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TOWARDS THE IDENTIFICATION OF LAMPREYS (*LAMPETRA* SPP.) IN ARCHAEOLOGICAL CONTEXTS

Ross E. Smith and Virginia L. Butler

ABSTRACT

Lampreys were and continue to be an important resource for Native Americans in the Pacific Northwest. Lampreys possess several skeletal structures that are regularly identified in marine mammal and bird stomach contents and fecal samples, suggesting that lamprey elements may preserve in archaeological contexts. However, their remains have not been identified in archaeological faunal samples in the Pacific Northwest. This may be due to the lack of an adequate “search image” for lamprey remains among faunal analysts and limited use of fine screen sampling. Descriptions and photographs of lamprey remains that are most likely to survive in archaeological contexts are presented to increase awareness of lamprey anatomy. Horn-like teeth located around the lamprey oral disc are the largest and most distinctive elements that may be encountered in archaeological samples. Use of standard 1/8 in. (3.2 mm) and 1/16 in. (1.6 mm) mesh will retain elements from mature adult Pacific Lampreys.

Introduction

Lampreys (*Lampetra* spp.) were and continue to be an important resource for many Native Americans in the Pacific Northwest. While it is likely that this fish was utilized prior to the contact period, lamprey remains have not been identified in Pacific Northwest archaeological settings. We suggest they are an underappreciated component of prehistoric subsistence systems in the region. While lampreys lack a bony skeleton, they possess mineralized dental plates and statoliths (specialized structures similar to otoliths in teleost fishes). Such structures are robust enough to have been recovered in the fecal material and stomach contents of marine mammals and birds, suggesting they might preserve in archaeological contexts.

Establishing the presence and distribution of lampreys from archaeological contexts is important for several reasons. Understanding their role in past human subsistence is of obvious value. With recent declines in lamprey populations, fishery scientists and resource managers have emphasized the need for detailed historical records regarding the distribution and abundance of lamprey populations prior to industrial fishing, introduction of alien species and

modification of Pacific Northwest river environments to inform future management decisions (Kostow 2002; Moser and Close 2003). Archaeological sites provide a repository for such data (Butler and Delacorte 2004; Gobalet 2004; Lyman and Cannon 2004).

Over 30 years ago, Casteel (1972) suggested that lamprey remains may be present in western North American archaeological contexts. Why have their remains *not* been documented since his publication? We suggest four possible reasons: lack of knowledge of lamprey anatomy and morphology of lamprey elements, inadequate field and lab recovery methods, low preservation potential, and finally limited human use. This paper addresses the first two factors. Our goal is to familiarize archaeologists with the lamprey physical remains that may be encountered in the course of archaeological investigations. We also describe the appropriate sampling and identification strategies to document the occurrence of lampreys in archaeological faunal assemblages.

Natural History

Lampreys (family Petromyzontidae) are members of the superclass Agnatha (“jawless fishes”). They possess an elongated eel-like body form and lack jaws, internal ossification, scales, and paired fins (Fig. 1) (Wydoski and Whitney 2003). Many Native Americans in the Pacific Northwest refer to lampreys as “eels.” True eels are part of a different evolutionary line within the “jawed vertebrates,” superclass Gnathostomata, Order Anguilliformes. The lamprey life cycle involves two stages: a larval stage (during which they are referred to as ammocoetes) followed by an adult stage. Ammocoetes burrow into river sediments and filter feed for up to six years. At the end of the ammocoete stage, larvae transform into the adult form, which involves development of eyes and an oral disc with pointed, horn-like teeth. At the end of their metamorphosis, adult lampreys assume a parasitic or nonparasitic mode of life. Parasitic forms are usually migratory, spending the majority of their adult life in marine environments where they feed on fish or other organisms, and then return to rivers to spawn. Most lampreys die soon after spawning, although cases of multiple spawning migrations have been observed (Michael 1980, 1984; Kostow 2002; Wydoski and Whitney 2003). Nonparasitic lampreys typically spend more time in their larval stage and significantly less time in their adult stage. It is common for nonparasitic lampreys to spawn and die within a month of their metamorphosis.

Three lamprey species from the family Petromyzontidae are generally recognized in the Pacific Northwest. Two of these taxa, the Pacific Lamprey (*Lampetra*, subgenus *Entosphenus tridentata*) and the Western River Lamprey (*Lampetra ayresi*) are anadromous, while the River Lamprey (*Lampetra richardsoni*) spends its entire life in freshwater river systems. In addition to these three species, several enigmatic lamprey taxa have also been described in Washington, Oregon, and northern California (Kostow 2002). The Pacific Lamprey, which may grow up to 750 mm in length, is the largest and most commonly recognized lamprey species found in the Pacific Northwest. River and Western Brook Lampreys are typically much smaller (averaging 280 mm and less than 180 mm in length respectively) (Hart 1973; Wydoski and Whitney 2003).

Ethnohistoric Lamprey Utilization

Lampreys were a seasonally abundant resource that was widely used by the indigenous peoples of the Pacific Northwest. A review of the published accounts of Native American subsistence practices from the Northwest Coast and Plateau culture areas (Suttles 1990; Walker

1998 editor) reveals that lamprey are listed as food items for 13 out of 43 named Native American tribal groups (Table 1). Detailed descriptions of the cultural importance and traditional ecological knowledge of lampreys have been collected and published for American Indian groups such as the Umatilla (Close et al. 2002; Close et al. 2004). At least two types of lamprey are recognized and distinguished by native peoples on the Plateau (Close et al. 2004). Among Sahaptin speaking peoples along the Yakima River, two different names are used to refer to lampreys from the stretches of the river above and below Rock Creek (Hunn et al. 1990).

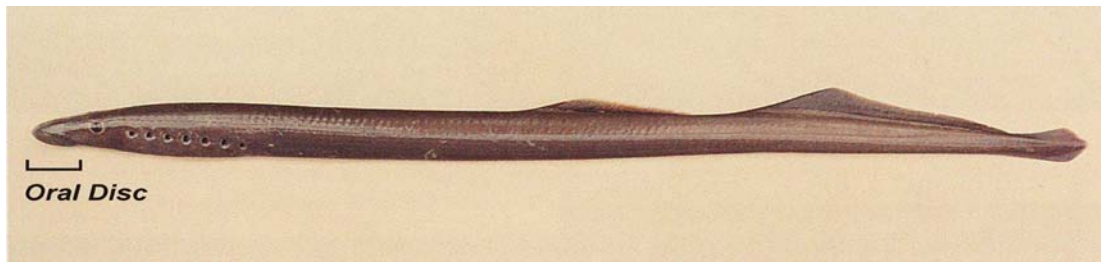


Fig. 1. Photograph of a Pacific Lamprey (*Lampetra tridentata*). Reproduced courtesy of Wydoski and Whitney (2003).

Lampreys were primarily harvested during the summer months in the course of their annual upstream migration towards the spawning grounds. Since lampreys are not fast swimmers, they tend to congregate at waterfalls where steep grades and fast flows slow their progress upstream. At these locations, lampreys use their oral discs to attach themselves to the surface of rocks to rest in the water, and in the steepest portions they may use their oral discs to secure themselves to the rocks as they slowly crawl up over the falls. Native peoples harvested lampreys on both the mainstem of large river drainages at locations such as Celilo Falls and Kettle Falls on the Columbia River (Morris 1975; Close et al. 2004), and from tributary drainages such as at Willamette Falls on the Willamette River (Kostow 2002).

If the area were accessible, lampreys were picked off the surface of rocks around a falls by hand or with a hook (Close et al. 2004). Dipnets with small mesh were also used below the falls (Close et al. 2004) and lamprey harvest sometimes occurred at night. While lampreys were sometimes taken at the same locations as salmon, it is clear from ethnohistoric accounts that lampreys were sought specifically, and were not simply incidental catch in the course of the salmon fishery (Close et al. 2004). According to these accounts, lampreys were eaten fresh but also frequently processed and stored for later consumption. For example, in early July 1835, John Townsend, botanist with the Wyeth Expedition, noted thousands of lampreys smoke-curing in Native American houses near the Cascades, a major rapid now submerged behind Bonneville Dam, Columbia River (Thwaites 1966:346–347 as cited in Martin 2006). Besides food, lampreys were used for medicinal purposes; lamprey oil was put on distressed areas of the body, used to cure ear aches, and condition hair (Bonneville Power Administration 2005). In addition, the Nez Perce utilized lampreys as bait for sturgeon (Walker 1998).

By comparing abundance estimates from early historic observations with recent counts of lampreys passing through fish ladders at dams, it is clear that Pacific Northwest lamprey populations have experienced severe declines over the last 70 years (Kostow 2002; Moser and Close 2003). Cases of unintentional extirpation of anadromous lamprey populations trapped upstream of dams following dam construction have been recorded (Beamish and Northcote 1989; Wydoski and Whitney 2003). Lamprey populations perceived to be a threat to salmon and trout fisheries in some river systems were intentionally reduced through poisoning (Close et al. 1995).

TABLE 1. PLATEAU AND NORTHWEST COAST NATIVE AMERICAN LAMPREY USE BASED ON THE HANDBOOK OF NORTH AMERICAN INDIANS (SUTTLES 1990; WALKER 1998 editor)

Area	Group	Lamprey Utilized
Plateau	Lillooet	+
	Thompson	-
	Shuswap	-
	Nicola	-
	Kootenai	-
	Okanagan, Lakes, and Colville	+
	Middle Columbia River Salishans	+
	Spokane	+
	Kalispel	-
	Flathead and Pend d'Oreille	-
	Coeur d'Alene	-
	Yakima	+
	Palouse	-
	Wasco, Wishram, and Cascades	+
	West Columbia River Sahaptins	+
	Cayuse, Umatilla, and Walla Walla	_*
	Nez Perce	+
	Molala	-
	Klamath and Modoc	-
Northwest Coast	Eyak	-
	Tlingit	-
	Haida	-
	Tsimshian	-
	Haisla	-
	Haihais, Bella Bella, and Oowekeeno	-
	Bella Coola	-
	Kwakiutl	-
	Nootkans	-
	Makah	-
	Quileute	-
	Chemakum	-
	Northern Coast Salish	-
	Central Coast Salish	-
	Southern Coast Salish	-
	Southwestern Coast Salish	+
	Kwalhioqua and Clatskanie	-
	Chinookans of the Lower Columbia	-
	Kalapuyans	+
	Tillamook	+
	Alseans	-
	Siuslawans and Coosans	+
	Athapaskans of Southwestern Oregon	+
	Takelma	-

* Subsequent research by Close et al. (2002) and Close et al. (2004) have documented extensive use of lampreys by the Umatilla.

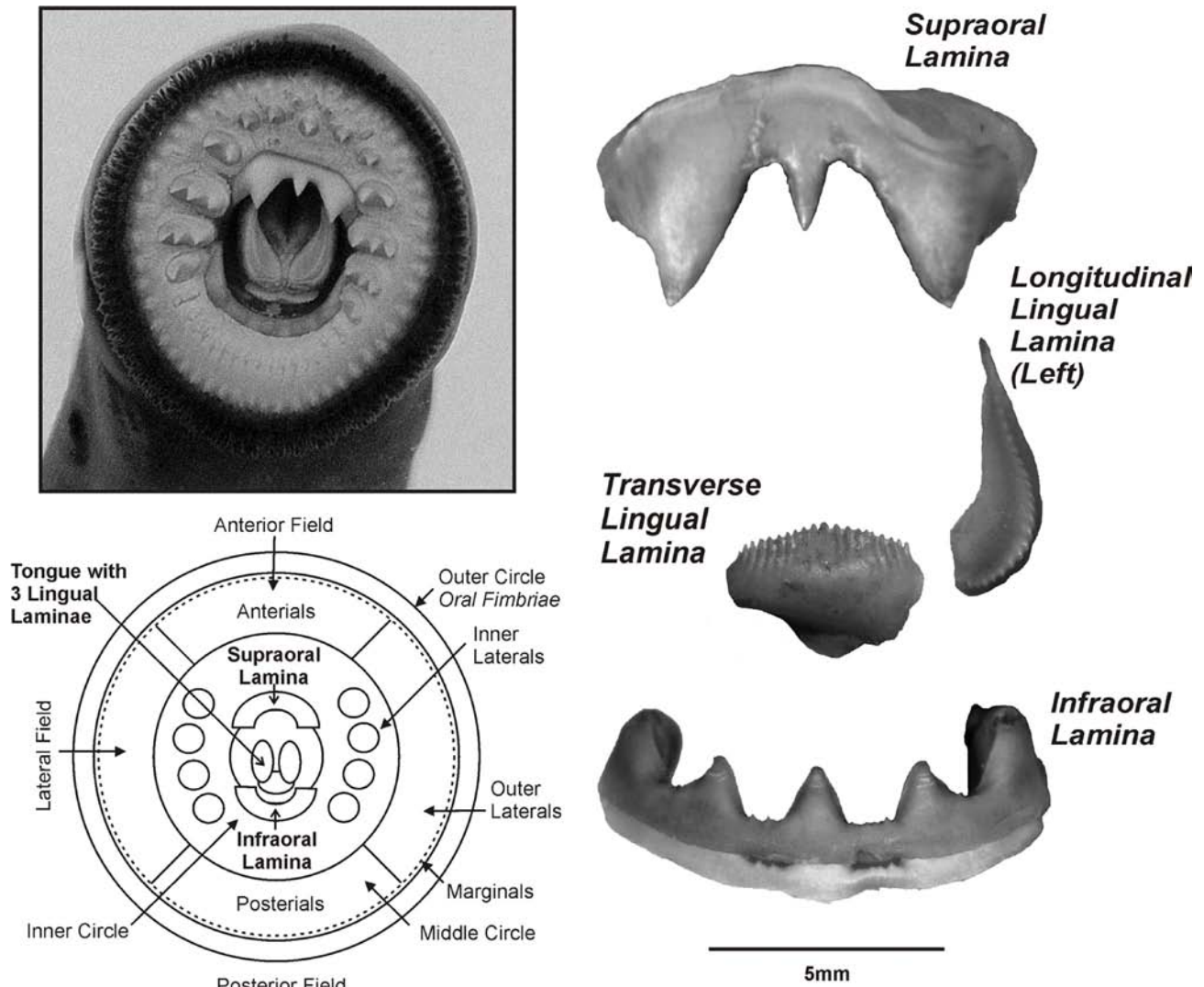


Fig. 2. Top left, photograph of Pacific Lamprey (*Lampetra tridentata*) oral disc and the idealized oral disc and dentition of a lamprey (Petromyzontidae); bottom left, illustration modified from Casteel (1972:78); right, anterior view of Pacific Lamprey oral disc dentition (PSU Reference Specimen No. 07-2-1). Reproduced courtesy of Wydoski and Whitney (2003). Additional photographs at <<http://web.pdx.edu/~virginia/photocollection.htm>>.

The loss and degradation of spawning and rearing habitat, mortality during downstream migration at hydroelectric dams, and increased predation pressure by non-native species have also contributed to declines in lamprey populations (Moser and Close 2003). Native American communities in the Pacific Northwest were among the first to recognize the decrease in lamprey abundance and have urged management agencies to study existing lamprey populations and restore diminished populations (Kostow 2002; Close et al. 2004).

Taxonomic Identification from Skeletal Structures

Lampreys have two types of hard skeletal structures that could be preserved in archaeological deposits. The surface of a lamprey's oral disc is covered with pointed teeth or dental plates (Fig. 2) and paired statoliths (specialized internal structures similar to otoliths in teleost fishes) are found in the labyrinth chambers of the cranium (Jebbink and Beamish 1995).

Lamprey teeth are not true teeth as known for other vertebrates, but rather hollow pointed structures with one or more cusps made of keratin—a form of protein comprising hair, claws, hooves, and horn—that appear to develop from epithelial cells (Warren 1902). Taxonomic identifications are made using the shape and number of the cusps found on the principal teeth, specifically the supraoral and infraoral laminae located along the anterior and posterior margins of the mouth, and the lingual teeth located on the surface of the tongue (Vladykov and Follett 1958). The lingual teeth are composed of a pair of longitudinal lingual laminae and a single transverse lingual lamina (Fig. 2). Since the Pacific Lamprey is the largest and most commonly occurring lamprey species found in the Pacific Northwest, the following discussion will focus on the dental characteristics that are most useful in identifying this species.

