboratory processing can obliterate microwear and residue, shrinking and randomizing the sample. If a tool was used to butcher fish for most of its functional life and then overprinted with woodworking and hide scraping in its final months, then microwear and residue may not reflect most of its use history.

Finally, time and cost usually constrains laboratory analysis to a few tools. As O’Shea notes, “if ... three-fourths of the (lithic artifacts) in ... a nonprobabilistic sample bore either organic residues or microwear traces referable to butchery, one could not legitimately infer that the preponderance of (lithic artifacts) in the larger population of such tools from that site were used for butchery” (2007:217, emphasis mine).

Clearly, improving our ability to recognize fishing tools requires us to identify the factors that regularly influence the morphology of tools, including manufacture, use, repair and discard. We now turn to Kettle Falls on the Upper Columbia River, where fishing was carried out for thousands of years and associated lithic tools were regularly deposited. In this ‘bottleneck’, major salmon migrations allowed for periods of intensive fish procurement and processing.

THE KETTLE FALLS COLLECTIONS

The Upper Columbia River salmon fishery was eradicated in the 1940s by the construction of the Grand Coulee Dam. Detailed oral histories of Elders from the Spokane Tribe of Indians, and the constituent tribes of the Confederated Tribes of the Colville Reservation (the Wenatchee, the Moses-Columbia, the Nez Perce, the Okanagans, the Lakes, the Sanpoils, the Nespelems, the Methow, the Palus, the Colville, the Entiat, and the Chelan) provide details about important characteristics of traditional fishing (Butler and O’Connor 2004, Pouley 2008).

Salmon, lamprey, and steelhead were harvested in large quantities and processed for storage and trade (Figure 2.1; Ray 1933; Teit 1930; Thompson 1968). Plateau fishermen and women coped with variability in timing and abundance of migrating fish that was affected by random, often remote, events (Davis 2007; Gould and Plew 1996; Grabowski, in press). These factors include sea level changes, deglaciation, rockslides, stream bed morphology, precipitation, global temperatures, migration routes, local runoff, and altered sediment load and vegetative cover from wildfire (Cannon 1996; Davis 2007; Plew and Guinn, in press; Schalk 1977).
When fish migrations were strong, a successful harvest required long-range planning, excellent communication, and rapid deployment of a sizeable labor force that was skilled and well-equipped. The archaeological record shows that, with minor exceptions, salmon fishing along the Columbia increased in intensity over a ten-thousand year span, particularly in the last 1,500 years (Galm 1994; Meengs and Lackey 2005; Schalk 1977, 1986).

For more than 70 years, excavations conducted at archaeological sites inundated and eroded by Lake FDR on the Columbia River have collected, analyzed, and curated millions of artifacts from Kettle Falls and nearby fishing locations (Chance 1986; Chance and Chance 1985; Chance et al. 1977; Collier et al. 1942; Galm 1994; Larrabee and Kardas 1966; McKay and Renk 2002; Pouley 2008).

These artifacts are now curated by the Confederated Tribes of the Colville Reservation and the Spokane Tribe of Indians on behalf of the federal government. Stone tools associated with fish processing, defined here as all tasks from butchering and drying to packaging for storage, have received little attention in the peer-reviewed literature (Yu and Cook, in press), but thousands of lithic tools from the legendary fishing site of Kettle Falls offer an opportunity for large-scale analysis.

This paper has three goals: first, to describe the relationship between salmon life history and functional properties of fish butchering tools. Second, to formulate a model describing the expected range of variation in tool morphology relative to a sample of archaeological tools from the Kettle Falls collection. And third, to apply performance requirements for mass-processing tools as a frame of reference for fishing tools used at smaller scales expected in most of the Intermountain West.

**RELEVANT CHARACTERISTICS OF ANADROMOUS FISH**

Harvest and processing of migratory salmon was conditioned by life history, habitat, and distribution. Characteristics include

- large seasonal upriver migrations of thousands of fish,
- uneven distribution with periodic concentrations at specific locations,
- de-coupling from local environmental productivity (reproducing individuals rely on
marine productivity and stop feeding once upstream migration has begun), and

- inter-annual variability driven by a variety of geologic and hydrologic factors.

