CHAPTER 2
IMPLICATIONS OF UPPER COLUMBIA
RIVER LITHIC TECHNOLOGY FOR
PREHISTORIC FISHING IN THE ROCKIES

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ABSTRACT
Lithic tools used for fish processing in North America range from hafted lanceolate bifaces and microlithic blades to handheld lunate tools. Despite use wear and residue analysis, archaeologists still lack diagnostic means to identify archaeological fish processing tools at larger scales, resulting in a dearth of knowledge about past fishing behavior. This paper describes and predicts variability in tool shape using ethnographic fish processing data and functional morphology of tabular quartzite tools from Kettle Falls, a major Columbia River salmon fishery. Gender-specific organization of labor during intensive fish harvest and technological behavior associated with large-scale processing practiced by aquatic-focused foragers are featured. A model for fishing tool use is evaluated using data from the Kettle Falls lithic collection. The paper describes expectations for diagnostic characteristics of fish processing tools at smaller organizational scales expected in the Rockies and discusses the increase in Native American fishing due to resource pressures from Euro-American incursions.

DISCERNING FISHING ACTIVITY IN THE
ARCHAEOLOGICAL RECORD
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, procurement technology (e.g., hook-and-line, nets and sinkers, weirs, and dams [Lindström 1996; Lyons, in press; Lubinski 2000]). Relative frequencies of these items, most of them organic, are often used to infer changes in the contribution of fish to subsistence. However, depositional environments of western rivers are characterized by acidic soil, erosion, wave action, currents, and dynamic stream and terrace structural morphology. These processes can influence the attrition rate of organic materials and 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 subsequent reservoir operations over the past 70+ years.

Relying primarily on vulnerable organic fish remains can lead to conflicting or ambiguous conclusions about past human behavior, cultural systems, and cultural evolution. For example, salmonid remains at Snake River archaeological sites are used to presume a focus on salmon that is at odds with ethnographic reportage (Plew and Guinn, in press). On the other hand, in Northern California the scarcity of archaeological salmonid remains is cited to argue that the ethnographic record overstates the importance of salmon relative to prehistory (Gobaleta et al. 2004). Gaps in fish bone deposition have been used to propose that the Upper Columbia River Plateau was cyclically abandoned and re-populated by ethnically distinct peoples (Chance and Chance 1985; Pouley 2008).

In a study of fishing in Wyoming, Lubinski (2000) states that the paucity of archaeological evidence for fishing on the Green River is representative of the Rocky Mountain region as a whole. He argues that the disjuncture between ethnographic reports of frequent fishing in the Rockies and the dearth of archaeological indicators is real, not just a preservation issue (Lubinski 2000: 163). Lubinski suggests this may be an historical pattern associated with post-Contact disruptions to subsistence and mobility that necessitated increased focus on aquatic resources (Lubinski 2000: 164), although sampling, preservation, and cultural change are still contributing factors to the lack of archaeological evidence for fishing (also see Bogstie 2012). This conundrum is repeated in the archaeological and
ethnographic record of the Upper Truckee River drainage in the Sierras (Lindström 1996).

Archaeologically, fish procurement technology (hooks, netting or line, fish spear points, weirs, baskets, dams, and traps), is not much more helpful than fish remains. Most fishing tools are organic, so much of what we know about them and the functional requirements that influence their characteristics comes directly from ethnographic reportage. Stone net sinks are durable, but indicate little more than the fact that nets were used. Tools used to butcher fish and prepare them for storage are more likely to be made of lithic raw material that preserves 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, ethnographically documented use of fish processing tools for other tasks like hide processing 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 variability supports Odell’s argument that functional requirements, of stone tools may play out morphologically in different but equally valid ways in various settings (1981).

Techniques to identify use wear and trace residues of lipids and proteins on tools (cf. Butler and O’Connor 2004; Hardy and Moncel 2011) are improving in quality and affordability, and offer hope for identifying fishing in the archaeological record. However, there are limits to the information obtained with these techniques. Post-depositional processes (including washing and other processing) can obliterate microwear patterns and residue in most cases, shrinking the sample to tools that randomly preserve those elements. When fish butchering use wear and/or fish protein can be identified, this provides only dichotomous information (“yes, people processed fish with this tool” / “no, they didn’t”). 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 use wear and residue analysis may not capture the majority of its use. Finally, these techniques can only be used at the level of small samples of tools rather than assemblages. As O’Shea notes, “if ... one found that 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).

Because technology consists of the larger behavioral and organizational contexts in which tools are used, isolating the factors that condition tool morphology requires us to learn about manufacture, use, repair and discard. One area of the inland American West where intensive fishing was carried out over thousands of years, and lithic tools regularly deposited, is Kettle Falls on the Upper Columbia River. This area of the semi-arid Columbia Plateau was home to major salmon migrations, and although it is not an analogy for smaller fisheries of the Rockies, identifying regular characteristics of tools likely used to process fish will help to frame archaeologically observable characteristics that are germane to fish processing in general.