The Pacific Lamprey supraoral lamina bears two larger pointed cusps lateral to a third smaller cusp at the center of the element and the infraoral lamina is semicircular in shape with five sharp cusps (Fig. 2; Table 2). In contrast, the River Lamprey exhibits two cusps on the supraoral lamina and six or more cusps on the infraoral lamina. Regarding the lingual laminae, Pacific Lamprey collected in Oregon possessed between 17 and 21 cusps on the transverse lingual lamina and from 18 to 28 cusps on the paired longitudinal lingual laminae (Kan 1975:40). Both the Pacific and River Lampreys possess an enlarged median cusp on the transverse lingual lamina. However, the River Lamprey exhibits fewer cusps on both transverse and longitudinal lingual lamina (Kan 1975:41; Vladykov and Follett 1958:57). The presence or absence of posterior teeth and the number of paired lateral teeth are also useful for distinguishing intact specimens of Pacific Lampreys from River and Western Brook Lampreys (Table 2).

TABLE 2. DISTINGUISHING LAMPREY ORAL DISC ATTRIBUTES

Name	Supraoral Lamina	Infraoral Lamina	Lateral Teeth	Posterior Teeth
Pacific Lamprey (<i>Lampetra tridentata</i>) Maximum Length: 30 in. (~760 mm)	3 Cusps	5 Cusps	4 Pairs	Present
River Lamprey (<i>Lampetra ayresi</i>) Average Length: 11–12 in. (~280–300 mm)	2 Cusps	6+ Cusps	3 Pairs	None
Western Brook Lamprey (<i>Lampetra richardsoni</i>) Average Length: Less than 7 in. (<180 mm)	Very Small Weakly-Developed Rounded Teeth			

Sources: Hart (1973), Wydoski and Whitney (2003).

While the criteria presented above are commonly employed to identify mature adult Pacific Lamprey, species determinations may be complicated by changes in lamprey dentition associated with maturation and reproduction. It has been estimated that lampreys may shed and replace their teeth from 20 to 40 times between transforming into adults and spawning (Hardisty and Potter 1971). Captive studies of Pacific Lampreys demonstrated that young adult Pacific Lampreys may exhibit only two cusps on their supraoral lamina and that the third cusp develops between four and six weeks after transformation (Wydoski and Whitney 2003). Morphological and physical changes are also associated with the spawning migration (Hardisty and Potter 1971). In some lampreys, the approach of spawning may be accompanied by the shedding and replacement of sharp-cusped teeth with blunter teeth, or the degeneration and fusion of disc teeth into a single mass (Kan 1975).

The second type of hard skeletal structures found in lampreys are the statoliths. Statoliths are composed primarily of noncrystalline calcium phosphate and small amounts of calcium carbonate. These structures assist in the orientation and balance of the lamprey and grow by acquiring additional rings at regular intervals in the course of a lamprey's life. While statoliths are not commonly used to make specific taxonomic identifications, statoliths have been used to make age determinations (Beamish and Medland 1988; Jebbink and Beamish 1995).

Assessing Preservation Potential

Lamprey fossils are present in Upper Carboniferous fossil locales in North America (Forey 1995) and have recently been discovered in Early Cretaceous fossil locales in China (Chang et al. 2006). Although these fossils clearly exhibit cartilage that supports the oral disc and the branchial basket (Bardack and Zangerl 1971; Forey 1995; Chang et al. 2006), dental plates are not visible in the fossils. Lamprey dental plates have been recovered and identified from the stomach contents and feces of extant marine mammals and cast pellets of birds along the Northwest Coast (Roffe and Mate 1984; Ford et al. 1998; Lance et al. 2001; Browne et al. 2002; Couch and Lance 2004), the coast of New Zealand (Imber 1976), and the South Georgia Islands of the southern oceans (Xavier et al. 2003). The presence of identifiable lamprey dental plates from these contexts, and the recovery of other rigid proteinaceous materials (such as the chitin exoskeletons of insects and marine arthropods) in archaeological contexts, suggests that lamprey dental plates should also be preserved under certain conditions. While there are anecdotal accounts of "dried eel" being recovered from a cache pit located in McGregor Cave near Joso, Washington, on the Palouse River, in 1953 (Mallory 1966; Kirk and Daugherty 2007), this material has not been systematically analyzed and lampreys have not been subsequently identified among the faunal remains recovered from archaeological sites in the Pacific Northwest.

Recovery Recommendations

The small size of lamprey dental plates and statoliths suggest that relatively fine mesh sizes are needed to recover these elements from archaeological contexts. Although numerous statoliths form in the labyrinth chambers of the lamprey's cranium, lamprey statoliths are extremely small, the largest reaching a maximum length of between 100 and 250 μm (Jebbink and Beamish 1995). Therefore, it is unlikely that lamprey statoliths would be recovered from archaeological samples using even extremely fine mesh (for example 1/128 in.). Descriptions of

the screening of albatross stomach contents suggests that identifiable lamprey dental plates may be recovered using ~1/8 in. (3.2 mm) or smaller mesh (Xavier et al. 2003). However, differences in the size of dental plates found in different lamprey taxa would influence recovery, particularly of fragmentary remains.

To provide a crude estimate of the minimum mesh size needed to recover Pacific Lamprey dental plates, we attempted to pass complete dental plates from two modern Pacific Lamprey reference specimens (PSU07-2-1, 520 mm total length; PSU07-2-2, 665 mm total length) through archaeological screens with 1/4 in. (6.4 mm), 1/8 in. (3.2 mm), and 1/16 in. (1.6 mm) mesh openings. We included the supraoral, infraoral, and three lingual laminae (Fig. 2) in this test because they are the largest, most easily recognized elements used to make species level identifications. While dental plates were not retained in the 1/4 in. mesh, the 1/8 in mesh retained the supraoral and infraoral laminae. The lingual laminae were only caught by the 1/16 in. mesh. Degree of fragmentation and other factors would obviously affect the likelihood of recovering lamprey dental plates in screens of varying mesh sizes. Recent laboratory analysis of bulk samples from a lower Columbia archaeological site that were processed through 1 to 2 mm mesh shows the value of including such samples in research (Butler 2005). Extremely small fish (for example three-spine stickleback (*Gasterosteus aculeatus*) and eulachon (*Thaleichthys pacificus*)) were primarily found in bulk sample processing; their frequency (as measured by Number of Identified Specimens) greatly surpassed counts of fish such as sturgeon (*Acipenser* sp.) and salmon (*Oncorhynchus* sp.). We recommend that future research designs related to faunal recovery include some bulk samples and laboratory processing to establish the presence and abundance of fish such as lamprey from archaeological contexts.

Summary

In spite of abundant evidence of Native American lamprey utilization in ethnohistoric and contemporary accounts, and anecdotal accounts of “dried eels” from McGregor Cave, lamprey remains have not been identified in archaeological contexts in the Pacific Northwest. As noted, four factors could account for this absence, including low preservation potential, the limited use of fine screen recovery methods in the field and lab, lack of knowledge on the part of the analysts who process archaeological samples, and a lack of use by native peoples. The last possibility seems unlikely due to their significance in oral traditions and widespread use by Native Americans in the Pacific Northwest during the post-contact period (Close et al. 1995). It is more likely that regional archaeologists and even faunal specialists have not had an adequate search image to identify lamprey remains.

This work addressed the “lack of knowledge” problem by presenting detailed descriptions and photographs of diagnostic structures most likely to survive in archaeological contexts. It is hoped that increasing awareness of the importance of lampreys in the Pacific Northwest, improving knowledge of lamprey anatomy, greater use of fine mesh recovery methods, and future research projects focused specifically on documenting native use of lampreys in the Pacific Northwest (Neuman in press), will result in the inclusion of lampreys among the fish taxa recovered and identified in the course of archaeological research.

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TRADITIONAL ECOLOGICAL KNOWLEDGE OF PACIFIC LAMPREY (*ENTOSPHEUS TRIDENTATUS*) IN NORTHEASTERN OREGON AND SOUTHEASTERN WASHINGTON FROM INDIGENOUS PEOPLES OF THE CONFEDERATED TRIBES OF THE UMATILLA INDIAN RESERVATION

David A. Close, Aaron D. Jackson, Brian P. Conner, and Hiram W. Li

Abstract

The purpose in seeking Traditional Ecological Knowledge (TEK) of Pacific lamprey from tribal members within the Confederated Tribes of the Umatilla Indian Reservation was to gain additional natural history insights and baseline life history information for a poorly understood species. Tribal members described harvesting two types of lamprey from spring through fall, the short brown type and the long dark type. Lamprey spawning distribution was from the mouth to the headwaters in the Umatilla River. Larval lampreys were observed in the mud and sand areas of the mainstem Umatilla and Columbia rivers. Tribal members observed a major decline in numbers of lamprey within the Columbia River basin.

Introduction

The Pacific lamprey (*Entosphenus tridentatus*) is an anadromous fish, which is distributed in rivers from Baja California, Mexico along the Pacific Rim to Hokkaido, Japan (Simpson and Wallace 1982; Ruiz-Campos and Gonzalez-Guzman 1996). Native to the Columbia River basin, Pacific lamprey spawning migration extends hundreds of kilometers inland to rivers draining Oregon, Washington, and Idaho (Simpson and Wallace 1982; Kan 1975; Hammond 1979).

Pacific lampreys are important to Native Americans of the Pacific Northwest. Indigenous peoples from the coast to the interior Columbia and Snake rivers have gathered lampreys for subsistence, religious, and medicinal purposes for many generations (Close, Fitzpatrick, and Li 2002). Historically, tribal peoples harvested adult lampreys in the tributaries of the Columbia and Snake rivers. Traditional fishing areas of the Umatilla, Walla Walla, and Cayuse tribes included portions of the mainstem Columbia, and Snake rivers. In addition, the John Day,

Umatilla, lower Yakima, Walla Walla, Tucannon, Grande Ronde, and Powder rivers were also traditional fishing areas of the Umatilla, Walla Walla, and Cayuse (Fig. 1). In the 1970s, tribal members began noticing declines in the numbers of lamprey migrating into the interior Columbia River basin and in 1995 the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) initiated a project for restoring Pacific lamprey. The overall goal of the project is to restore self sustaining wild runs of Pacific lamprey in traditional fishing areas of the CTUIR. Restoration of Pacific lamprey in the Umatilla River may be challenging due to unknown aspects of their life history. A recovery plan for a species should include several strategies. Petersen, Barfoot, and Sauter (2000) state, “An overall recovery strategy should include habitat restoration, monitoring of the population, research of the life history, and an understanding of the population dynamics of the species.”

Resource managers may not appreciate Traditional Ecological Knowledge (TEK) as a way of knowing, or an alternative means to gain knowledge (Berkes, Colding, and Folke 2000). There is increased interest, however, in traditional knowledge as a legitimate and integral part in conservation biology and sustainable resource use in general. Agrawal (1995) questions whether a real difference exists between TEK and western science. For example, both TEK and western science contain virtually the same processes in gaining knowledge. Important components of each are: 1) accumulation of observations, 2) development of hypotheses, and 3) testing of hypotheses either by strict methods or by long term observations.

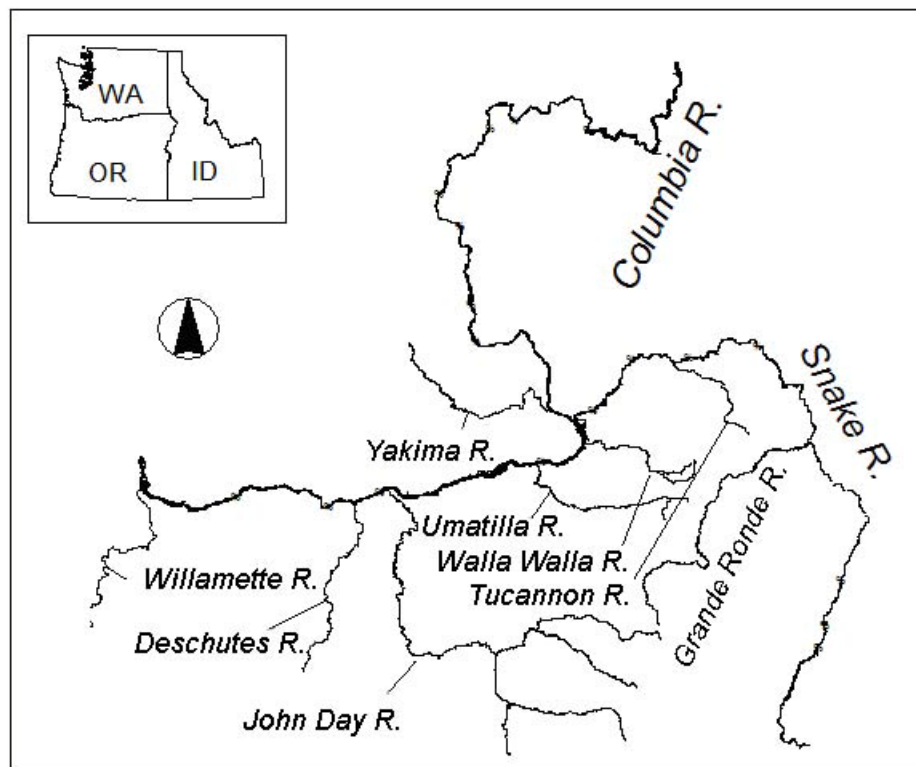


Fig. 1. Map of the Columbia and Snake river tributaries in northeastern Oregon and southwestern Washington.

TEK may assist in understanding Pacific lamprey life history and their historical status in the Umatilla River and surrounding sub-basins. Understanding lamprey life history in the Umatilla River basin will help managers identify potential factors limiting its recovery. Gaining TEK of lamprey from tribal members is essential because information from the scientific literature is scant. Perhaps of equal importance is documenting the value that the resource has for tribal members. Many species such as the lamprey are considered pests or trash fish by the dominant society, the result of which is the development of eradication programs or at best, a management policy of benign neglect.

It is presumed that during fishing, tribal members may have developed hypotheses to explain what was observed in nature. Our objective was to gain TEK about Pacific lampreys from indigenous peoples of the CTUIR. Specifically, tribal members may know the historical timing of adult migration into tributaries, location of spawning areas, larval rearing areas, and limiting factors in the Umatilla River basin.

Methods

Questions developed were designed to help us understand the life history and historical status of Pacific lamprey in the Umatilla River. From these questions, was developed a standardized questionnaire to be used in interviews with tribal members from fishing families of the Umatilla Indian Reservation (Table 1). To encourage tribal members to interview, a notice was published in the local newspaper (*Confederated Umatilla Journal*). Information sought was fishing site names, name of rivers fished, years of harvest, numbers harvested, seasonal indicators for harvest, stream conditions, gear used for harvest, dietary importance, and cultural significance. Twelve tribal members (ages 48 to 90) from the Umatilla Indian Reservation were interviewed from 1996 to 1999. Interviews were conducted at their homes or in the CTUIR's Fisheries office. All interviews were recorded on videotape or cassette tape for review and analysis. Tapes were replayed and questionnaires were filled out according to the response for each question. Verbal consent from tribal members to publish information was acquired.

TABLE 1. TRIBAL MEMBERS INTERVIEWED FROM 1996 TO 1999 TO GAIN TRADITIONAL ECOLOGICAL KNOWLEDGE OF PACIFIC LAMPREY

Number	Name	Age	Sex	Tribal Affiliation
1	Percy Brigham	90	Male	CTUIR
2	Elias Quaempts	78	Male	CTUIR
3	Armand Minthorn	48	Male	CTUIR
4	Alphonse F. Halfmoon	77	Male	CTUIR
5	Michael Farrow	48	Male	CTUIR
6	Ceceila Charlie-Bearchum	71	Female	CTUIR
7	Jay Minthorn	60	Male	CTUIR
8	Lillian Shocki-Spino	70	Female	Yakama
9	Eva Watchman	80	Female	CTUIR
10	Wes Tias	62	Male	CTUIR
11	Ethel "Tessie" Williams	67	Female	CTUIR
12	Earl "Taz" Conner	61	Male	CTUIR

Results

Note that the number refers to the informant in Table 1.