Longer migrational distances ‘stacked’ the chances that some random external factor would alter the timing of the run (Davis 2007; Schalk 1977; Gould and Plew 1996). Inland communities needed to monitor and communicate about salmon movements, assemble at constricted locations, organize the labor force, establish living and working spaces quickly, and create or refurbish infrastructure and tools. These ‘gearing up’ events are well documented in ethnographic sources (Graesch 2007; Ray 1933; Teit 1930; Thompson 1967).

With anadromous species the access window is narrow and likelihood of spoilage is high (Ibid), so the incentive to procure and process as many salmon as possible was extreme (Ames and Maschner 1999:115-116; Graesch 2007:581; Schalk 1977:226). Salmon can be cached temporarily in the river, but butchering and drying were generally done as quickly as possible (Graesch 2007:581).

This required many skilled hands. Binford’s (2001) database, which uses known characteristics of foragers to project organizational characteristics in environments where they no longer reside, predicts very large task groups in regions with access to salmon (p. 261). Task group sizes should have co-varied with the bulk of resources processed per unit time and the degree of dependence on stored resources (Ibid).

Periodic, random collapses of local salmon fisheries—sometimes for decades—required logistical tactics to maximize returns when the fish were running. These included a sophisticated system of communication, rapid deployment of the labor force, regulation of access to fishing locations, mass processing, regulation of fish distribution, long-term storage (e.g., delayed return), and, if the run failed to materialize, re-directing efforts to alternative bulk resources such as camas (Ray 1933; Thoms 1989).

Spiritual measures to minimize risk and uncertainty included an array of prohibited activities, substances, and at times, persons (Thompson 1967) as well as tight social controls at fishing locations to ensure that spiritual errors did not offend or frighten the fish (Ray 1933:28, 70-71). If all went well and the run was strong, facilities and personnel for fish processing needed to be primed for action. Preparation began weeks beforehand (travel, establishing camp, gathering of raw materials, constructing/refurbishing facilities, etc. [Ibid]).

THE TASK OF BUTCHERING

On the Upper Columbia River and many other locations ethnographic sources state it was the men’s job to procure and deliver salmon to the women. Fishermen stood on natural features and platforms and used an array of net forms (including J-shaped basket nets or dip nets (see Figure 2.1; Ray 1933; Graesch 2007; Thompson 1968), or traps at major confluences (Ray 1933). Fishermen gaffed and clubbed the salmon and handed them to others who transported them to processing locations. The women had already constructed drying shelters and prepared large staging areas of sunflower leaves, a plant connected spiritually to salmon (Ray 1933:28). The women had also manufactured, refurbished, or otherwise obtained their butchering toolkits.

In North America, salmon butchery methods appear somewhat standardized across cultural and geographic boundaries. On the Upper Fraser River of British Columbia, women cut open the fish along the backbone, removed the head, drained the blood, and removed the vertebral column and attached ribs (Graesch 2007:580-581). The head was split and set aside to dry separately, then the body was laid open and the remaining fillets, still connected by a section of ventral skin, were scored perpendicular to the length of the fish. Fillets were typically no more than one cm. thick and were backed by the skin—backing was essential to the integrity of the fillet for drying and transport. The thickness of each row of scored flesh was determined by anticipated weather conditions.

In Central Alaska, Cu’pik women cut off the head just below the gills, split the belly, and removed the fish’s
internal organs (Frink et al. 2003:119). The body was then split along both sides of the vertebrae, which were removed and either dried or discarded. The head was also split. Filleting entailed leaving two flanks of meat attached at the tail, and the alternative method of stripping separated the fillets from the tail and cut them into strips. Scoring of the fillets, a step to facilitate drying, is not mentioned in the Central Alaskan experiment, perhaps due to the lower risk of spoilage in a cooler climate. Similar fish butchery techniques have been observed among the Tutche of the Southwest Yukon (O’Leary 1992) and the St’át’imc Nation bands of the Fraser River region (Prentiss et al. 2012).