THE STUDY AREA: KETTLE FALLS AND ITS COLLECTIONS

Four generations ago, the Upper Columbia River salmon fishery was eradicated by the construction of the Grand Coulee Dam and filling of Lake Franklin D. Roosevelt. 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 detailed descriptions of important characteristics of traditional fishing (Pouley 2008) that enrich our knowledge about the deep history of the fishery (Butler and O’Connor 2004).

Aquatic species like salmon, lamprey, and steelhead were harvested in large quantities and processed for storage and trade (Ray 1933; Teit 1930; Thompson 1968). Plateau fishermen and women coped with unpredictable timing and abundance of migrating fish that could be affected by stochastic, often remote, events (Davis 2007; Gould and Plew 1996; Grabowski, in press). Some factors
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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, 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 resulted in the collection, analysis, and curation of 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. The durable 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). Thousands of lithic tools have been found at the well-known fishing site of Kettle Falls.

This paper has three main goals. First, we will discuss conditioning effects of salmon life history upon ethnographically known fish butchering technological systems to develop an independent but germane frame of reference about expected properties of butchering tools in a high-intensity processing setting. Second, a model statement will describe the expected range of variation in functional morphology of tools relative to a sample of archaeological tools from the Kettle Falls collection. We expect that performance requirements for tools to bulk-process fish will be a useful frame of reference for generalized functional requirements for fish butchering tools. We will then consider implications for tools used in less intensive fishing such as the mountain rivers of the Rockies (for discussions of smaller-scale or more occasional fishing also see Lyons, in press; Plew and Guinn, in press).

Figure 2.1. The traditional fishery at Celilo Falls. c. 1950.
CONDITIONING EFFECTS OF THE RESOURCE

The technology needed for intensive harvest and processing of migratory salmon was conditioned by characteristics of anadromous fish life history, habitat, and distribution. These include

1. large seasonal upriver migrations of thousands of fish,
2. uneven linear distribution of fish with periodic concentrations at specific locations,
3. de-coupling from local environmental productivity (reproducing individuals rely on marine productivity and stop feeding once upstream migration has begun), and
4. inter-annual stochasticity driven by a variety of geologic and hydrologic factors.

All other things being equal, longer migrational distances ‘stacked’ probabilities of exogenous influences (Davis 2007; Schalk 1977; Gould and Plew 1996), reducing predictability of runs further inland. People needed to monitor and communicate about salmon movements, assemble at bottleneck 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. With anadromous species the window of access is narrow and the likelihood of spoilage is high (Graesch 2007; Ray 1933; Teit 1930; Thompson 1967), so there was an extreme incentive to procure and process as many salmon as possible (Ames and Maschner 1999:115-116; Graesch 2007:581; Schalk 1977:226). Although salmon can be cached temporarily in the river, butchering and drying were generally done as quickly as possible (Graesch 2007:581). This required many skilled hands. Binford’s (2001:261) database, which uses known characteristics of foragers to project organizational characteristics in environments where they no longer reside, predicts very large foraging task groups in regions with access to salmon. Task group sizes should co-vary with the bulk of resources processed per unit time and the degree of dependence on stored resources.

Periodic, random collapses of local salmon fisheries—sometimes for decades—required logistical tactics to maximize fishing returns. These included a sophisticated system of communication, rapid deployment of the labor force, regulation of access to fishing locations, rapid mass processing, regulation of fish distribution, long-term storage (e.g., delayed return), and, if the run failed to materialize, the ability to re-direct efforts to alternative bulk resources such as camas (Ray 1933; Thoms 1989). Spiritual measures to minimize risk and uncertainty included an extensive 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 migrating fish. If all went well and the fish run was strong, facilities and personnel for fish processing needed to be ready for action. Preparation began weeks beforehand (travel, establishing camp, gathering of raw materials, constructing/refurbishing facilities, etc.) (Ray 1933: 28, 70-71).

THE WORK OF BUTCHERING

On the Upper Columbia River and many other locations 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 geared up by constructing drying shelters and preparing large staging areas of sunflower leaves, a plant connected spiritually to salmon (Ray 1933:28), and manufacturing, refurbishing, or otherwise obtaining their butchering toolkits.

In North America, salmon butchery methods appear to be 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...
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 (Ibid). The thickness of each row of scored flesh was determined by anticipated weather conditions (Ibid). In Central Alaska, Cu’pik women cut off the head e·e·en split along both sides of the vertebrae, which were opened and either dried or discarded. Heads were 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 (Ibid). Scoring of the fillets, a step to facilitate drying, is not mentioned, perhaps due to the lower risk of spoilage in a cooler climate. Similar fish butchery techniques have been observed among the Tutchone 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 the heads 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.