How long have you lived in this area? where were you born?

1. I was born in Salem, Oregon, and lived at Gibbon, Oregon since 1920.
2. I was born at Gibbon, Oregon in 1921.
3. All my life. I was born in Pendleton in 1948.
4. I have lived here since 1922, and I was born at the old homestead where I am living at now. Just north of the Umatilla River.
5. I was born in Pendleton in 1948, I was gone seven years in military service and I have been here ever since.
6. I was born up at Cayuse. I have lived here most of my life.
7. I was born here on the Umatilla Reservation on April 22, 1936.
8. 1928.
9. Most of my life, but I've been off the reservation a few times. I've lived up in Nespelem (Washington), and then I went to school down at Chemawa (Government Boarding School in Salem, Oregon). Those are the times I've been gone but I've been here most of my life.
10. About sixty years.
11. About sixty years. Was born in Cayuse, Oregon in a long tent.
12. Approximately 35 years and was born in Pendleton, Oregon in 1938.

How far back can you remember fishing?

1. I started commercial fishing in 1930 at Celilo.
2. started as a child.
3. I can remember back on the late 50s and 60s going out fishing at Catherine Creek, Fly Creek, McCoy Creek, Vey Meadows, Tucannon River, and Imnaha River. Those are the places that I can remember fishing for salmon.
4. Fishing like for any kind of fish? . . . we had a fish hatchery adjacent from our property. My father used to work there and he planted our creek in our property. So that we could fish every Friday. . . we usually had fish on Fridays. With friends we would hook Whitefish. We would use a small hook on our gaff.
5. When I was about 8 or 9 years old. By age 12, I was gaffing.
6. Since I was very young, my dad would only fish in the spring time . . . he fished until blue backs came. The particular place he fished was his . . . it was unspoken law that no one ever bothered your site . . . that's when people's word was good.
7. I started fishing as a child, and we continued to fish there for the subsistence and the income. We fished sometimes into November.
9. Well I was a very small girl, I don't know how old I was but, when school was let out at Saint Andrews, all the children went home and I was there alone. My Uncle, James Billy would come down from the mountains and he'd pick me up, and they'd be coming back from digging roots. And that would be in the spring, I don't know when school was out. May or June, it could have been the later part of May or early June, I can't remember that. I figure I must have been about seven, seven or eight, but I remember that when we'd get home they'd put their roots away. He used to have a great big wagon, the old people used to call it a Spring Wagon. We'd load that all up with camping gear and everything and we'd move down to the Columbia River right about Umatilla. I couldn't say exactly how many miles away from Umatilla it was, but it

was above there. But of course the dams flooded that. It must have been below Hat Rock because, when we'd run out of anything, my uncle used to walk down the tracks and he wouldn't be gone very long. So it must have been near Umatilla (likely near present day Wanaket on Columbia River, Rk 476). But I know there were bluffs and there was a plateau. Well we used to put our camp, what you would say drying shack. And my uncle used to fish for eels there and what ever he caught that night then the next day my aunt Agnes and I used to cut them. I know how to cut eels and how to dry them. And, I don't know how long we'd stay there. But my, when we'd catch up with our cutting, then my uncle, he'd go fishing during the night and then what he caught, we'd cut it the next day. Well I'd guess we'd cut eels until we had enough to last the winter. While we waited for the eels to dry we used to go up to the marshes and get those reeds that you make those mats with. We'd make those there too, and there used to be wild curds, used to grow along the river. My aunt Agnes used to make jelly out of it. Well, when our eels would get dry then we'd move home, and after we'd move home, then that's when we'd move to Celilo. And the only other place that I we used to get eels is where that Three-Mile Falls Dam is, until they closed it to us. But we never did dry that because we had no drying shack but we froze most of that. That's all I know about eels.

10. Back about 1949 or 1950.

11. Well being raised by a grandmother most of our activities, dealing with all of the woman issues. But fishing as always been a part of our lives because it was kind of a family life. Everybody always went in the directions of whatever time it was, whatever season it was, we all went together. We'd go to the mountains and go fishing there and fish was always part of the meal.

12. Late forties and fifties.

Who are some of your family members?

1. I have a son who lives right down here (at Cayuse, Oregon), Oliver Brigham.
2. Oh, my cousin Steve Hall, my cousin Dan, Pete Hall, Joe Sheoships.
3. Charlie Wacotsie, Lucy Minthorn (grandmother), Phillip Minthorn (father), Wilbur Minthorn (grandfather).
4. Mathias Webb, Gus Slickpoo, Charlie Wacotsie . . . there was quite a few of us.
5. Shippentower Clan, the Cranes.
6. Thomas Charlie (father), Sophie Wilson Charlie (mother)
7. We fished a lot with Charlie McKay, Bruce McKay, Henry Beavert, my Dad (Aaron Minthorn), Louie McFarland, Oswald Tias, and Bill James.
8. Alfalfa Jim
9. No, there was just me, cause other people would already be at Celilo, my Grandfather, Grandmother.
10. Sisters Veronica Tias and Eleanor Shippentower, my father was Oswald Tias and my mother was Mary Wildbill Tias.
11. My great great grandmother raised me and she was my teacher. We always ate traditional meals. Tuk-waa-sau (Tessie Williams, confirms, great great grandmother), she was the mother of the Johnlee's, and the Johnlee's of the Cayuse area, and there were four brother's. They were pretty well known for their horsemanship, there was a time that, this was kind of their life style.
12. My father and mother were the late Gilbert and Elise Conner.

Where did most people fish?

1. Celilo—everybody fished at Celilo.
2. Up Meacham Creek, Gibbon area, and up the Umatilla, Bingham Springs, Buck Creek, North Fork Meacham, and South Fork Umatilla, Celilo, Wallula, Blalock channel. We used to go up to the falls near Duncan (Meacham Creek, Rk 19.3) and fish. We used to go to the depot and pay a nickel and ride up to Duncan and fish back. We used to go up North Fork (Umatilla River, Rk 144) and fish. If we looked real pitiful, my cousin Steve and I would take our fish poles and ride up and fish back.
3. My family fished those areas I mentioned.
4. There used to be, before they straightened the river all out, it used to meander all over . . . there were logs, trees or whatever and they created nice holes . . . about every mile or so there would be a good hole.
5. We hit the Grande Ronde, Vey Meadows, Catherine Creek, Tucannon, John Day . . . mostly for salmon, and hook and line for trout.
6. In the spring, my dad fished at Spearfish. It's just upriver from the dam (The Dalles Dam) . . . it's all under water now. In the fall, the people that lived across from us fished at Celilo, but my father never did fish there. Across from Chenino there was another fishing site there.
7. Well we had different areas where we fished; some of the people had their own regular sites and a lot of us fished with the different members who had sites. Then we fished with people from different tribes. It was kind of a mixture of all the tribes fishing with each other.
8. Three Mile Dam for eels.
9. Celilo
10. Mostly at Celilo.
11. I guess when we did anything it was up to the forks, (Umatilla River, Rk 144), and I guess at that time prior to are days they would tell stories of how thick the salmon run used to be up the Umatilla River. There was fish all the time and the river was high and they told us a lot of times that they used to not have to worry whether there was going to be fish or not, it was always there.
12. Francis McFarland and I would hunt mostly up and down the Umatilla River and fish and swim, always looking for a nice swimming hole. From about Maudey Antoine's place (Mission, Oregon) to Thornhollow, Oregon. About fifteen miles was our range.

What species of fish did your family fish for?

1. Chinook and Steelhead both.
2. Salmon and eels.
3. Many of the times we fished there . . . at these area . . . one species we fished for is the whitefish, and the other was the salmon.
4. Just the boys we fished for whitefish and trout as our target fish . . . and suckers for the older people that enjoyed them.
5. Salmon and trout.
6. Spring Chinook, and bluebacks eventually.
7. I don't think there was a definite species in them days. They always said the bluebacks were good for the oil, and everything and the tules were good for drying, but it seemed like there wasn't a definite species, they were all used for subsistence.
8. Eels and salmon.

9. Used to catch Steelheads and Chinook. There was an old Indian thing that we believe, eels and fish could not be dried together. They had to be dried separately. We never did dry eels down at Celilo, we just dried fish. Whatever eels we did catch down there, we ate it. I don't know what it was, ah, whether the eels spoiled the fish or what it was, but the Indians never did dry eels and fish together.

10. All kinds, chinook, steelhead, jack salmon.

12. We would fish for trout and once in a while we would catch a steelhead.

Did you/your family ever fish for eels?

1. What they call Chief's Island there is a little creek running over there with rocks and the eels would run over there by the thousands. I caught enough eels for six different people there one night.

2. We used to fish for eels at Three Mile Falls [Umatilla River].

3. North Fork John Day, Middle Fork John Day, confluence of John Day and Columbia, another place was Tup-ta across from Prosser, Washington now on the Yakima River. North and South Fork Walla Walla River, Looking Glass Creek, confluence of Looking Glass and Grande Ronde River, Wallowa River, Minam River.

4. My friend and I, after the war, would go to Celilo out at Chief Island and there was scaffold with a nine foot drop off . . . the eels would hang on the basalt breaks. We would get a gunny sack and put as many as we could handle in the gunny sack.

5. Mostly locally . . . at Three Mile Dam, we would get 15 or 20 and that would last us for a while.

6. Oh yeah, my mother dried them.

7. We done a lot of that, and a lot of it had to do with people from here who would even pay the way to go down to pick them up such as Mrs. Craig. She used to hire us sometimes. We would be home yet, and she'd make it a point to pay our way down and give us so much money if we'd go down and fill her up sacks of eels, and there was a lot of people who came down that didn't fish. They had ways of trading for the eels.

8. Yes.

9. Celilo and Three-mile Falls Dam.

10. Yes.

11. Well eels were mostly caught kind of coming up the river. We never knew where they came from when we were small, because they had their own areas. But as we grew older they used to talk about Three-Mile Dam down in that location in Umatilla.

12. On the Umatilla, here and there we would see the eel.

Was there a popular area that people fished for eels?

1. Yeah, Celilo, nighttime is when the eels would come. They would hit the channel; a few would come up the channel. They could catch a few there.

How many people would you say fished this area at once?

It's hard to say they would be coming all night long in pickups and load up with eels and taking off. How many they got I don't know. A lot of people, we had more eels in one year than since (recently).

2. Just down here at Three-Mile Falls Dam.

4. The Slide and Albert Island (both near Celilo). Over on the Snake, and a place known as Asotin, Washington. "Hoastino" is the Nez Perce word for eel.

5. Three Mile because it was close. I fished at Priest Rapids Dam . . . I would climb around on the dam and go eeling. Seems to me . . . Walla Walla, Hanford Reach, NF John Day, and here on the Umatilla.

6. Spearfish and Three Mile Falls Dam.

7. There was an abundance of that you didn't really have to look for a certain place. A lot of them talked of Albert Island where you had to cross along cable to get them, I fished out on what they called Standing Island (at Celilo) and there was three or four areas where you could go out and get an abundance needed.

8. Three Mile Dam, Shears Bridge, Celilo, and Priest Rapids. They used to stack up like logs against the ladder, and we would put our nets below them and spit the water and the eels would fall in. You could get all you needed at Three Mile Dam.

10. Not really.

12. Only here and there we would see the eel attach it self to the rocks around the areas where there would be small water falls.

How many people would you say fished this area at once?

6. My father fished by himself.

7. Sometimes two or three, we had fishing partners, someone who you fished together with all the time and when the people came down, if there was a man among them, we had him come out and help.

8. Many people would come and go all day and night long.

9. There weren't any body else, just James Billy's family (Umatilla site for fishing of eels). But I remember way back when I was really small, I know my grandfather and grandmother used to go down there but I don't know where, and to tell you for sure, I don't know why we weren't down there. But I can still picture the place, how it used to look.

10. About three or four at one time.

Did your family have a special fishing site besides Celilo that you fished for eels?

1. Well the site everybody fished there (Celilo) but you wouldn't always fish there.

3. What I can remember there were specific areas that were used, specifically on the Tucannon River and on the Imnaha River, and too on Catherine Creek.

5. Not really, like I say we were tributary fisherman. I didn't really fish the mainstem (Columbia). I was brought up down there, and my family used to get eels at Celilo before The Dalles dam went in. My uncle Joe Shoeships used to repair nets at Celilo, people would trade him fish for repairs.

6. Spearfish, just above The Dalles Dam.

7. We didn't have a special fishing site. Everyone awaited the Celilo Feast. The eels were a big part of the Celilo Feast, and you will hear a lot of our elders talk of getting the eels right here at Three Mile Falls Dam. The eels could be caught here at Three Mile for the Celilo Feast.

9. Celilo and the Umatilla River at Three Mile Falls Dam and Columbia River near Umatilla. Above mouth of Umatilla River but below Hat Rock and Celilo Falls above The Dallas Dam.

10. Yes. There were scaffolds out in the middle islands of Celilo Falls.

12. No. Maybe just Celilo.

When did you know that the eels were going to run, and what time of year was that?

1. The eels would start to run when the water went down in June, but there was no place that we could get them before that.

2. Oh late summer.

4. Usually in the summer months they were always there . . . when the water came down because you had to go to Chief Island to get them, or find an area where there were rocks hanging . . . there were areas like this on the Washington side. The easiest place was Chief Island . . . you didn't have to walk so far.

5. Word of mouth. End of June, July . . . sometimes August.

6. It was just a known fact . . . everyone knew when they were running because you could see them in the water . . . springtime.

7. I think probably the latter part of the spring, and they run almost all summer.

8. April.

9. My Uncle James Billy and his family would come down from the mountains and pick me up after school was out, late May or early June, after the roots were gathered and put away. Spring time I always thought was eel time.

10. We knew in the early spring, between March and April.

11. This was mostly when I recall in the fall.

Any other signs indicating the run of the eels?

1. No, eels ran only at nighttime. Years ago before my time there was an area near Boardman that tribal members used to go to get eels. Ninety percent of the eel go up the Snake River. We used to go up the John Day at the little falls and get a few eels but not many. We went right at the mouth to get eels.

2. No, someone would just say that the eels were running, and down we would go.

3. What I've heard the old people say it was a time or times that they went to gather the eels . . . they knew it was getting close when the huckleberries and the choke cherries were getting ready . . . and also another indicator was the fish runs that would take place in September, they also would call it the fall run. But generally somewhere either end of July into August was the time they knew the eels would be coming.

4. No.

6. Not to my knowledge.

7. From here now it seemed like when the Root Feast came it seemed like the eels were available at that time so you could look toward the end of April and the beginning of May when they came into Three Mile Falls Dam.

9. Well it was usually after they had gathered their roots.

10. After the season would change, a few eels would come out early.

Describe the eels that were harvested? (color, size, etc.)

1. Most of the eels were called big blue eels, we didn't bother with them other ones. They just didn't have as much meat on them. They (big blues) were three feet long, pretty good size.

2. There were lampreys . . . lampreys. The blue eels or night eels.

3. That's one of my shortcomings; I never did harvest the eels. I had several opportunities but again I can go back on my oral histories . . . the eels that were harvested were harvested at night.

4. At nighttime when you seen them they looked kind of brownish . . . but they were large lamprey . . . bluish colored . . . (Alphonse confirmed that some would be three feet long).

5. They were dark colored in the Umatilla. We watched them in swimming holes . . . they were one and a half to two feet . . . maybe grayish or black.

6. They are about the same as they are now. Night eels.

7. The ones we caught were kind of a blueish-gray color, they had a yellow mouth on them, I notice the eels today don't have the color to them and they are a lot smaller. You could catch some of those eels that were big, they were big long eels, and they were big. The big blues or night eels were the ones we used to see when we were down there. We used to see tiny eels in the sand at Celilo.

8. Night eels. The long eels are the eels that I know.

9. Well they kind of look black to me and they must of been about, I'd say about foot and half long. The big one's were in all the females because they had all the eggs inside . . . The small ones we never used them we threw them back.

10. No, I don't remember the size.

11. They were all sizes; some were short and very fat. Some were long and gray and some shiny and just a grayish color.

What forms of gear did you used to harvest eels?