On the Upper Columbia River, women of the Lakes, Sanpoil, and Nespelem divided the task into two main phases. First, women removed the intestines immediately and placed the fish on drying racks for about one hour (Figure 2.2; Ray 1933:75). After several fish had accumulated, women cut off each head and opened up the body: “One flank was partially severed from the body by cutting along one side of the backbone, between the bones and the flesh. The fish was then turned over and a second cut was made from the ventral side extending almost to the backbone. Each flank, thus separated, was slashed transversely about every half inch. Long slender splints of cedar were used to hold the sides of the salmon apart” (Ibid). Heads were also split and placed on drying racks.

Salmon were hung from racks by piercing the tail and inserting a forked stick. Ten to 14 days were required to dry fillets, and twice as long for heads and roe (Ibid). During the drying period, fish were vulnerable to pilfering by wild animals, dogs, and kids (Marchand 1999; Ray 1933) and had to be guarded.

Modern fishermen and women would be surprised by the scale of traditional Native salmon processing. The closest analogy is 19th century salmon canneries prior to mechanization, in which hundreds of Asian and Native laborers worked around the clock for several weeks (O’Bannon 1987:559-60; Newell 1988:630; Price 1990:48). There are clear implications for the prehistoric labor force: women (Frink et al. 2003, Graesch 2007, Ray 1933, Rousseau 2004). In Alaska, Oswalt (1963:44) observed that even a small increase in salmon meant a significant spike in workload for women.

On the Upper Columbia and other camas-rich regions, the spring salmon season arrived with women having already spent significant energy on the camas harvest, processing, and storage (Ray 1933:27), entailing two closely-linked workload surges in the spring months. Romanoff (1992:235) estimates that each woman worked for about 12 hours continuously to process 60-100 fish, and Graesch citing Frink et al. (2003) and Schalk...
1977 estimate between 67 and 100 salmon processed per woman per day.

In western Alaska the average household took in about only 150-300 salmon per annum (Frink et al. 2003). In a maritime household the estimate is 54 woman-days of labor needed per year to supply enough salmon for the family; if ritual/giveaway salmon are added, the workload could double to 110 woman-days (Graesch 2007:581-582). A modern estimate of 'continuous effort' probably does not include time for refurbishing tools, family-related interruptions, resting, eating and drinking, dealing with work-related injuries, and so forth. In our opinion, it is appropriate to add 10-20% more time to a woman's annual salmon-processing budget to arrive at a maximum estimate of 132 days—or about one-third of her year.

We can now summarize elements affecting technological needs that were common to large-scale salmon processing.

1. Tasks were carried out by labor groups near key procurement locations.
2. Due to the messy nature of fish butchering and the need to monitor drying salmon, the processing area was separate from, but near to, residential areas.
3. Labor was skilled, and organized by gender (men procuring and transporting; women butchering,

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Figure 2.3. Some fish butchering knife forms: Slate knife (Graesch 2006:579); chert fish butchering knife (drawing after Kroeber and Barrett 1960, plate 20, p. 196); and hafted microlithic tool (Hoko River Digital Image Archive). Scale is approximate.
drying, and packaging for storage).

4. Incentive to process salmon quickly during a strong run was high, imposing physical and logistical demands on the labor force and their gear.

From these data we argue that physical traces of these organizational characteristics should be visible archaeologically (Cannon 1996:25). Salmon processing tools, features, and by-products should be functionally and spatially distinct from, although associated with, procurement and residential areas. Discarded tools should accumulate at or near processing areas, covarying with frequency, intensity, and duration of site use. We now turn to characteristics of the tools themselves.

CHARACTERIZING VARIABILITY OF FISH BUTCHERING TOOLS

The relationship between morphology and function is not straightforward (Figure 2.3). In sub-Arctic North America, fish butchering tools come in a wide variety of hafted and handheld forms. Knives of tabular slate are well-documented on the Fraser River (Hayden 1997; Graesch 2007; Prentiss et al. 2007), and in late 19th-century Northern California, Kroeber and Barrett (1960) observed hafted knives with bifacially flaked points. They describe a typical example as “…a nicely chipped flint blade, hafted in a wooden handle, wrapped and pitched for firmness” (92). In what is now northwest Washington, hafted microlithic tools found in the wet sites of the Hoko River (Croes and Hackenberger 1988) and Ozette (Kirk and Daugherty 2007) are described as fish butchering tools.