Today’s 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 Native 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, estimates 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—about one-third of her year.

We can now summarize elements common to large-scale salmon processing technology.

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. Skilled labor was organized by gender (men procuring and transporting; women butchering, 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.

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.

CHARACTERIZING VARIABILITY OF FISH BUTCHERING TOOLS

Processing of salmon is necessarily linked with fish butchering tools (Graesch 2006:577)—but 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. For example, 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 along the Hoko River (Croes and Hackenberger 1988) and Ozette site (Kirk and Daugherty 2007) are described as fish butchering tools. At Five-mile 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) mention tabular handheld forms.
This variability may reflect distinct functional requirements of fish butchering. Cu’pik 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, and blade edges are long 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 butchery: 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).

Since similar qualities are desirable for processing hides, fish butchering tools were apparently suited for a variety of other uses; Chance and Chance (1977:74) report unpublished observations of hafted unifacial tabular knives in use as hide scrapers, but 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 many 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 materials, slate butchering tools are most common 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 laden with camping equipment, using 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 thin plates or sheets required little thinning or cortical reduction (Ibid). In a salmon butchering experiment, Cu’pik women assessed performance of replicas of traditional slate ulus 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 did state 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 probably lasted for months or even multiple seasons. Tools that were exhausted or broken beyond repair were discarded in higher numbers near fish butchery locales (Ibid. p. 596); 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 archaeological 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 for both piercing/slicing and scoring/filleting;
3. Varied morphologies that may be 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 offer a model statement about expected characteristics of large-scale fish butchering technology and tools:

*Intensive fish butchering requires tools that are easy to make and transport, and can perform both piercing and shallow slicing functions rapidly with minimal repair, refurbishment, or replacement. Multifunctionality may be reflected at the level of the assemblage rather than*
individual tools. To reduce the need for re-sharpening, tools may have more than one slicing edge. Discarded and broken tools will accumulate in large quantities near key access locations, and useful tools may be left on-site for later use, including non-fish butchering tasks.

We can now evaluate an archaeological assemblage of tools from the Kettle Falls area in terms of the model statement. Our objective is not to produce a classificatory system for salmon butchering tools, nor a range of expected variability in forms across space, nor yet a systematic study of change in form over time. Rather, we consider the utility of the model statement about the conditioning effects of larger organizational characteristics of fish processing technology upon specific traits in the morphology of tools, and implications for archaeological examples in other settings.

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 4,000 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

Table 2.1. Kettle Falls Area Sites Sampled.

<table>
<thead>
<tr>
<th>Site</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>45 FE-43</td>
<td>N = 9</td>
</tr>
<tr>
<td>45 FE-45</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>

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.
were excavated over several years and assigned multiple catalog numbers, but are here treated as single collections. The very large collection of tabular tools precluded analysis of all tools, so tools were selected as they were pulled 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, our analysis will describe and evaluate characteristics of sampled tools relative to the model statement rather than arrive at a statistically-derived conclusion. The Takumakst or Fishery Site (45 ST-94) was not included, but is a significant fishing locality 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 the 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 by virtue of a raw material source 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 (<90o) 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 (1977, 1982) that separate the tabular tool assemblage into

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;
3. Ovate or semi-lunar knives with tightly curved edges most likely used for filleting, and
4. Concave knives which they consider to be unfinished semi-lunar knives.
Figures 6a, 6b, 6c

Figures 6d, 6e

Figures 6f, 6g, 6h

Figure 2.6a-h. Kettle Falls tabular tools showing a range of forms
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, multifunctionality is observable both at the assemblage level and in individual tools.

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.

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.

![Kettle Falls Tabular Tools N=253; number of working edges](image)

**Figure 2.7. Working edges, Kettle Falls sample of tabular tools (N=253)**

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

The Kettle Falls tools should include some with use-life remaining if women intended to refurbish them in later seasons. For a proxy of ‘exhaustedness’ we used the ratio of surface area to thickness, with the expectation that exhausted tabular tools 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 sample is comprised mostly of tools that retain some utility; the thickness relative to surface area is fairly consistent regardless of tool shape. Also, as can be seen Figures 2.6a-6h, piercing and slicing capabilities of all Kettle Falls tools sampled are still present.

DISCUSSION

The Kettle Falls assemblage indicates that morphological characteristics of fish butchering tools reflecting manufacture and function can be predicted at the assemblage level. Results supported our 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, convenient 1-cm fracture planes) wherever possible. Our expectation of multi-functionality was partly supported; it appears that individual tools are just as likely as an assemblage to exhibit both piercing and filleting capability. We expected most tools to have more than one working edge to minimize re-sharpening time, but this does not appear to be the case at Kettle Falls. Our expectation that tools will accumulate in large numbers where processing was intensive and long-term was supported, but it was surprising to see that every tool in the sample still has plenty of use-life left. These expedient but high-performing tools may have formed ‘site furniture’ (sensu Binford 1979) left by women who intended to use them in subsequent seasons. Presumably the Kettle Falls butchering tools gradually stopped being used with the advent of metal knives.