1. We used gloves. If you hooked one eel the rest would be gone as soon as the blood came out. We would start at the bottom of the falls and work our way up. If you started at the top and get one eel the rest would take off.

2. Hooks made from wire. When the eels would bump the hook, I would pull up and have an eel.

3. They would use gloves and grab hooks.

4. Hooks, canvas gloves, or eel nets. Eel nets were half inch mesh, double-knotted so it wouldn't slip . . . you would get one about eight feet long and take it (scrape) along the rocks . . . had to make sure everything was tight because they got out of there.

5. Gloves and gunny sacks, sometimes small dip nets, hoop nets.

6. Dipnet and Cotton gloves.

7. It depended on how close you were. If you were close enough, you put on a canvas glove and threw them out. If you were quite away off, you had an eel net with small mesh which the fisherman made, or you had the gaff hooks. Those are the ways that we caught them.

8. Our hands, treble hooks, eel nets, and gloves.

9. They used to have different nets for eels and different nets for salmon. They'd have small mesh for eels, its like they used to dip it.

10. Just my hands.

11. Most of the time they just about getting them by hand.

12. We would catch them by hand.

What were the stream conditions like when the eel runs were good in the past?

1. The water was low, we didn't catch to many eels till September when they really come in.

2. About medium. In the fall the water would get low and we would go fish up by Gibbon for trout by horseback.

3. They only thing that they indicated was when the moss on the rocks was long . . . which indicated low flow.

4. Blue-green . . . some clear water.

5. The water was fairly low in the Umatilla. The best place to go now is Oregon City; I would eel there with Yakamas, and Warm Springs people.

6. There was a channel the old wheels used to set in, after they outlawed that, the eels used to come up in the channel and it was swift and low.

7. It seemed like they followed a muddy water and a high fast flow, it seemed like that is how they began to come up.

8. I can't remember the water color, the water used to be low. We would see steelhead and salmon at the fish ladder at Three Mile Dam at that time. Just about everybody from up here used to go down there.

11. The water was definitely better then it is today. Because there weren't the traffic that there is along the rivers that there is today. And it was just a flow all the time, and it was clear.

Is there a specific year you can remember many eels being caught? If so, do you remember where this was?

1. Different times I saw them pretty thick in the channel. We would go down with a gunny sack, and one guy would spit in the water and they (lamprey) would fall in the sack. Right now we could catch a few near Cascade Locks with a dipnet.

2. Oh, it must of been about 1955. That's when they started the fish poisonings. "We want to get rid of the trash fish." Now the river is so bare that you can't do nothing with it. When they had chubs, shiners, bullheads, suckers the river was clean. They killed all them fish . . . the trout have nothing to eat.

3. No.

4. I think the average catch was about four or five sacks...whatever they could take care of to dry.

5. No, I think I'm too young to witness the good days . . . before the dams went in.

6. No.

7. It seemed like right until the of the flooding (The Dalles Dam flooding) that there was an abundance.

12. If there were any great runs, they were depleted before that my time.

How long did the eel runs last?

1. Oh, probably two months.

2. We used to go down there a couple times . . . we'd get two sacks full, or whatever we wanted. We would camp down there a couple days. Someone was always getting eels, so they were around.

3. I understand from ones that caught eels before that the time to harvest them was not a long time. They don't run too long.

4. As long as they were fishing for salmon the eels would be there also . . . there wasn't a real effort just to concentrate on eels.

5. This time of year . . . summertime . . . you could find them. At Priest Rapids, it seemed like the last part of July, first of August they were up there pretty good. At Three Mile, probably early July.

6. I don't know.

7. It seems like they lasted most of the summer.

8. Most of the summer.

9. It was in the spring when we dried our eels. Then when we'd move to Celilo that was during the summer and fall that we dried our fish. I'd say May and June.

10. About a month and half, something like that, yeah.

11. Well at that time there was such an activity, we just knew when they brought in eels and whether it would be every other day or a week it was just always there.

Did you ever see or hear of areas where eels spawned?

1. They spawned mostly around Thornhollow (Umatilla River, Rk 118.4), they hardly ever come above Thornhollow. One place that you can see them is Multnomuth Falls in that little creek.

3. Jasper Shippentower said that they used to spawn in Meacham Creek (confluence with Umatilla River, Rk 126.9) as well as the mouth of Meacham Creek.. He said that's where they used to spawn....that's where he also remembers getting the short eels.

4. No, well I know they used to spawn in the Umatilla . . . we used to go to Lostine (confluence with Wallowa River, rk 41.4) in the summer swimming, we did notice eels up there but never did bother catching them.

5. Mouth of the Yakima and Hanford Reach. I've seen them in the mainstem Umatilla.

6. There was a lake from where we stayed, and in the mud we would find the little eels.

7. No, that's one thing. But certain times of the year when you'd catch them or when the women would cut them for drying, they'd find a lot of eggs.

8. Lewis said that eels used to spawn below Three Mile Dam in a big pool, the same type of a area that a salmon spawns at. I'm not sure if they still spawn there or not, it's been a long time since I have been down there. I haven't been there since they fenced it off.

10. No.

11. No.

12. No.

Was there more than one season or run of eels per year?

1. Just the one run.

2. Gosh I never paid no attention. When we were young we never paid no attention, we just went. We was always out doing something.

4. It was just that one run that we were concerned with . . . everyone seem to know when the eels would come . . . there were no regulations, you went and got what you wanted and that was it.

5. I couldn't say. I think it was summertime because that's the only time I went after them.

7. At that time we never addressed different runs, it seemed like they were all in abundance so we never addressed these species and there runs.

9. It was usually after they dug their roots and had that all put away, then it was time to go down to the Columbia River to catch the eels. I always thought of spring as eel time.

10. No, just springtime.

11. Just the one certain time.

12. The fall run is when we would be down there.

What other types of animals/fish were abundant when the eels were running?

1. Suckers.

4. Before the rotenone there was mink, otter, skunk . . . there was a lot of mink on the river.

5. Mink, raccoons and skunks, crows, ravens, magpies

6. Carp, Sturgeon, the Silver sometimes.

7. There wasn't that many around the falls except for the seagulls. But never did see animals at the falls. When the water would drop down you could see ponds where carcasses were.

How were the eels prepared after they were caught?

1. Well, a lot of the Indians dried them, we took and skinned them then boiled them a little bit to get the oil out, then put them in the oven and roasted them.

2. Well my wife (Lucille) and I would go down to Three Mile and then take them up McKay Creek and clean them. We would make a fire and get a stick and put them on there and cook them and eat eels. Most everybody did. Some that were good smellers would smell the eels cooking and sit down and eat.

3. They were basically dried, that's the only way I have seen them.

4. They would clean them out . . . try to take the backbone out, stretch them out, use cedar to help keep them spread out and wind dry them.

5. We always baked them or roasted them over a fire. The ladies would clean and fillet them; they are hung in a garage and wind dried. Depending on how hot the wind was maybe a week to two week to dry them.

6. Dried them, just dried them.

7. We cooked them on a stick, or dry them. They also began to can eels in the later years.

8. We air dried them and froze them. I liked them dried better. We used to take them up to the mountains for lunch.

9. The way they used to roast, they wouldn't even gut it, they'd put it on a stick and make a circle out of it without gutting it and cook it like that. And when was done they'd cut it with a string, other times they'd just cut it in pieces and put it just like barbecuing, always roasted out side. I don't know why it just never did taste good in the oven. They'd always cook it out, I guess maybe the fire gave it better flavor.

10. Cut and dried.

11. Yes, that's the fun part, but that was a lot of work. At that time the elders, you know, didn't really complain. They were always just happy to have it because this was part of our life and it was part of their survival. So whenever anything came in, like the eels or the fish they were happy to get because they were either going to dry it or they were going to cook it for the family. But it was always saving some and cooking some now. So this was the time when they started thinking of how many eels they had and how long it was going to last. So then, they would either cut it or dry it or cut it and cook it on a stick like they used to a long time ago, out side. With a fire burning out side, just put the eels on a stick until they were done.

12. Our extended family had drying sheds and that's where the woman would say, you guys didn't get any eels, you better go get some eels.

When was the last time you/your family caught enough eels for a good feast?

1. The boys would go to Oregon City, and come back with a ton or so. You can still do it now.

2. Oh, last year we happen to get some that was caught at Oregon City. And we would get some at Fifteen mile Creek. Yeah my cousin used to go get them down there. Another area was where Tom Joe was born there is some falls near there, and that was a good area. We would catch a half of a wash-tub. It wasn't how many you caught; it was how many sacks you caught.

3. I think it was several years ago we had a root feast . . . the eels were got at Shears Bridge . . . Shears Bridge on the Deschutes River.

4. We weren't that good of fisherman . . . we would have dried eels, but we didn't make it our main course.

5. Probably about four or five years ago . . . they were from Oregon City. We rented a boat and got eels . . . some Norwegian people bought a couple from us.

6. Oh gosh . . . years ago, just before they dammed the river at The Dalles.

7. About three years ago. A family at Warm Springs catches them at Shears Bridge. But not this year, there has been a decline in abundances.

8. Last Friday, (29 November 1996) the McKay family had a feast and their family brought some from Shears Bridge.

10. 1952

11. We were fortunate in our younger years that the men didn't mind doing these things, because they could run up and down the river along all the areas to chase the salmon, So whenever they went in a distance to where they were, they would get the eels too about a hundred eels to a gunnysack and some times they would work on one or two sacks at a time.

12. We had quite an encampment down at Celilo. We would camp down by the channel. We had a bow tent we would put up down there. Twenty camps or twenty families any way, (1940s). Usually a couple of gunny sacks.

Do you still fish for eels? If not, why did you stop fishing for eels? What year did you last fish for eels?

1. I can't even fish. I haven't done much eel fishing after Celilo.

4. The last time we fished for eels was at Three Mile Dam just before they (ODFW) rotenoned the river . . . we went to collect trout . . . I remember seeing little eels floating in the mud.

5. The early 1960s was the last time we went eeling at Three Mile Dam. Thirty-five or forty eels. About the only choice for eeling anymore is Oregon City . . . that's all we have.

6. No, none of my family members fish. Because after we got the money from The Dalles Dam our site was flooded.

10. No. Because there's really no place to get them now. There're dams everywhere.

Did you fish the same sites for eels as you did salmon?

1. No, we had to have areas where eels would come clear out of the water. There was a pipe at Celilo that was wet, and I seen them eels work their way right up there.

2. No . . . eels you had to find an area where they could climb up. If you hooked them, once the blood got in the water the eels would disappear.

3. One was at Three Mile Dam. Another was on the Columbia near The Dalles on the south (Fifteen Mile Creek).

4. I don't know.

5. No, before the tribe regulated each other in ceded areas, I would dip net with my in-laws at Parker Dam on the Yakima River . . . caught my first salmon at Parker Dam.

7. The eels were in the fast rapids like the salmon.

10. Yeah, pretty close.

Were eels an important part of your everyday diet? When they were abundant, how often did you eat eels?

1. We would eat them everyday if we had them. Everybody ate eels them days. We would be down there fishing, and we would build a fire, cut them in links and hold them on sticks by the fire and roast them.

2. It wasn't everyday but it was quite a bit. They dried a lot of eels. In the winter time you would take those dried eels and there was nothing better. Eating eels is like eating popcorn . . . when one don't do, you have to eat another.

3. I understand what the white man says; the eel is high in protein but is also high in fat. I don't know if that is true or not. The eels was part of the July feast . . . because along with the salmon . . . this is what our older people tell us . . . that when time began the foods were created . . . the foods were here before us . . . and they said that the foods made a promise on how they would take care of us as Indians and the eels was one of those who made a promise to take care of us.

4. Eels were not a everyday food for my family.

5. I would say they were more seasonal . . . my family never dried them but we used to barter for them.

6. It was like a variety of food, eels were just another form of seafood.

7. They were one of the main ones, I would say that it was just a way of life at that time.

8. Part of it yeah, now it's just a luxury to know that there are some at somebody's table. Because we can't get it around here anymore, I get mine from somewhere else.

9. Oh yes it was. Just like now, we don't get any eels on this reservation. We have to go to the valley to eat eels, (Yakima Valley). I don't know were they get theirs. Ever since, the Indians used to get their eels down at Three-mile, then we used to freeze that for winter use. We gutted those and just put them in can whole and put a little water in there to keep them moist. But we never did dry them on the reservation.

10. Oh, about once a week, just for your taste you know. When you were sitting around you would chew on eels.

11. When they were dried, you could just take them and wrap them up when you went digging or camping of any time of the meal, like lunch meal . . . like lunch meal, so dried eels were good all the time.

What items could you trade for with eels?

1. When we fished at Celilo people told that they took there eels home and dried them. You have to have a warm dry air with a breeze to get them to dry right.

2. My folks did . . . my mother used to go digging and get roots put them in a bag and go to Mox'ee out of Yakima and trade for dried clams . . . or she would go down river to our relation and trade for dried fish.

4. I don't know . . . they weren't that popular for trading.

5. Usually the ladies did the trading . . . clothes, foods, huckleberries, sometimes people just give them to you. You didn't have to trade . . . part of being neighborly.

6. We never traded for eels . . . we gave.

7. Just about anything now.

10. One time I traded, I can't remember what I traded but I traded this one guy, he was looking for eels to fish for sturgeon. Oh, two boxes of apples.

11. I don't know if my grandparents ever did, just know that if company came, they would share it with them because they were happy to see them.

If eels were restored to these tribes fishing sites, would you fish for them again?

1. No, we never really fished for them, we took a few off of Three Mile Dam (Umatilla River, Rk 5.9) we couldn't get more than 10 or 12 there.

2. Oh yeah . . . yeah.

3. If the eels were to become available again, I think tribal members would take advantage of it.

4. Yes, I think there would be . . . for fresh eels for drying.

5. Yes . . . I crave them from time to time . . . barbecue them now.
6. Not at the rate of what people are eating now.
8. Oh yeah, I believe so because there's still a lot (of people) that use them.
9. Well I wish, ah, I don't know who would fish for It, I don't have anymore fishermen in my family.
10. Oh, if they'd come up you know I'd fish for them.
12. Yes.

What was the eels abundance when you saw people catching them, as compared to today?

1. I am not sure what they are now, but when the boys are down dipping shad, they seem to be hitting them quite regularly.
4. It's opposite extremes now . . . there is nothing, except for Willamette Falls . . . then on the Chehalis River there was also a good run, but you have to travel.
5. There is nothing to eel for really without damaging the run.
6. I don't no because I don't go down there.
10. There were a lot of eels then.
11. There are no eels, what ever happen to them?
12. At Celilo, there were great numbers.

Did you ever observe other animals feeding on eels? (eagles, hawks, seals, bears) Did they take large numbers?

1. The seagulls would catch them little ones sometimes. The mink must of. The otter probably too.
2. No . . . Oh dead eels yeah . . . we used to see dead eels down at Celilo. Eels down there . . . if you get hungry you catch the eels, make a fire, and cook it right there . . . Indian style . . . I miss all that.
3. One of the indicators when the steelhead were running was the fish hawk . . . Jasper used to say that when the short eels were running here there used to be the cranes or herons near the river.
4. No, I never have.
6. I haven't the slightest idea because the fishing area was quite away from where I was staying . . . we weren't allowed to go down to the river.
9. Well I don't know, I know, the Indians used to move down there, (mouth of Umatilla). Oh along time ago the Indians would wait along the railroad track and when the train would come by, on flat beds they would load their gear in there and ride down on the train and they always used to camp down there on the mouth of the Umatilla River. And of course there used to be clams down there too. Because I remember when we used to go around there we would see a lot of those shells. But I don't think there is anymore.
10. Oh yes. They'd just swoop down and get 'em and take off.
11. No.

Do you know any other information about eels that we have not discussed today?