At Fivemile Rapids in the Dalles, archaeological examples of fish processing ‘blades’ are described as made from thin conchoidal or lamellar flakes of chert with straight or convex edges occasionally on opposing sides (Cressman et al. 1960:48, 91; Minor et al. 1999). Rousseau (2004) proposes that prehistoric tools from the Canadian Plateau were bifacial and lanceolate, hafted with a blade on both the proximal and distal end. He argues that these unusual tools (admittedly without an ethnographic basis) arose c. 3500-1200 BP as a result of increasing logisticality and functional specialization. Near Kettle Falls, Ray (1933:43) mentions hafted bifacial chert fish butchering knives, whereas Chance and Chance (1977, 1982) describe tabular handheld forms.

This variability may reflect distinct functional requirements of fish butchering. Cu’rik women have observed that more than one tool is required to butcher salmon (Frink et al. 2003); the first to pierce, and the second to make shallow, precise slices. Graesch notes that slate cutting surfaces need to be finely ground and oiled to minimize sticking, with long blade edges to score flesh without cutting the backing skin (Ibid). In British Columbia, Graesch reports “because the beveled edges on slate knife blades are typically not sharp enough to penetrate the thick skin of most salmon ... the initial dorsal incisions and removal of the head (which required cutting through the vertebral column) were likely accomplished with flakes, retouched flakes, or bifaces” (2007:582).

This would implicate unmodified flakes in fish butchery although they are likely under-reported for this and other functions (also see Andrefsky, this volume). Handheld slate knives may have been designed and used for only a subset of fish butchering tasks: filleting and scoring (Ibid). Some of the slate Fraser River tools show both chipped and ground edges, which Graesch argues represent functionally different working edges (p. 586).

Similar qualities are desirable for processing hides. Thus fish butchering tools were apparently suited for a variety of other uses: Unifacial tabular knives are commonly reported as hide scrapers (Chance and Chance 1977:74; Mourning Dove in Miller 1990:103). Chance and Chance (1977) state later in the same sentence “That at least some of the (tabular) knives were used for cutting fish is attested by numerous informants” (Ibid). Thus, while these tools may reflect the functional requirements of fish butchering, they were almost certainly used for other tasks.

Multifunctionality of tools is well-documented for other lithic tools including projectile weaponry, particularly among foragers with diverse subsistence processing requirements (see Shott 1986 and Greaves 1997 for summaries). Reference knowledge from
ethnographic and traditional sources can be used to strengthen linking arguments between technological requirements and tool morphology for specific activities. Salmon processing clearly required skill, concentration, and speed (Frink et al. 2003:117), which conditioned for tools with superior piercing, slicing, and filleting capabilities as well as ease of manufacture and repair.

Of all raw material types, slate butchering tools appear most often in the ethnographic literature (Burley 1980; Frink et al. 2003; Graesch 2007; Matson 1983). Along the Fraser River in British Columbia, slate outcroppings were close to fishing localities and toolmakers could acquire cobbles of good quality within a short walk’s distance (Graesch 2007:585). Since foragers usually travelled to fishing grounds loaded with camping equipment, expedient tools from nearby sources minimized transported burdens (Ibid. p. 582).

Frink et al. (2003) quote the preference of Cu’pik women of western Alaska for tools that are easy to use, reduce processing time, and require less resharpening (118). Slates that were “soft and poorly cemented, breaking along bedding planes into thin plates or scales and terminating in joint-planes or irregular fractures” reduced manufacturing time because the plates required little cortical reduction or thinning (Ibid).