The Kettle Falls assemblage, which numbers in the 1,000s, provides an interesting contrast with the Five Mile area of the Dalles, another renowned salmon fishery that is 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 (Cressman et al. 1960). This could be the result of several factors: large portions of the site were demolished for highway construction, possibly destroying activity areas, and the original number of fish butchering tools may have been smaller due to manufacture from chert, a high quality raw material with long use-life suitable for curation and transport. If the Dalles raw material source is distant (not known), and fish processing ‘blades’ of thin conchoidal or lamellar flakes (Cressman et al. 1960:48, 91; Minor et al. 1999) required greater manufacturing effort, women may have made fewer butchering tools and curated them rather than leaving them on-site. Thus workability and accessibility of raw material should directly influence the degree of butchering tool accumulation at fish processing locales.

Comparing characteristics of the unusually robust Kettle Falls assemblage with different fish processing settings offers insights into the interplay between functional requirements of the tools and conditioning factors of their manufacture and use: The nearby raw material source and ease of tool manufacture at Kettle
Falls conditioned for a large accumulation of ‘site furniture’ at the fish processing locality, but the more costly Five Mile/Dalles tools were probably carried away by their owners to serve multiple functions in a variety of settings. The proximity of raw material sources to a fish processing locale made the difference between expedient and curated fish butchering technology, (sensu Binford 1979) and therefore modes of accumulation.

Turning to the Rocky Mountains region, large accumulations of salmon butchering ‘site furniture’ would not be expected for mobile groups who fished for spatially and seasonally dispersed species like cutthroat trout, chub, pikeminnow, and mountain whitefish. According to Shott, increased mobility requires a smaller number of more flexible tool classes, each capable of application to a broader range of tasks (1986:23). Archaeologically, we expect that tools used for fish butchering in montane settings were manufactured on an as-needed basis, served a variety of functions as personal curated gear, and eventually deposited in small numbers at multi-purpose sites. Overprinting of functions would likely eliminate residue or use wear evidence of fish butchering. If this is the case, the scarcity of archaeological evidence for fishing activity in the Rockies and other mountain settings does not equal evidence for absence.

The disparity between ethnographically observed fishing and scanty archaeological evidence cannot yet be linked with subsistence intensification due to Euro-American colonization and resource pressures. In an analysis of Paleolithic tool assemblages that were (like fish butchering tools) subsistence-related, highly variable in form, most likely multipurpose, and required little advance planning and effort to make and use, O'Shea
notes that certain questions 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).

This is not to dismiss the interesting question of post-Euroamerican intensification of Native subsistence. For example, there is new archaeological and oral history evidence that Blackfeet hunters moved into montane zones as a result of Euro-american incursions on traditional plains hunting grounds (Zedeño 2013). The bigger issue of post-contact subsistence intensification in the Rockies may not be answerable with fishing evidence alone, but could be explored using a combination of oral tradition and readily diagnostic archaeological evidence such as low utility meat elements, inclusion of smaller bodied game, and increased bone grease processing. If, as forager ethnographies indicate, a foraging intensification sequence moves from terrestrial game to aquatic resources and then plants (Binford 2001; Kelly 1996), we expect that an increase in evidence for plants in the diet and value-added practices such as pit roasting of roots would signal that intensification using aquatic resources has already occurred.

To conclude, large-scale fish butchering technology is organized around specific system requirements that permit us to anticipate variability in form and distribution of fish butchering tool assemblages. The smaller scale of fish processing expected in mountain settings precludes easy identification of individual tools for fish butchering, but provides suggestive characteristics for tools and assemblages that can be evaluated for consistency with fish butchering and complemented with residue and microwear analysis. Increasing our knowledge about fishing in the Rocky Mountains region has interesting ramifications for larger questions of technological and subsistence behavior in the diverse mountain habitats, and the intersection between historic events and processes. We hope our results will be useful to those who seek to increase the body of knowledge about prehistoric fishing localities, including researchers and descendant communities interested in geographic and chronological ranges of ancient fishing and fish habitats.

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REFERENCES CITED


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American fisheries of California, with emphasis on steelhead and salmon. *Transactions of the American Fisheries Society* 133(4): 801–833


Marchand, J. 1999. Oral History Interview. On file at the History and Archaeology Department, Confederated Tribes of the Colville Reservation, Nespelem WA.

Martinez, B. 2009. Personal communication.

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