1. We used to sneak an eel or two out of the ladders at Bonneville and John Day area for sturgeon bait. They never counted eels when they were accessing the income for Indians at Celilo, when they sold it. They (assessors) never came at night when the eels were running, so they were not counted as a fishery. Once we found eels in Beaver Creek when we were installing a bridge

2. Well, around here (Umatilla River) when they poisoned the river. After the railroad got done with Meacham Creek.. There used to be good fishing in Meacham Creek . . . the river used to come winding down . . . there used to be a lot of meadows, a lot of beaver ponds and marshes and a lot of grassy areas . . . and the river used to come meandering down and there was a lot of good fishing holes. Then the railroad came along and straightened it out because they didn't want their track near the water . . . and it all went to hell. I have seen what you may never see in your life time . . . I've seen salmon . . . I've seen the river blue-green . . . salmon bank to bank pushing themselves out of the river trying to get up. I go down there . . . and there was hundreds and thousands and thousands of salmon. Indians had laws when fishing for salmon, some of them were pretty tough . . . when commercialized fishing came in everyone was a fisherman.

3. Jasper Shippentower used to harvest the short eel at the mouth of Meacham Creek . . . he used to catch those at Cayuse (Umatilla River, Rk 107.8) also . . . they were part of our diet . . . those type.

4. No.

5. Not really.

6. My cousin said she had heard there were small eels going up the Umatilla.

10. No.

11. Oh, just that, the Indian People respected all of these foods. Took just what they needed and used just what they needed and tried not to waste it. So what ever they got, either in deer meat, or ah, elk, or fish, eels. It was always an amount they could use and not waste.

12. No.

Is there anyone else that you know that we could talk to about eels?

1. My son Oliver he collects down by Bonneville.

3. Inez Spino, Elizabeth Jones, Jesse Jones, Raymond Burke, Lawrence Patrick, Velma Burke, Teresa Eagle, Les Minthorn, Marcus Luke, Percy Brigham, Jasper Shippentower, Eva Watchman . . . that's about all I can think of now.

5. Inez Reeves, and Lucy Minthorn.

6. Elizabeth Jones . . . her sons still fish.

7. Eleanor Shippentower, Louis McFarland, Wes Tias, Jasper Shippentower, Shirley Speedius.

8. Inez Reeves, or Louie Dick, Jr., and Jay Minthorn.

10. Ah, Jasper Shippentower, but he's in Salem now.

Did tribal members from other tribes use the same fishing sites? Where might such sites be located?

1. The Colville fished up here (Celilo), I don't see why they didn't get paid.

3. The Wanapum, Nez Perce, Yakamas . . . at the mouth of the Walla Walla River . . . Wallowa River, Wallowa Lake, Imnaha, Minam those are jointly used with the Nez Perce . . . Mainstem and Middle Fork John Day was shared with the Warm Springs, Paiutes, and Columbia River Tribes . . . and mainly the North Fork was shared with the Paiutes and the Sho-Bans. And then Yakima River...Andrew Barnhart had a fishing site right at the mouth of the Yakima River, we called the Yakima River "Koots Koots A-nim-na" . . . that site was jointly used with the Yakamas and the Wanapums. Another up further called "Wina-wish" which is . . . what the white name for it? . . . I can't remember, anyway it's up further and it was jointly used by us, the Yakamas, and the Wanapums . . . at the corner of the Yakima and Benton City . . . Johnson Chapman used to have a fishing site there, it was used by the Yakamas and the Wanapums . . . I can go on and on.

4. Nez Perce, Yakamas.

5. When I was a young guy we would spend berry season at Tower Ridge. Then, the next summer at Potato Hill with the relatives and berry up there. (Then,) Howard Lake and Fish Lake . . . like a rotation.

6. It was more a family thing . . . there were some others across the river.

8. There used to be some people that came from Yakima Valley.

10. No.

11. I think that they used to talk over about Richland (Washington) there. There was an area when the Yakamas used to come over, and they'd meet, ah, at that time there was no boundaries, you know. Where ever they want to be along the Columbia River or the Umatilla River there was food there that was plentiful for the Indian People.

12. I've heard of our relatives that are related to the Lyle, Washington area and those tributaries over there. They've got fishing places over there that they use, both eels and salmon.

What do you think led to the decline of the eels?

3. The first is the dams . . . the dams killed everything. Second is when they treated the rivers, in particular when they treated the Umatilla River to kill what they call the trash fish . . . just wiped out everything . . . not only the trash fish but also the eels. But I think the dams are the major factor. If they would have some form of facility for them to do what they need to do.

10. Dams!

11. Oh, all of these changes in these last few years. The dams going up, the changes of the people that didn't believe how important all of this food was, and, all of the agriculture that came in. All the people that moved into the areas recognized these foods that we ate and they became familiar with it and enjoyed it and they started making use of it too. So it was people learning to eat these foods would also take it. So it was just the changes in everything through these years would have a tremendous affect on all of these traditional foods.

12. I think the dams had a lot to do with it. Stopped the salmon run, stopped the eel run. Too many dams on the river for them to get past.

Other than for food, what other uses was there for eels?

3. It is was also used as a medicine . . . we could use the oils to heal our bodies and our illnesses. I used to hear stories on how they would use the oils to remedy ailments. But I think it would be a wonderful thing if we could get our eel back in the river.

4. They kept the oil and used it for earaches, and other medicinal purposes. The oil was almost pure black like coffee.

5. Some use the eel skin like a wrap, for a fiber. Possibly glue, I can't remember if that was eels or salmon.

6. Some of them used the oil for something, but I couldn't tell you what.

7. I think every species were used, the different oils were as fuel for the fire.

8. The eel oil was too rich for me. We just let it all drip out. But they used to use (it). I remember, my aunt got as earwig in her ear and we were going berry picking and we camped. I remember waking up at night when I was real young and they put that eel oil into her ear and the earwig backed out.

9. Just the oil, if you wanted to collect the oil. I don't know what they used to use it for. But the oil off of the salmon they used to save that because it was right inside it. It was kind of, ah, I can't describe it, but they'd melt that and then when, then they'd make that real fine salmon you know, I mean, meal, they used to mix that oil in that.

10. Well ah, it was like I was telling you, people was coming along there, asking me how many eels I had, and I'd tell them. It was like: I'll give so much, you know, I mean, for sturgeon bait.

11. Oh, they used a lot of things, oil would be use for earaches and because of the oil, and people needed it in their diet.

Discussion

Biological questions

Our survey revealed that adult lamprey distribution occurred throughout many rivers in the Columbia River basin. Lamprey were historically available at harvestable levels in the mainstem Columbia, Umatilla, mainstem John Day, North Fork John Day, Middle Fork John Day, Yakima, Klickitat, Walla Walla, and Grande Ronde rivers.

The adult migration consisted of just one run that occurred from spring through fall. In addition, indicators of lamprey migration included the completion of root, huckleberry, and chokecherry gathering.

Tribal members described catching two different types of lamprey. One type was the big blue type or night eels and the other was the short or small ones. Siletz tribal members had similar descriptions of their lamprey along the coast. They described night eels and sun eels which are similar to our descriptions (Downey et al. 1993). It is suspected that tribal members are describing new migrants (recently entered freshwater) and near spawning individuals. The larger, gray-blue, night eels may be fresh from the Ocean; whereas, the smaller, brown colored, day eels may have spent a year fasting in freshwater and perhaps have recently spawned. We cannot rule out, however, the possibility of two life history types.

Tribal members recalled large run years which were linked to the absence of mainstem dams. One response described large runs before the Dalles Dam was built. The other response was specific to the year 1955, which may be linked to the near completion of McNary Dam. It is speculated that mainstem dams may have redirected a portion of the spawning migration to nearby rivers below the dams. Another reason for the demise of lamprey was proposed: "restoring the fishery" by poisoning "trash fish" using rotenone in the Umatilla Basin. This was once a widespread practice now falling into disuse because of its expense and because a new generation of fisheries managers now recognizes the value of native fishes and the ecological limitations of fish poisoning operations.

Tribal members described lamprey spawning distribution in the Umatilla River. Lampreys were mainly observed spawning in the upper mainstem Umatilla and Meacham Creek. One tribal member, however, described lampreys spawning near the mouth of the Umatilla River. It seems there is wide variability in spawning area selection of Pacific lamprey.

Pacific lamprey is part of the food web according to tribal members. Seagulls, cranes, heron, mink, and otter prey on lamprey. Cranes and heron apparently feed on lamprey during their spawning activity.

Tribal members described larval lamprey living in the mud and sand areas of the river. In addition, they observed larvae in the mainstem Umatilla and Columbia rivers. These observations describe the tributaries and mainstem Columbia as a continuum for larval rearing areas.

Cultural issues

What stands out clearly is that the lamprey was a cherished resource for the tribal elders. It still is a food item that is eaten with some regularity and with obvious relish. It holds some medicinal value for earaches and as a salve. Sadly, the lore associated with the lamprey could be lost. As this resource becomes rare, the opportunities to engage in the fishing, the eating, and learning about the medicinal applications become infrequent and the value of this resource to younger generations may not be transmitted. Although values extend beyond the utilitarian perspective (e.g. ethical, spiritual, cultural), it is important to document the practical value of natural resources. The culture of western natural resource management is imbued with the utilitarian point of view which is used to justify the existence or elimination of a species. Historically, this narrow mindedness has led to the demise of the natural diversity and its loss to human use. We must preserve the lore of lamprey fishers.

Conclusions

1. Two types of lampreys were harvested and observed by tribal members; short brown eels and dark long eels in the interior Columbia River basin.
2. Harvest of lampreys occurred from spring through fall.
3. Adult lampreys spawned from the mouth to the headwaters in the Umatilla River.
4. Juvenile lampreys live in the mud and sand areas of the rivers.
Tribal members have noticed major declines in lampreys within the Columbia River basin.
5. Pacific lampreys are culturally important to families of the Umatilla Indian Reservation.
6. Tribal members believe the decline of lampreys is related to declining habitat conditions. Mostly dams and then chemical treatments (rotenone).
7. Tribal members gathered adult lampreys and observed larval lamprey in the mainstem Umatilla and Columbia rivers.
8. Tribal members have noticed adults have keen sense of smell (spit and blood affect behavior).
9. Lampreys are a valuable resource for humans.

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IMPLICATIONS OF AN EXPERIMENTAL FRESHWATER SHRIMP HARVEST

Mark G. Plew

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ABSTRACT

Henrikson et al. (1998) propose that freshwater shrimp were an important spring resource for aboriginal peoples who moved widely to harvest shrimp that in some instances were taken in lieu of fish. This paper evaluates their arguments and presents findings of an experimental freshwater shrimp harvest and nutritional analysis that suggests that the use of freshwater shrimp was less optimal than proposed.

Introduction

This study reports the results of an experimental freshwater shrimp harvest conducted as a test of a hypothesis put forward by Henrikson et al. (1998) that freshwater shrimp were a significant spring resource used by aboriginal peoples who altered transhumant rounds and moved widely to schedule their harvest. Though demonstrating the potential biomass (calories) of shrimp per square meter, and that such phyllopods can be harvested with seines, the study, lacking systematic collection procedures, failed to document the amount of time spent in harvesting, the productivity of harvests, and an assessment of the success rates of variable methods of collection. Without such data we lack any means of calculating the optimality of the resource. This work evaluates the Henrikson et al. (1998) thesis and provides data on harvesting and nutritional values of shrimp which are of importance in assessing the likelihood that freshwater shrimp were a valuable and annually scheduled resource.

Background

Two orders of phyllopods are known on the Snake River Plain. These include Anostraca, the fairy and brine shrimp, and Notostraca, the tadpole shrimp. Though diversity, range, and numbers are not known, they are thought to be relatively abundant (Henrikson et al. 1998). The fairy shrimp have translucent bodies characterized by 19 or more segments within an adult size range of 10–100 mm (3/8–4 in.) (Dodson and Frey 1991). The tadpole shrimp has a shield-like carapace, between 35 and 71 pairs of legs, and adult size ranges between 10 and 58 mm (3/8 and 2 7/16 in.) (Pennak 1989:346–347).

Henrikson et al. (1998:75–76) describe the ethnographic documentation of the use of phyllopods in the Great Basin as “infrequent, at best.” Though noting the use of brine shrimp by peoples inhabiting the Great Salt Lake area (Morgan 1947:376) and by the Northern Paiute groups at Mono Lake (Davis 1965), they provide no ethnographic evidence of its use in Idaho. Further, the archaeological record does not provide direct evidence of basketry or nets that would have easily allowed the collection of shrimp (Plew 2000).

A primary assertion of the thesis outlined by Henrikson et al. (1998) is that freshwater shrimp constituted a resource of such magnitude that hunter-gatherer groups scheduled their harvest in some instances to the exclusion of spring salmon. Henrikson et al. (1998:83) write:

Assuming that modern harvesting is consistent with the past, it is possible that hunting and gathering people living along the middle Snake River opted to miss these fishing opportunities in order to arrive on the plateau in time for the shrimp harvest, if significant shrimp blooms, could be predicted in any way and their ranking as a resource was greater in terms of optimality (which remains to be demonstrated).

While the authors argue reasonably that freshwater shrimp may have been used by aboriginal peoples, they leave numerous assertions unaddressed. The authors describe the presence of ephemeral lakes and ponds that appear in the lava formations of the Snake River Plain during the early spring. Within the study area of 127,014 hectares (313,847 acres) surrounding the Craters of the Moon National Monument, the authors note the presence of 452 lakes. They provide, however, no data relating to size variations though they imply that water levels were as great as 3 or 4 ft. ($1\pm$ m) in depth (Henrikson et al. 1998:73). Such water levels are atypical of the playas with which we are familiar. Regardless, the levels of water and the duration of these ponds preclude their use as fisheries.

The use of these areas prehistorically, presumably for freshwater shrimping, is based on the presence around the perimeters of ponds of pottery fragments, groundstone, and utilitarian artifacts said to include scrapers and expedient tools and rock alignments extending toward the centers of ponds that are interpreted as “shrimping piers” from which people netted shrimp. The authors provide no evidence that such alignments are piers. As with their failure to consider the depth and size variations of ponds and ephemeral lakes within the study area, the authors present no data relating to the archaeological assemblages that allows assessment of the broader functions of the locales. While it impossible to assess these data since they are not presented, some observations can be offered about what appear as rather curious conclusions. The authors note a wide variety of artifacts that they observe are most consistent with residential bases (Binford 1980) but which they believe probably represent “the remains of long-term field camps, perhaps occupied for several weeks during spring and early summer” (Henrikson 1998:82). This seems curious since the authors state that “the seasonal nature of these ponds strictly limits resource availability to a specific time of year and discounting the possibility that these sites represent the remains of more permanent residential bases. Though the authors speak of several weeks, the availability of water and shrimp would have in many instances been restricted to a few days. This argument is further flawed as ephemeral lakes often fill during the summer and fall, thereby creating the same conditions that the authors associate with spring and early summer visits. The presumed intensity of occupation is based on the common presence of projectile

points, pottery, groundstone, and expedient tools. What appears odd is the presence of such formal tool categories in association with contexts the authors associate with freshwater shrimping. While the authors discuss at length the presence of shrimping piers they allude to, but appear to avoid discussion of rock alignments of the types that are common throughout the area and suggest hunting activity. As with other arguments, the authors fail to consider alternative explanations. Though the logic of steppingstones for water often no deeper than 30 cm (1 ft.) is questioned, it is pointed out that the movement of shrimp in pods is erratic, thereby making shrimping piers, useful only if shrimp were consistently aggregated in the same areas. It is also noted that the steppingstones might be just as useful in taking waterfowl.

While noting Daborn's (1977) estimate of the biomass/caloric value of freshwater shrimp populations as 2700 calories per meter, they do not address how variance in size and depth of ephemeral ponds/lakes or the duration of water would impact potential harvests and thereby the overall caloric or nutritional values of the shrimp. In a similar vein and while noting that phyllopod eggs can remain viable for a number of years in desiccated lakes, the authors fail to consider the implications of the common multi-year desiccation cycles of such ponds and lakes and the extremely short intervals of their existence.

The primary basis for demonstrating the use of freshwater shrimp was immunological analysis of ground stone found near playas. Of the tested sample, 50% ($n=10$) tested positive for *Lepidurus*, while a single sample tested positive for rabbit, and four produced negative results. If it is assumed that the results are accurate, the authors demonstrate that freshwater shrimp were sometimes utilized by aboriginal peoples—a conclusion with which we do not argue. Noting, however, that freshwater shrimp was an important source of calories and protein for birds and humans, they fail to consider the relative ranking of the resource to values for common species. The availability of water and shrimp that would have attracted birds and other animals may have been the primary reason the ponds were utilized by people. Yet, these obvious correlates require a demonstration of probability. The value of the resource—particularly one which reflects an improbable scheduling in which hunters and gatherers elect to exclude the use of more optimal resources for those with higher risks—must be evaluated by assessing the harvest, processing, and return costs.