In a salmon butchering experiment, Cu’pik women assessed performance of traditional slate ulu replicas compared to modern steel ulus with sharp pointed corners. Overall, the women preferred steel ulus because the pointed corners could make the initial perforation, the blade was stronger, and the edge did not require retouch or sharpening as often (Ibid p.120-121). However, the women stated that once the perforation was made with a piercing tool, the duller slate edge of the traditional slate ulu was better at filleting without cutting the essential ‘backing’ skin (also see Morin 2004).

The use life of fish processing tools and rate of discard probably depended on the raw material. Frink et al. (2003) note that Cu’pik women resharpened their slate knives after processing each salmon. Thus a woman processing at a rate of 60 fish in one day could potentially exhaust one slate knife per day! However, knives made of more durable raw material like chert or quartzite may have lasted for months or multiple seasons.

Tools that were exhausted or broken beyond repair were discarded in higher numbers near fish butchery locales (Ibid. p. 596) so exhausted hand-held unifacial tools made of tabular raw material should exhibit reduced surface area relative to thickness. If large numbers of fish butchering tools were made for each season, we expect that some with utility value remaining would have been left on-site for recovery and refurbishing in future seasons.

In sum, expectations for fish butchering tools used in large-scale processing events include

1. Raw material that is easily accessed and worked (e.g., local source; tabular fracture planes);
2. Formal characteristics that meet functional requirements of piercing/slicing and scoring/filleting;
3. Varied morphology discernible at the level of an assemblage rather than individual tools;
4. Large accumulations of exhausted or broken tools at processing localities, co-varying with intensity and frequency of site use;
5. Smaller numbers of tools with use life remaining also present at processing localities; and
6. Some use of fish butchering tools for hide processing and other tasks.

We can now make a model statement about expected characteristics of fish butchering technology and tools.

**Intensive fish butchering tools should be easy to make and transport, and perform both piercing and shallow slicing functions with minimal repair, refurbishment, or replacement. Salmon processing tools, features, and by-products should be functionally and spatially distinct from, although associated with, procurement and residential areas. Discarded tools should accumulate at or near processing areas, co-varying with frequency, intensity, and duration of site use.**

We will now evaluate an archaeological assemblage of tools from the Kettle Falls area relative to the model.
Our objective is not to produce a classificatory system for salmon butchering tools, a range of expected variability in forms across space, or a systematic study of change in form over time. Rather, we consider the conditioning effects of organizational characteristics of fish processing upon specific, archaeologically visible, morphological traits.

**THE KETTLE FALLS COLLECTION**

Due to erosion and other dynamic site formational processes, artifacts recovered from Kettle Falls range from c. 9,000 to Euro-American contact, with the majority dating to the Takumakst culture historical period (c. 2000-1700 BP; Chance and Chance 1982; Pouley 2008). The study sample of tabular tools from the known fishing site of Hays Island (45 FE-45; also called the Ksunku Site) and adjacent locations at Kettle Falls (Figures 2.4-2.5; Table 2.1) is curated at the Confederated Tribes of the Colville Archaeological Repository in Nespelem, WA.

More than 11,000 tabular tools have been recovered over decades of archaeological work, and many more remain in situ. We selected a sample of 253 tabular tools from six Kettle Falls area sites (45 ST 119 and 45 FE 45 were each excavated over several years were each

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**Table 2.1. Kettle Falls Area Sites Sampled.**

<table>
<thead>
<tr>
<th>Site</th>
<th>Sample Size</th>
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<tbody>
<tr>
<td>45 FE-43</td>
<td>N = 9</td>
</tr>
<tr>
<td>45 FE-45 (A and B)</td>
<td>A = 176; B=21</td>
</tr>
<tr>
<td>45 ST-95</td>
<td>N = 18</td>
</tr>
<tr>
<td>45 ST-116</td>
<td>N = 6</td>
</tr>
<tr>
<td>45 ST-119</td>
<td>N = 17</td>
</tr>
<tr>
<td>45 ST-201</td>
<td>N = 6</td>
</tr>
</tbody>
</table>

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Figure 2.4-2.5. Kettle Falls and Hayes Island in northeastern Washington State (map by J. Pouley 2008:4, used by permission of the author), and aerial view of Kettle Falls prior to Grand Coulee Dam construction.
treated as a unified collection). Tools were selected for sampling if they were tabular, 1 cm or less in maximum thickness, and not clearly a projectile point or other bifacial tool.

Due to the non-representative nature of the collection (c. 2%, selected as they were pulled), our analysis will describe and evaluate characteristics of sampled tools relative to the model statement rather than arrive at a statistically derived conclusion. The important fishing locality of Takumakst or Fishery Site (45 ST-94) was not included in this study and should be prioritized for future analysis.

Artifacts were selected for this study if they were
1. Tabular (roughly equal thickness along both axes formed by parallel fracture planes in the source material)
2. 1 cm or less in maximum thickness
3. Not clearly a projectile point or other bifacial tool

Chance and Chance (1977, 1982) view tabular, bifacially retouched tools from 45 ST-45 and other sites as a distinct artifact class (1982:74). Excavators, and subsequently curators, have labelled tabular artifacts from Kettle Falls sites and assigned them to a functional category of “tabular knife”. After reviewing the collection catalog we feel the above characteristics match well with this designation in all but an insignificant number, although we use the more generic term “tabular tools.”

For this study, the weight, maximum length, maximum width, and thickness of artifacts were measured, as well as maximum thickness and thickness at one working edge. Each artifact was photographed with a metric scale with two map views.

RESULTS
Using the model statement, we address individual expectations for the Kettle Falls sample below.

1. Fish butchering tools had low transport and manufacture costs.

The Kettle Falls tools are primarily made of two local raw material sources: tabular quartzite from the Colville formation, which is located right at the 45 FE-45/Hayes Island site and nearby at 45 ST-98/the Kwilkin Site; or micaceous quartzite interleaved with micaceous schist (also called argillite) at the mouth of the Kettle River c. 2.5 miles upstream (Chance and Chance 1977, 1982; Depuydt, personal communication; Martinez, personal communication).

A few small slate tools were present in these sites but not sampled. As with Fraser River fish butchering tools, the Kettle Falls tabular tools were easy to manufacture and transport: a raw material source lies within a day’s stroll from the main fishing locality. This raw material fractures into c. 1 cm. thick pieces that require minor retouch to become functional tools.

2. The assemblage should reflect multifunctionality in which tools exhibit piercing/perforating features as well as shallow curvate ones.

The sampled tools do show variability in form, with piercing functionality reflected in acutely angled (<90°) points (Figures 2.6a, 6b, 6c, 6g, and 6h), and filleting functionality reflected in 2-3 mm-thick edges that are straight (Figures 2.6a, 6e), shallowly curved (Figure 2.6c, 6d), or tightly curved/ovate (Figures 2.6f, 6g, and 6h).

A subset of 171 tools was examined for morphological characteristics. Of these, 79% (N=135) exhibited both piercing and filleting characteristics (with a subset of tiny tools c. 5-8 cm. in maximum length that appear to be functionally different), and 21% (N=36) exhibiting only filleting capability.

These categories agree somewhat with Chance and Chance’s formal designations for tabular artifacts (1977, 1982).

1. Cornered or cutting knives, with angled edges between 90 and 180 degrees, most likely used to perforate or pierce;
2. Pointed knives with angled edges more acute than 90 degrees, most likely used to make deeper perforations;
Figures 6a, 6b, 6c

Figures 6d, 6e

Figures 6f, 6g, 6h
3. Ovate or semi-lunar knives with tightly curved edges most likely used for filleting, and
4. Concave knives, which are considered as unfinished semi-lunar knives.

However, the Chance categories do not take into account the combined piercing and filleting capabilities of the majority of the Kettle Falls individual tools. In this sample, acute piercing points and curved filleting edges are observable in individual tools and at the assemblage level.

3. Fish butchering tools should have multiple working edges to minimize re-sharpening

The Kettle Falls sample shows that the majority of tabular tools (56%) have one worked edge, excluding ovate examples (which comprise 8% of the assemblage) (Figure 2.7). About 34% of the sampled tools have two or three straight edges. Our expectations were not supported by the sample, but a mitigating factor may be the high durability of the Kettle Falls argillite and quartzite raw material, reducing the rate of edge wear.