Methods

Based on our joint experiences with ephemeral lakes, we selected Tadpole Lake, a playa located within the Idaho Army National Guard Orchard Training area some 24 km (15 mi.) south of Boise, Idaho. It covers approximately 4.6 hectares (11.3 acres) and has variable depths ranging from 10 to 30 cm (4 to 12 in.). The lake in its dimensions and location is quite typical of playas throughout the area. Aware that playa lakes fill and water levels fluctuate very rapidly, a location was sought that would allow daily monitoring so as to determine the best time to conduct an experimental harvest. Further, Tadpole Lake was selected as the junior author had monitored the lake for the presence of shrimp for a number of years. His observations suggested that shrimp were not always present even when the playa was wet. He had further observed only one instance in which tadpole shrimp were present in small numbers in the lake.

We began to inspect water levels in late April at a time when water and mean temperatures would affect the emergence of shrimp. Not until early May did Tadpole Lake contain enough water and the water temperature reach sufficiently high levels that shrimp began to emerge. Within a period of two days the lake dropped from its greatest maximum to an area

of shallow water on the east side of the lake where an area of approximately 20 x 40 meters (65 x 130 ft.) was marked by average water depths of between 10 and 20 cm (4 and 8 in.).

Two 20 cm (8 in.) straight end dip nets with 1.8 m (6 ft.) length handles were used. We initially walked parallel transects net-to-net from the southernmost edge of the pool. After six transects and little recovery, it was recognized that shrimp appeared to group in pods within small areas of between one and two square meters. A cursory examination of the pool determined that two such pods existed. Then end-to-end transects were walked across these areas. When the nets quickly became clogged with shrimp, the seines were washed with buckets of water poured through the nets two or three times. The remaining shrimp were placed in a separate container. It was found that within an hour of beginning the harvest, the numbers of shrimp collected by individual transects dropped from >100 shrimp to as few as 6–10.

Analysis

The total sample weighed ca. 1.7 kg (3.7 lb.). Individual shrimp averaged 5–6 mm (3/16–1/4 in.) in length. A sample of the collected shrimp was submitted for proximate analysis to Analytical Laboratories, Inc., Boise, Idaho. The proximate analysis was calculated per 100 gram units and is presented in Table 1.

TABLE 1
PROXIMATE ANALYSIS OF FRESHWATER SHRIMP
FROM TADPOLE LAKE PER 100 GRAMS

Moisture	Fat	Ash	Protein	Carbohydrates	Calories
87.2	0.9	7.3	3.71	0.89	26.5

Notably, the shrimp in this analysis consisted largely of water, with little fat or carbohydrates, and minimal amounts of ash and protein. While fat, ash, and carbohydrates approximate those for other common animal species including rabbits, deer, and salmon (Watt and Merrill 1963; Schrimsher 1967), protein values for these species are four times greater than those for phyllopods. Calories per 100 gram unit were calculated at 26.5 calories per unit—a rate lower than those for suckers (94/100g) and freshwater mussels (95/100g) (Watt and Merrill 1963). The total caloric value of the harvest is 450.5 calories. If we calculate the cost per hour and per person assuming minimal to no processing costs, the return rate is a mere 225 calories per person. While we recognize that fitting harvest time to the return rate, which decreased over the period of our collection, would affect the caloric return, we consider this negligible.

Conclusions

This study suggests a number of things. First, it was noted that while freshwater shrimp may be relatively abundant at times in ephemeral ponds and lakes, many ponds or playas do not fill annually owing to local conditions of runoff, rainfall, and temperature. It was also noted that

the distribution of phyllopods appears to be configured in a way that indicates bloom aggregation. This, it is argued, would likely affect the cost-benefit returns of the harvest of shrimp. Secondly, it was noted that during the narrow windows within which Tadpole Lake filled, it contained emergent shrimp, but became desiccated within a week. Notably, and due to water levels and temperature, shrimp were not present in the lake over the entire wet period. Our experimental harvest of freshwater phyllopods suggests that shrimp may be taken with the use of simple nets within short intervals of time, though the biomass of our harvest was relatively small (1.7 kg./hr). We cannot evaluate the extent to which aboriginal techniques and gear (presumably the use of nets) would result in comparable catch rates.

Proximate analysis of phyllopods indicates that the nutritional value is relatively insignificant at 26.5 calories per 100 grams per hour per two-person harvest. Such a return rate does not appear particularly optimal. The findings strike a notable contrast with Daborn's (1977) figures of 2700 calories/biomass per square meter. Even if biomass were measured at this level, it would never be uniform for a period sufficiently predictable to allow scheduling and harvest.

It is not argued that harvesting of phyllopods did not occur—only that environmental, technological, and nutritional factors may have rendered the scheduling and harvest of shrimp less than optimal. We do, however, on the basis of our findings disagree with the Henrikson et al. (1998) assertion, that a resource—which we believe is not particularly optimal—served to alter the logistical organization of groups who traveled considerable distances to harvest shrimp at the expense of what are clearly more optimal resources. It is argued that the relatively narrow windows open for scheduling and harvest and variable bloom aggregations would make this a rather risky strategy, particularly when coupled with low caloric return values of the resource. Though we think that aboriginal groups may have occasionally utilized the resource, we think it just as likely that it occurred fortuitously at times when groups found themselves near playas during spring-summer and perhaps fall. We also believe an equally plausible argument can be made that connects the use of freshwater lakes or playas to the hunting of birds and mammals that frequented the locations when water was available at different times of the year. The junior author has observed eggs, and in some instances adult shrimp, being deposited by wind along the playa shore at Tadpole Lake. Given this observation, it is suggested that the collection of eggs and perhaps adult shrimp, could have been harvested without nets and piers, and could have been more productive than shrimping. Such collection could account for the positive tests for *Lepidurus*. Though we believe that freshwater shrimp may have been used by aboriginal peoples, we do not think that Henrikson et al. (1998) make a strong case for its importance.

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THE ETHNOHISTORY AND ARCHAEOLOGY OF SHELLFISH UTILIZATION IN PUGET SOUND

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ABSTRACT

The rich ethnographic record of the Pacific Northwest Coast has allowed archaeologists to use ethnographic and historical accounts to reconstruct the prehistoric settlement and subsistence patterns of the aboriginal occupants of the region. These detailed accounts, however, have not been used to their full extent in the creation of viable archaeological and ethnographic models of subsistence and transhumance. By examining a discrete region of Puget Sound, this work examines the use of shellfish in both in the ethnohistoric record and in archaeological settlement pattern reconstruction. In so doing, a more robust model of transhumance and shellfish utilization is presented. Historical accounts from Puget Sound suggest that shellfish formed a major component in the subsistence of the Southern Coast Salish. An examination of the ethnographic record references to shellfish use shows that settlement patterns appear much more fluid and variable than in other coastal zones. Based on the ethnohistoric data, there are at least three possible categories of shell middens in Puget Sound: short- and long-term (seasonal) special purpose stations and relatively permanent residential bases. Some residential loci were occupied year-round while others were more seasonal in nature. Inferences based on the historic data are used to examine specific questions concerning the use of shellfish and the settlement pattern within the Puget Sound region and present a more feasible model that can be used by archaeologists.

INTRODUCTION

During the past 20 years, the study of maritime-oriented hunter-gatherers has gained importance as a specific research topic in archaeology and anthropology (Yesner 1980; Erlandson 1988; Erlandson and Colten 1991; Lightfoot 1993; Plew, 1996). Particularly, research has focused

on relationships between settlement patterns and subsistence orientation (Yesner 1980; Mitchell 1983) to regional resource use and social complexity. This has been true especially for the Northwest Coast of North America (Nash 1983; Isaac 1988; Plew, 1996). Despite the extensive ethnographic and ethnohistoric record for the southern Northwest Coast, particularly Puget Sound, this region has not been fully integrated into discussions of maritime adaptation. In order to fill this lacuna, the following are examined: (1) the ethnohistoric and ethnographic data regarding shellfish utilization; and, (2) the use of these data in archaeological settlement pattern studies of the prehistoric aboriginal inhabitants of Puget Sound. The focus is on shellfish for two reasons: (1) shellfish are significant resources for many societies throughout the world, particularly in terms of accessibility, ease of procurement, and reliability; and, (2) shell middens represent one of the most archaeologically visible aspects of coastal occupation.

In an historical and ethnographic sense, the literature is rich with references to shellfish use by the aboriginal occupants of Puget Sound; however, much of this information is scattered throughout diverse sources, including published ethnographic works (Haeberlin and Gunther 1930) and historical accounts (Vancouver 1798; Eells 1985). Due to this dispersed record, archaeologists have tended to deal in gross generalizations concerning settlement along the Northwest Coast, often ignoring the great diversity that exists within specific regions, particularly Puget Sound. Therefore, an in-depth review of the historical and ethnographic record is necessary and essential in order to evaluate the fluidity and variability of the settlement pattern of the Southern Coast Salish of Puget Sound and its relationship to shellfish availability

AREAL DEFINITION

Puget Sound as a region is defined by its modern hydrology (Fig. 1) and includes all drainages flowing into the Puget Sound Basin: the Deschutes and Nisqually to the south and all basins northward to the Pilchuck River along the eastern side, including the northeastern tip of the Olympic Peninsula (Nelson 1990; Suttles 1990a, 1990c; Kruckeberg 1991). This region includes a large area of protected saltwater with numerous inlets, bays, and channels as well as estuaries, rivers and streams. The littoral zone is emphasized within this work, although extensive terrestrial plant and animal resources also exist in the Puget Sound Basin (Kruckeberg 1991).

Puget Sound encompasses an extremely productive region with many overlapping microenvironments that create numerous habitats for shellfish assemblages. Between one and two million pounds of meat have been taken annually in the commercial shellfish industry of Puget Sound since the early twentieth century (Schink et al. 1983). Potentially, a much greater quantity of meat could have been taken by the Southern Coast Salish, especially when one takes into account the greater diversity of shellfish used by aboriginal inhabitants (Belcher 1985a, 1985b) than the few modern commercial species harvested today.

Kroeber (1939:30) defines the Puget Sound area as a sub-region of the Northwest Coast Culture Area. This region is considered distinct in terms of culture and environment (Haeberlin and Gunther 1930; Smith 1941; Mitchell 1971; Suttles 1990a). The area was inhabited by the Southern Coast Salish groups, primarily speakers of the Northern Lushootseed, Southern Lushootseed, and Twana languages (Fig. 2). Historical sources also contain references to the Southwestern Coast Salish who inhabited the areas to the west of Puget Sound and include those regions surrounding Grays Harbor and Willapa Bay (Hajda 1990; Suttles and Lane 1990; Thompson and Kinkade 1990).

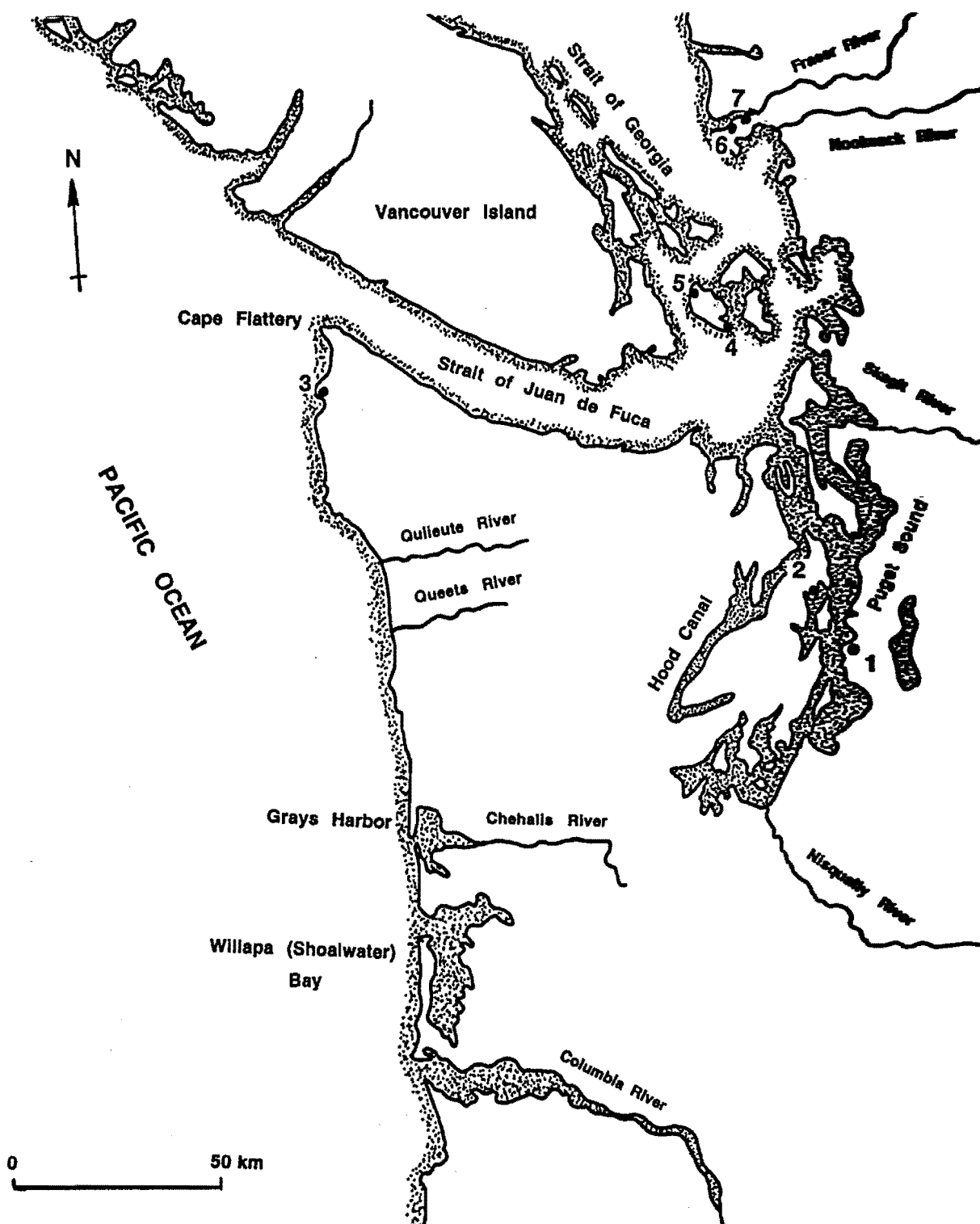


Fig. 1. Lower Northwest Coast and Puget Sound archaeological sites discussed in text: 1, Duwamish No. 1 (45-KI-23); 2, Old Man House (45-KP-2); 3, Ozette Village (45-CA-24); 4, Cattle Point (45-SJ-1); 5, English [British] Camp (45-SJ-24); 6, Glenrose Cannery (DgRr-6); 7, St. Mungo (DgRr-2).