Figure 2.7. Working edges, Kettle Falls sample of tabular tools (N=253)
4. Discarded and broken tools will accumulate in large quantities near key access locations. Corollary: Still-useful tools may have been left on-site and refurbished upon return.

To date, the total number of tabular tools recovered in the Kettle Falls vicinity is 11,541. Site 45 FE-45 (Hays Island) alone accounts for 6,005 tabular tools, and 45 ST-94 (Takumakst) for 4,325 (Figure 2.8). Most of these tools are densely packed in thin strata, with highest numbers near the surface (Chance and Chance 1977), possibly as a result of reservoir-related deflation of sediments.

If women intended to refurbish and re-use the tools at Kettle Falls, we expect that the ratio of surface area to thickness should be variable, and tabular tools with less use-life remaining will be thicker relative to their surface area (Figure 2.9). Our analysis shows that, regardless of shape or number of working edges, the Kettle Falls tools mostly retain some utility; the thickness relative to surface area is consistent regardless of tool shape, and as can be seen Figures 2.6a-6h, acute angled piercing points and curved or elong:

Figure 2.8. Tabular tool exposed on surface at Hays Island, with water action visible. Photo: Brent Martinez, 2004.

Figure 2.9. Surface area (approximated by max. length x max. width) to thickness ratio by tool form.
5. Salmon processing tools, features, and by-products should be functionally and spatially distinct from, although associated with, procurement and residential areas. Discarded tools should accumulate at or near processing areas, covarying with frequency, intensity, and duration of site use.

Kettle Falls is comprised of several discrete archaeological sites; the greatest concentration of fish butchering artifacts appear on raised areas such as Hays Island in the drainage channel or on the immediate banks of the river, downslope from residential areas (Chance and Chance 1977; 1985). Sites located to the south of Kettle Falls, away from the main fishing area, contain significantly fewer fish butchering tools (Pouley 2008).

DISCUSSION

Morphological characteristics of fish butchering tools reflecting manufacture and function can be predicted at the level of an assemblage. Analysis of the Kettle Falls collection supported expectations that, among groups who practice large-scale salmon processing, fish butchering tools will be made of raw material that is easy to access and lends itself to quick manufacture (in this case, slim fracture planes) wherever possible. This is consistent with Andrefsky’s finding (this volume) that tool form found on sites relates to tool function, human choices and raw material availability.

We expected most tools would have more than one working edge to minimize re-sharpening time, but this does not appear to be the case at Kettle Falls. The expectation that tools will accumulate in large numbers where processing was intensive and long-term is supported, and every tool in the sample retains some usefulness. These expedient but high-performing tools may have collectively formed ‘site furniture’ (sensu Binford 1979) left by women intending to return each season. Salmon processing continued at Kettle Falls until the flooding of Lake Roosevelt in the early 1940s so the lithic butchering tools we see in such high numbers today had likely been replaced by metal knives.

The Kettle Falls sites themselves are consistent with expectations that fish processing on a large scale happened in areas associated with but separate from residences, and that numbers of fish processing tools should taper off in less intensely used sites.

A contrasting case is the Five Mile locality of the Dalles in Oregon, another renowned salmon fishery characterized by large archaeological deposits of fish remains (Cressman et al. 1960; Butler and O’Connor 2004). The total number of artifacts stipulated as fish butchering tools at Five Mile does not exceed 100 for all strata combined (Cressman et al. 1960), compared to more than 11,000 tools known for the Kettle Falls area. This could result from several factors: first, large portions of the Five Mile site were demolished for highway construction. Second, the original number of fish butchering tools may have been relatively small due to manufacture from chert, a high quality, durable raw material suitable for curation and transport.

It is not yet known where the Dalles raw material source is located. If the source is distant, and bladelike tools of thin conchoidal or lamellar flakes required greater manufacturing effort (Cressman et al. 1960:48, 91; Minor et al. 1999), women had incentive to make fewer butchering tools, and curate and transport them. Thus the quality and accessibility of raw material should directly influence the degree of butchering tool accumulation at fish processing locales.