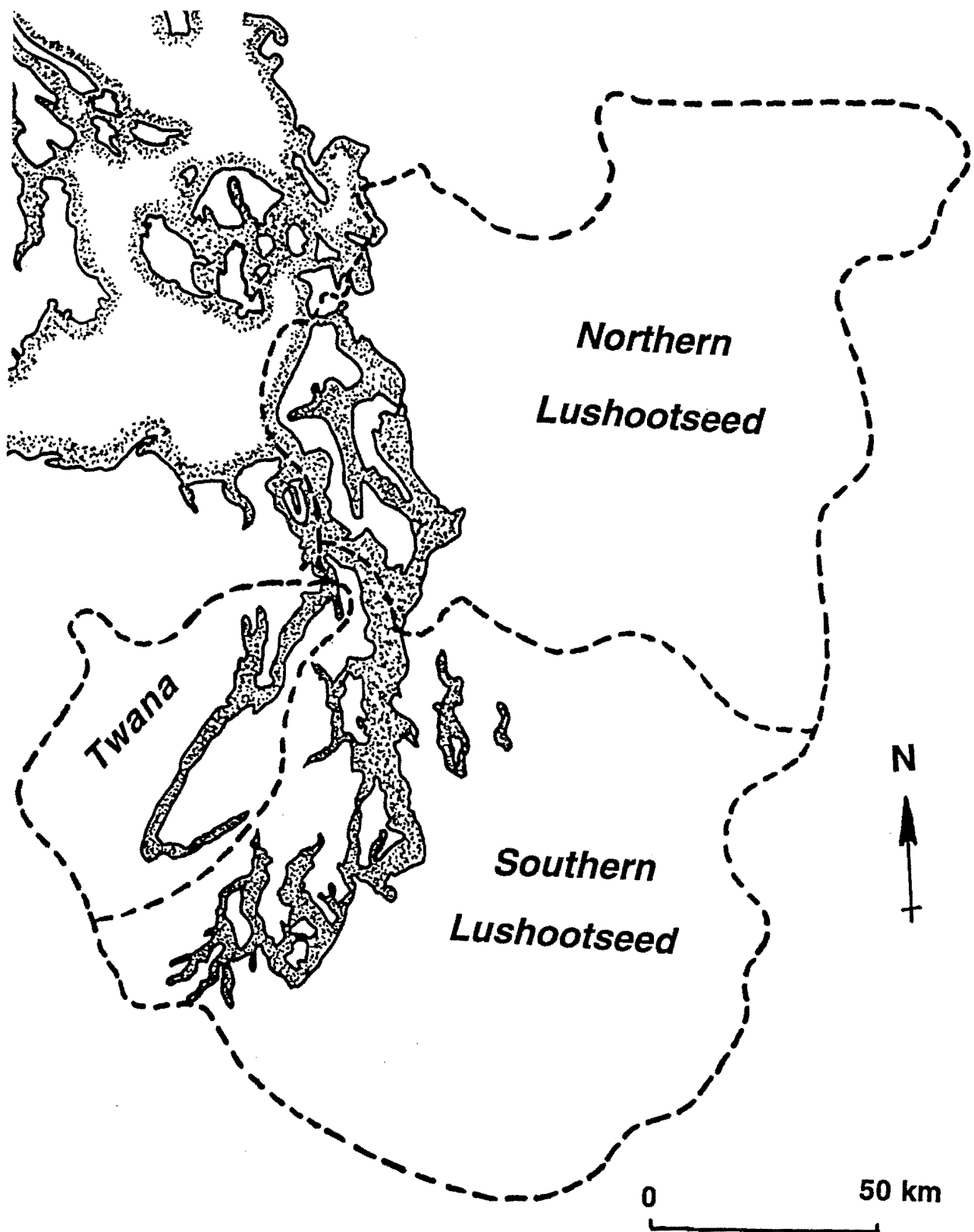


Fig. 2. Linguistic and cultural groups of lower Puget Sound (Suttles and Lane 1990:Fig. 1).

ETHNOGRAPHIC AND ETHNOHISTORIC DATA

Two sources of data are used to reconstruct protohistoric aboriginal shellfish utilization of the Southern Coast Salish: ethnographic and ethnohistoric sources. Each source has particular strengths and weaknesses. Ethnographic accounts of the Southern Coast Salish tended to be collected by professional anthropologists during the early and mid-twentieth centuries (Suttles and Jonaitis 1990). These data are based on informant interviews which recall a lifestyle that had not been practiced for several decades or from informants that may or that may not have ever practiced by the informants themselves.

Ethnohistoric data are based on direct observation of aboriginal activities during periods of early contact with Europeans or Euroamericans (Gunther 1972; Suttles 1990b). These first encounters were recorded by explorers or fur-traders in the late 1700s and early 1800s (G. Vancouver, A. Menzies, C. Wilkes); however, other important sources include reports made by individuals associated with the Native American treaty negotiations in Washington Territory during the mid-1800s (G. Gibbs, J. Swan). As with any historical data, these materials must not be used casually (Wobst 1978; Wood 1990) as the observations vary greatly in quality and thoroughness as well as the authors' motivations and cultural, economic, or political biases. These data must be evaluated in terms of the authors' cultural and temporal context.

Ethnographic Sources

Ethnographic sources tell us that aboriginal inhabitants of Puget Sound lived a semi-sedentary lifestyle with permanent villages located along the Sound at the mouths of rivers or small streams. These villages consisted of three to five houses with several surrounding structures arranged in a single row, facing the water. Politically, the village was the highest organizational unit and leadership was often task- or skill-specific. In general, the characteristics of leadership were based on prestige gained through various methods of wealth procurement and disposal. A person exhibiting these characteristics was called by the title of 'siEm'. Leaders often were the recognized heads of households and family units (Smith 1940:7-34; Suttles 1951a:303; 1990b; Barnett 1955:2-45; Taylor 1962, 1974; Suttles and Lane 1990).

Subsistence patterns in the Puget Sound Basin appear to have followed a form of "logistic mobility" (Binford 1980, 1982), with specialists moving out from a central place to procure resources for the community and then returning to the central place. Villages in Puget Sound served as central places during the annual subsistence round and were periodically abandoned as people traveled to various loci in search of particular foods. Although generally similar patterns of transhumance existed along the Sound, specific strategies varied geographically.

In the northern part of Puget Sound and the Straits of Georgia, winter villages were disassembled and later reassembled in other areas to serve as summer fishing settlements (Suttles 1951a). In the southern areas of Puget Sound, the village was not abandoned for any extensive period of time and was often inhabited year-round by the children and the elderly (Haeberlin and Gunther 1930:20; Smith 1940:7).

Women left the villages in the spring and moved to various specialized procurement camps throughout the region in order to gather shellfish, roots, tubers, and berries. These activities lasted until mid-summer when fishing became the major activity for all members of the community. Men procured fish, while women, children, and the elderly processed and cured it. Fishing continued

until late fall and early winter. Hunting occurred in the early fall, although sometimes seals and ducks were hunted in the winter by small parties (Haeberlin and Gunther 1930:20; Smith 1940:271; Suttles 1951a:67; 1990c; Elmendorf 1960:123; Suttles and Lane 1990). Temporary camps were set up at resource sites during seasonal transhumance and consisted of structures covered with mats and/or bark. At these camps, resources were procured and processed into a storable form, usually by smoking and/or drying. Table 1 presents food resources that were exploited and seasons of abundance and collection, according to the various ethnographic sources.

Shellfish gathering and processing usually were female tasks; however, elderly people and children also would participate. Shellfish were harvested by hand or with a digging stick. Sticks were used to dig clams and to break mussels and barnacles away from rocks. Then the shellfish were placed into open-work baskets. No special rituals were associated with gathering shellfish; any man, woman, or child could dig clams. There was no specialization or special training associated with shellfish gathering, unlike other subsistence pursuits (Smith 1940:271; Elmendorf 1960:123).

Women would leave the village periodically to gather shellfish at particularly productive areas. Occasionally, it was more profitable to go to a single area once a year rather than to collect throughout the year, especially when gathering for winter storage. If the areas were distant, men would accompany the women to offer protection from enemy assault as well as to assist in the collection. Women tended to work together in task-oriented groups at a single locus. Swan (1857:59) mentioned several Indian groups congregating in the Shoalwater (Willapa) Bay area: "Some of these Indians came as far as the region of Puget Sound."

Individuals maintained these sites, which were inherited through hereditary or stewardship rights. Shellfish beds were sometimes cleared of rocks to improve the substrate or to ease digging. Recipients held the right to utilize these resources as long as they used and maintained the site, although these sites were often overseen by the owner (Gibbs 1877:187; Haeberlin and Gunther 1930:20; Suttles 1951a:67-68).

Shellfish consistently mentioned in the ethnographic literature are the larger species of clams and oysters, particularly butter clam, horse clam, thin-shelled clam, blue mussel, and geoduck (Table 2). Additionally, sea urchins, chitons, and octopi were collected. Octopi were not usually gathered by women, but men procured these cephalopods with specialized spears and gaffs. Crabs are reported to have been taken by various methods, such as nets and spears (Smith 1940:271; Suttles 1951a:65, 505; Elmendorf 1960:123).

Shellfish also had value other than as a food resource. The accumulation of food was a sign of prestige and wealth, and dried clams were traded for other goods from various parts of the coast and the interior regions beyond the Cascade Mountains. The shell itself was valuable and as particular shells were traded across the Cascade Mountains their value increased. Dentalium (*Dentalium pretiosum*) shells from southern Vancouver Island were particularly desirable. Clam shells were often cut into discs and strung into long strands, whose length and quality were related to different units of value. Haeberlin and Gunther (1930:29) noted that such strands generally were only half as valuable as dentalia shells. Large mussel shells were also valued as they could be sharpened and used as knives and adze/celt blades as well as harpoon points (Gibbs 1855:38; Menzies 1923:28; Haeberlin and Gunther 1930:20; Smith 1940:245; Elmendorf 1960:291).

TABLE 1: GENERALIZED PUGET SOUND SUBSISTENCE ROUND

	Month											
Resource	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Deer												
Wapati (Elk)												
Waterfowl												
Seal												
Shellfish												
Salmon												
Camas												
Berries												

Note: Black represents primary times of harvesting; gray represents non-primary periods of time; white represents times of non-harvesting. Sources include: Gibbs (1855); Haerberlin and Gunther (1930); Smith (1940); Suttles (1951); Barnett (1955); and Elmendorf (1960).

TABLE 2: SHELLFISH NOMENCLATURE: LINNAEAN AND COMMON NAMES

Linnaean Nomenclature	Common Name
<i>Mytilus californianus</i>	California Mussel
<i>M. edulis</i>	Blue or Bay Mussel
<i>Modiolus rectus</i>	Giant Horse Mussel
<i>Protothaca staminea</i>	Steamer Clam
<i>Saxidomus giganteus</i>	Butter Clam
<i>Tresus (Schizothaerus) capax</i>	Horse Clam
<i>T. (Schizothaerus) nuttallii</i>	Horse Clam
<i>Panope generosa</i>	Geoduck
<i>Venerupis tenerrima (V. staminea)</i>	Thin-shelled clam
<i>Macoma secta</i>	Sand Clam
<i>M. nasuta</i>	Bent-nose Clam
<i>M. irus</i>	Polluted Macoma
<i>M. inconspicua</i>	Inconspicuous Macoma
<i>Ostrea lurida</i>	Native Oyster
<i>Pododesmus macroschisma</i>	Rock Oyster
<i>Clinocardium nuttallii</i>	Basket or Heart Cockle
<i>Chlamys rubida</i>	Scallop
<i>Littorina</i> sp.	Periwinkle
<i>Notoacmea</i> sp.	Limpet
<i>Collisella</i> sp.	Limpet
<i>Balanus glandula</i>	Acorn Barnacle
<i>Balanus cariosus</i>	Horse Barnacle
<i>Cryptochiton stelleri</i>	Giant Chiton
<i>Katharina tunicata</i>	Leather Chiton
<i>Thais</i> sp.	Snail
<i>Polineces lewisii</i>	Lewis Moon Snail

Ethnohistoric Sources

Various journals kept during Captain George Vancouver's expedition into Puget Sound in 1792 include information concerning shellfish procurement. Vancouver's ships were the first European vessels to enter the Sound past the Tacoma Narrows. The *Discovery* and *Chatham* explored the various arms and inlets of Puget Sound during the mid- and late-spring for less than four weeks between the months of April and May.

Many of the villages were deserted and infested with fleas at the time of Vancouver's entry. Vancouver thought that epidemics of small pox had decimated these villages. This was substantiated by Vancouver's observation of Indians with "pox scars" at Nootka Sound on Vancouver Island. The ships, however, had entered the area during spring while most people were elsewhere, gathering shellfish and plant resources. The village population thus was dispersed and may not have been entirely decimated by European diseases at that time (Taylor 1960, 1961, 1962).

The following excerpt is taken from Vancouver's journal (1798:261-262), dated Sunday, 20 May 1792:

In the meadow and about the village, many of the natives were seen moving about, whose curiosity seemed little excited on our account. One canoe had been near us, from which was thrown on board the skin of some small animal, and then it returned instantly to the shore. . . .

Towards noon I went on shore to the village point, for the purpose of observing the latitude: on which occasion I visited the village, if it may be so dignified, as it appeared the most lowly and meanest of its kind. The best huts were poor and miserable, constructed something after the fashion of a soldier's tent, by two cross sticks about five feet high, connected at each end by a ridge-pole from one to the other, over some of which was thrown a coarse kind of mat, over others a few loose branches of trees, shrubs, or grass; none however appeared to be constructed for the inclemency of winter. In them were hung up to be cured by the smoke of the fire they kept constantly burning, clams, muscles, and a few other kinds of fish, seemingly intended for their winter's subsistence. The clams perhaps were not all reserved for that purpose, as we frequently saw them strung and worn about the neck, which, as inclination directed, were eaten two, three, or half dozen at a time. This station did not appear to have been preferred for the purpose of fishing, as we frequently saw few of the people so employed; nearly the whole of the inhabitants belonging to the village, which consisted of about eighty or an hundred men, women and children, were busily engaged like swine, rooting up this beautiful meadow.

Vancouver described a temporary special purpose camp used for specialized procurement activities. Whitebrook (1953:123-124) determined the location of this village as Restoration Point on Bainbridge Island.

Archibald Menzies, the botanist/surgeon aboard the *Discovery*, also kept a detailed journal of events. In Admiralty Inlet on the 12 May 1792, Menzies (1928:28) recorded sighting several aboriginals at a temporary processing station where they were drying and smoking clams:

About five in the afternoon we observed smoke and some Natives on a Beach on the Starboard shore to which we pulled in with the Boats and on landing found two or three families occupied in drying and smoking of clams skewered upon small rods. We saw but a few men, the women and children having fled into the Woods at our approach and from all appearance their residence seemed to be a temporary one merely for the purpose of drying and collecting fish.

On 20 May 1792, Menzies (1923:28) observed several deserted dwellings near the Tacoma Narrows and made an interesting observation concerning aboriginal subsistence:

Men put off from shore in two Canoes to meet us, we made them some little presents to convince them of our amicable intentions, on which they invited us by signs to land, and the only one we found remaining on the Beach was an old woman without either hut or shelter, sitting near their baskets of provisions and stores, the former consisted chiefly of clams, some of which were dried and smoaked [sic] and strung up for convenience of carrying them about their Necks, but a great number of them were still fresh in the shell which they readily parted with to our people for buttons, beads and bits of Copper.

On 28 May 1792, Menzies (1923:42) made the following observation at Restoration Point: "This root [*Triandria monogina*] with the young shoats of Raspberries and a species of Barnacle which they picked off the Rocks along shore formed at this time the chief part of their wretched subsistence."

Scarce mention is given to any fishing activities while particular emphasis in the historical record is placed on gathering and processing activities. This emphasis is a product of the schedule of exploration. The *Discovery* and the *Chatham* entered Puget Sound in May, a prime month for food gathering at specific loci.

The United States Exploring Expedition of 1838-1842, under the command of Lt. Charles Wilkes explored much of western North America and eastern Polynesia. During 1841, the Wilkes expedition entered the Puget Sound region and recorded ethnographic observations as well as geologic and geographic data. Wilkes and his naval entourage entered Puget Sound in late April; thus, any observations made of aboriginal life again would reflect the spring cycle of the seasonal round. Wilkes comments on the abundance of shellfish in the area, although he mistakenly identifies some clam species as those he is familiar with on the Atlantic coast of the United States (Wilkes 1845:298-299). In a general discussion of the Nisqually Indians, Wilkes (1845:418) made the following comments:

They are all of a wandering character, and change their residence in search of food, which consists principally of fish, particularly shellfish. Clams are seen in great quantities among them, strung on sticks, upon which they have been preserved by drying and smoking. They also store up pounded salmon, and the cammass-root. In the fall and winter they are supplied with an abundance of game and wild-fowl, on which they live; but they are not upon the whole well fed, as they are little disposed to exert themselves to procure a supply of food, when they are not in actual want. In the winter several families live together in their large board lodges: when spring

comes on they break up, and resort in small parties to those places where they can obtain food most easily.