Across the Intermountain West, where small, mobile task groups fished for spatially and seasonally dispersed species such as cutthroat trout, chub, pikeminnow, and mountain whitefish, we would not expect large accumulations of salmon butchering ‘site furniture’. MacDonald’s analysis of lithics from around Yellowstone Lake (this volume) concludes that fishing was not an important component to subsistence there despite the proximity of prime fish habitat.

According to Shott, increased mobility would necessitate a smaller number of more flexible tool classes, each capable of application to a broader range of tasks (1986:23). The interesting microcore/microlith complexes discussed by Lee et al. (2013) illustrate the diversity of tool forms that can be expected with
Intermountain Western fishing, and potentially conservation of high quality raw material.

Archaeologically, tools used for fish butchering in non-intensive settings are expected to serve a variety of functions as personal curated gear, and be deposited in small numbers at multi-purpose sites. Overprinting of varied functions would likely eliminate residue or use wear evidence for fish butchering. In fact, the disparity between ethnographically observed fishing and scanty archaeological evidence in most of the Intermountain West is consistent with the expected scarce and ambiguous archaeological evidence for fishing.

In O’Shea’s analysis of Paleolithic tool assemblages, he notes that certain questions regarding tool use may not be answerable: “... context, residues, microwear, and some experimentation might establish the roles (of tableware) in our subsistence; but (a future) archaeologist would certainly not be able to infer the ratio of salads to T-bone steaks in our diet, nor the relative significance of fish versus potatoes” (2007:226).

However, this doesn’t eliminate the possibility of subsistence intensification in response to Euro-American pressures. Global ethnographic information about forager intensification indicates that a ‘typical’ sequence shifts from large-bodied terrestrial game to smaller terrestrial species and aquatic resources, then plants (Binford 2001; Kelly 1996). Thus, evidence of roughly contemporary terrestrial game intensification would corroborate and bolster the case for aquatic intensification. Such evidence could include increases in low utility meat elements; traps, drives, and other innovative hunting techniques to maximize yields; increases in smaller bodied game; and bone grease processing and other intensive methods to extract maximum nutrition.

In the northern Intermountain West, oral histories and archaeological evidence suggest that Blackfeet hunters moved into montane zones in response to Euro-American incursions on traditional plains hunting grounds (Zedeño 2013). Sheep traps, which appear in the Central Rocky Mountains at c. 1700-1800 AD, are another indication of a tactical shift in terrestrial hunting practices (Scheiber and Finley 2010).

Ethnographic observations of fish butchering tools in common use as hide scrapers at Kettle Falls, a major fishing locality, are suggestive of disruptions in traditional seasonal patterns of mobility and subsistence. Further study of archaeological evidence across the prehistoric/proto-historic divide will likely show that subsistence intensification -- using aquatic resources where available -- occurred in response to land and resource pressures from the profoundly disruptive process of Native-Euro-American colonization.

CONCLUSION

We’ve shown that the Kettle Falls assemblage of fish butchering tools were organized under specific requirements that can be inferred directly from ethnographic reports. These requirements allow us to anticipate patterns in form and distribution of fish butchering tools in large-scale settings like anadromous migration runs in the larger rivers. However, small-scale, intermittent fishing and multi-functionality of lithic tools typical throughout most of the Intermountain West makes overprinting and obscuring fish-related residues and use-wear likely and renders diagnosis of fishing ambiguous and minimal at best.

The cultural evolutionary process of intensification from Euro-American contact or any other systemwide trigger can’t be addressed using fishing lithics alone. Rather, the question requires a wide-spectrum analysis of subsistence tactics including procurement, processing, and storage of terrestrial animals, aquatic animals, and terrestrial plants. Ethnographic knowledge about subsistence is the most obvious frame of reference for developing testable hypotheses for expectations in the archaeological record. Increasing our knowledge about these processes in the Intermountain West has ramifications for the intersection between unique historic events and predictable processes in other colonized parts of the world.

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