Gibbs (1855:38) mentions the collection of shellfish in the winter. Also he implies that villages may have been located near areas having productive shellfish beds:

The tribes living upon the eastern shore possess also the territory upon the islands, and their usual custom is to resort to them at the end of the salmon season—that is, about the middle of November. It is there that they find the greatest supply of shellfish, which form a large part of their winter stocks, and which they dry both for their own use and for sale to those of the interior. . . . The summer and fall they spend on the main, where they get fish and put in their potatoes.

Potatoes were adopted by many Coast Salish groups from the Euroamerican traders and missionaries and government officials who attempted to introduce agriculture to the region and attempted to reduce mobility of the Coast Salish (Suttles 1951b). Despite the abundance of shellfish resources, the historic and ethnographic sources suggest that the Northwest Coast was not a lush paradise (Suttles 1968, 1990a, 1990c; Suttles and Lane 1990). There is evidence that although there was a large and diverse number of seasonally available resources, the quantity of available resources varied from year to year. Miscalculations in the amount of food processed for winter storage and consumption may have caused famine and starvation in some cases. Alternative resources, however, such as shellfish were available to alleviate these short-lived famines (Blukis-Onat 1984, 1985; Belcher 1985a, 1985b). These alternative subsistence pathways existed within the society, thereby allowing the survival of populations during periods of famine (Meehan 1977, 1982).

Direct evidence of subsistence miscalculation comes from John Jewitt, who was held captive by a group of Nootkan Indians on Vancouver Island between March 1803 and July 1805. Through his intimate knowledge, insight into alternative resources during famine is gained:

We are also often brought to great distress for the want of provisions, so far as to be reduced to collect a scanty supply of muscles and limpets from the rocks. . . . This was, however, principally owing to the inhabitants themselves experiencing a great scarcity of provisions this season there having been . . . but a few salmon caught at Friendly Cove, a most unusual situation, as they generally abound there in the spring [Jewitt 1915:115].

Rev. Myron Eells (1887:816) discusses scarcity and resource alternatives:

There are some kinds of fish in their waters year round, though some varieties they do not eat unless food is very scarce, but as long as there [are] any kind of fish with the clams and mussels, which always abound, there is never any need of real suffering for want of food. The only suffering to which they almost voluntarily subject themselves to is from improvidence. Sometimes they live from hand to mouth, not having much food beforehand, and so when severely inclement weather in the winter came, the old ones were obliged to go for clams in the cold storms and this caused some suffering.

In economic terms, a greater return of food value per investment of effort is available with shellfish than with other food resources (Erlandson 1988). Shellfish in Puget Sound were gathered in the spring and early summer for winter storage, but became increasingly important as food stores diminished in the winter and early spring. In addition, shellfish may have been harvested in the winter to supplement a diet consisting primarily of dried fish and vegetables. This subsistence pattern is similar to one observed by Meehan (1977, 1982) in Arnhem Land, Australia; shellfish resources are not considered a particularly significant resource except during periods of stress and famine, during which they gain importance in the diet.

The "winter" villages broke down into family units in order to collect and process shellfish and vegetables in productive areas away from the village. These items were processed for trade and winter use and then taken to be stored at the village loci. Women from various groups gathered at particularly productive areas and formed task groupings in order to process the shellfish. Through winter and early spring, shellfish would gain importance as a resource as winter food stores became diminished or non-existent (Blukis-Onat 1984; Belcher 1985a, 1985b).

In summary, the ethnographic and ethnohistoric records suggest that shellfish were a highly desirable food resource due to their abundance and ease of procurement. Shellfish were available for consumption throughout the year, with perhaps the exception of paralytic shellfish poisoning (PSP) months (usually some portion of the summer). Waselkov (1987:111) suggests, however, that for aboriginal populations, PSP may not have been an important limiting factor in shellfish collection. Immunity to PSP can occur with limited and increasing exposure, particularly at an early age. In addition, added phosphates through modern industrial population may have increased the frequency and severity of the dinoflagellate blooms that cause PSP.

These various data reveal a pattern of residential bases that broke down into smaller special purpose procurement sites during different seasons, primarily the spring, summer and fall months. In the southern Puget Sound area, the main residential base was never completely abandoned with children and the elderly making up the bulk of the population during certain times of the year. In the northern Puget Sound area, some villages were completely relocated during specific seasons. The historic settlement patterns of this region were marked by their variability and fluidity based on human decision-making processes that varied with the overall availability of subsistence resources seasonally and annually.

THE ARCHAEOLOGY OF PUGET SOUND

Evidence of the prehistoric use of shellfish is most conspicuously seen through the presence of large shell middens along present and former littoral zones throughout the world (Waselkov 1987). A shell midden is an accumulation of shell that is primarily deposited culturally. Middens are often hundreds of meters in length and can be several meters deep. Shell middens possess unique chemical characteristics. Calcium carbonates from molluscs allow the preservation of faunal materials that normally do not survive in the acidic soils of many temperature zones (Sanger 1988), however, see also Linse (1992) for the effects of high alkalinity on bone preservation. This situation enables faunal, subsistence, and seasonality issues to be studied.

Archaeologically, Puget Sound, particularly the southern area around Olympia, is not as well known as other areas of the Northwest Coast (Fig. 1). This is due to the paucity of extensive archaeological excavation and survey, as well as the general lack of regional syntheses in southern Puget Sound (Carlson 1983, 1990; Nelson 1990). Central Puget Sound, near the Seattle-Tacoma

area, as well as northern Puget Sound, has been surveyed rather extensively (although not intensively); however, few excavations have been undertaken (Snyder 1956; Bryan 1963; Grabert and Larsen 1975; Gaston and Jermann 1975; Logsdon 1975; Lorenz et al. 1976; Jermann et al. 1977; Larsen and Jermann 1978; Campbell 1981; Greengo 1983; Stein 1992).

Nelson (1990) divides the prehistory of the Puget Sound area into two sequences: littoral and riverine. Only the littoral sequence is discussed here. Most of the early research of the region was focused on the Skagit River delta and the nearby islands. This research was influenced by the cultural sequences developed in northern Puget Sound and the Fraser River delta area (King 1950; Borden 1951; Carlson 1960, 1983; Mitchell 1971, 1990).

Coastal hunting and shellfish collection are known from the earliest sites. Nelson (1990:482) suggests that a maritime orientation of the cultures occurred sometime between 5000 and 2000 B.C. Most interpretations of specific sites are based on changes in subsistence patterns rather than on artifactual materials. This is related to the general lack of syntheses in the region as well as the low density of artifacts that characterize shell midden deposits.

Nelson (1990:484) suggests that the cultural adaptation for Puget Sound spread from the northern Northwest Coast to northern Puget Sound by 500 B.C. Many of the subsistence and economic patterns of northern Northwest Coast cultures, however, did not spread into the Puget Sound basin due to the lack of deepwater habitats for sea mammal hunting and fishing. Thus, significant differences exist in artifactual and faunal assemblages between the northern Northwest Coast groups and the Southern Coast Salish. Mitchell (1971, 1990) includes the area of northern Puget Sound and the San Juan Islands in his discussion of the Southern Strait of Georgia area. Culturally, these areas appear to be more linked to the Fraser Delta sequence (Borden 1951) than to more northern areas of the Pacific Northwest (Ames and Maschner 1999).

DISCUSSION

During the last few decades of research in Puget Sound, researchers have focused on large shell midden sites, with some reconnaissance efforts focused on relatively small areas delimited usually by specific cultural resource management projects. Therefore, it is difficult to evaluate the archaeological record over this landscape due to differential coverage from these two strategies. It is even more difficult to reconstruct the behavior patterns of the past inhabitants of the Puget Sound region from the imperfect record of the archaeological landscape that is currently available. A more regional focus is necessary in order to understand the settlement pattern and seasonal use of the landscape.

In order to understand the archaeological record and its relationship to the ethnohistoric and ethnographic records, it is necessary to examine specific issues that are important in current hunter-gatherer studies. These include seasonality of occupation over a landscape and how this is reflected in settlement function and size as well as the reconstruction of human transhumance within the region. This discussion attempts to examine how a simplistic rendering of the ethnographic record has caused important variation in the archaeological record to be glossed over. Additionally, taphonomic issues, cultural change, and environmental fluctuations are considered as important factors in the examination of the use of shellfish and the settlement pattern along Puget Sound.

With the local ethnographic and ethnohistoric data from Puget Sound, it is possible to develop and evaluate models of settlement systems based on the archaeological record. The shellfish species utilized by historic and prehistoric populations provide the linkages between studies of settlement pattern and seasonality (season of occupation). Settlement patterns of hunter-gatherers

often are correlated with particular distributions of resources over a landscape (Suttles 1951a, 1990a; Binford 1980, 1982). Specifically, the location of sites are based on their function (residential base vs. special purpose camp) and access to specific seasonal resources.

Settlement models from other areas of the Pacific Northwest are implicitly applied, often without questioning the assumptions and origins of the analogy. In this section, issues of settlement pattern and seasonality are examined along with various problems that can and have developed in regional prehistory primarily due to an oversimplistic model of prehistoric landscape use.

For most maritime-oriented societies, access to beaches and intertidal zones with abundant shellfish resources was a particularly important variable in site location decisions (Greengo 1983; Kellogg 1987), especially for residential bases. In a region such as Puget Sound where resources were seasonally abundant, settlement patterns with a residential base and satellite special purpose camps were commonplace and are recognized by the presence of shell middens of various sizes and extent.

Shell middens are composed of rapidly accumulating cultural strata, often punctuated by periods of slower accumulation, that are exemplified by soil horizon development. Carbonates released from the shells usually allow the preservation of organic remains in alkaline environments and create excellent "repositories" for faunal remains (Sanger 1981; Waselkov 1987; Linse 1992). Discussions in the archaeological literature of the past 15 years have attempted to assess the diversity of shell midden deposits (Sanger 1981; Stein 1984, 1992; Waselkov 1987) in order to determine the effects of changing settlement patterns on shell midden formation. Primarily, these models have attempted to define compositional and quantitative differences, using sedimentological models, between residential bases and special purpose sites based on faunal and artifactual indices.

Settlement Patterns and Site Function

Ethnohistoric and ethnographic information from Puget Sound reveal that residential bases periodically or seasonally broke down into task-oriented groups that established special purpose stations in diverse geographic locales. Shellfish procurement stations have been emphasized here; however, fishing stations and plant procurement sites were also important.

Following Barber (1982, 1983) and Lightfoot (1985), differences in shellfish species composition, artifact density, and the presence or absence of architectural features are used to define three types of shell middens. "Special purpose processing camps" have a single shellfish species comprising the major portion of the shellfish assemblage, a limited range of artifact types, and few architectural features. "Short-term residential bases" are intermediate between special purpose processing camps and long-term residential bases in terms of shellfish species diversity, number of artifact types, and architectural features. "Long-term residential bases" have relatively diverse ranges of shellfish species, artifact types, and architectural features (Barber 1982, 1983; Lightfoot 1985:297-299).

This functional model of seasonal settlement pattern is conspicuously synchronous (Abbott 1972). Intrasite occupation may fluctuate horizontally causing refuse and habitation areas to overlies one another. Additionally, if settlement patterns shift over time, in response to environmental or cultural change (Ritchie 1969; Matson 1976; Sanger and Sanger 1987), specialized resource stations may be disturbed or overlain by residential occupation and vice versa. Richness and diversity of shellfish species in a particular area may be exhibited in the numerous species in the midden deposits of specialized stations as well as larger, more permanent settlements. Additionally, fluctuations in sea level can cause shifts in micro-environments across the landscape and create changes in

settlement patterns and a redistribution of functionally distinct sites (Matson 1976; Kraft et al. 1983; Stein et al. 1992; Waters 1992).

The use of low shellfish species diversity to identify special purpose camps is **problematic**. The model cited above was specifically developed for southern New England, an area of **relatively** low species diversity in shellfish. More specifically, based on the ethnohistoric data from Puget Sound, specialized procurement stations often are located in areas where several habitats could be exploited from a single locus. Table 3 presents important shellfish species grouped by preferred habitat and tidal zone. As indicated, several species could have been harvested from a specific camp located near a particular littoral environment.

As mentioned above, little work has been conducted on small shell midden sites. During a survey of the Nisqually National Wildlife Refuge, however, 12 smaller sites were located (Larsen and Jermann 1978). The historic and prehistoric environment is thought to have been an estuarine environment prior to the development of deltaic environs originating from the Nisqually River. Excluding four historic sites, all others were small shell concentrations, probably prehistoric in nature. Due to the size and locations of these sites, the authors believe that these sites were probably specialized resource procurement and processing stations. This research marked the beginning of an understanding of the regional settlement pattern within the southern Puget Sound. Unfortunately, little additional research along this avenue has been done.

Site Location, Coastal Environments, and Sea-Level Fluctuation

Geomorphic processes change the interface between the sea level and the land. This fluctuating interface can cause shellfish species to vary as a result of micro-environmental fluctuation. These factors can affect the distribution of shellfish habitats throughout a region. Additionally, certain microenvironments are more sensitive than others to these types of fluctuations (Fladmark 1975, 1983; Kellogg 1988). Kruckeberg (1991) presents a discussion of littoral environments. Sea-level fluctuations change the baseline of rivers and change patterns of sediment load, deposition, and erosion (Schwartz and Grabert 1980; Grabert and Larsen 1975). In the Skagit River delta, Thompson (1978) suggests that changes in shellfish species are related to the exploitation of dynamic delta and non-delta environs created by deltaic development and sediment deposition.

In an analysis of microenvironments within the Puget Sound basin, Greengo (1983:81) has demonstrated that 246 sites (59% of the sample) are found along protected shorelines. The next largest categories are the inner coast (14%) and estuaries (11%).

Of the three saltwater microenvironmental types listed, that of Protected Shores (which includes bays, coves, inlets, narrow passages, etc.) had the overwhelming number of open camp sites. We would not expect as many places to be inhabited on the unprotected shores. Estuaries are relatively rapidly changing microenvironments and almost certainly site frequencies are too low because of erosion and burying of such places [Greengo 1983:62].

TABLE 3: HABITAT AND TIDAL ZONE FOR SHELLFISH SPECIES

Linnaean Nomenclature	Tidal Zone	Habitat
<i>Mytilus californianus</i>	Intertidal	Open or Rocky
<i>M. edulis</i>	Intertidal	Rocky/Gravel
<i>Modiolus rectus</i>	Subtidal	Muddy Sand
<i>Protothaca staminea</i>	Intertidal	Protected Sand/Mud and Gravel
<i>Saxidomus giganteus</i>	Lower Intertidal	Protected Sand and Gravel
<i>Tresus capax</i>	Intertidal	Protected Mud/Gravel
<i>T. nuttallii</i>	Intertidal	Protected Mud/Gravel
<i>Panope generosa</i>	Upper Intertidal	Sand/Mud
<i>Venerupis tenerrima</i>	Inter-Subtidal	Protected Sand
<i>Macoma secta</i>	Upper Intertidal	Protected Sand/Mud
<i>M. nasuta</i>	Upper Intertidal	Protected Sand/Mud
<i>M. irus</i>	Upper Intertidal	Protected Sand/Mud
<i>M. inconspicua</i>	Upper Intertidal	Protected Sand/Mud
<i>Ostrea luridea</i>	Lower Intertidal	Estuaries/Mud/Gravel
<i>Pododesmus macroschisma</i>	Lower Intertidal	Protected Sand/Mud
<i>Clinocardium nuttallii</i>	Upper Intertidal/Subtidal	Protected Fine Mud/Sand
<i>Chlamys rubida</i>	Subtidal	Gravel
<i>Littorina</i> sp.	Supratidal	Rocky
<i>Notoacmea</i> sp.	Intertidal	Boulders/Cobbles
<i>Collisella</i> sp.	Intertidal	Boulders/Cobbles
<i>Balanus glandula</i>	Supratidal	Rocky/Boulders
<i>Balanus cariosus</i>	Intertidal	Rocky/Boulders
<i>Cryptochiton stelleri</i>	Inter-Subtidal	Rocky/Cobbles
<i>Katharina tunicata</i>	Lower Intertidal	Rocky/Cobbles
<i>Thais</i> sp.	Upper Intertidal	Boulders/Cobbles
<i>Polineces lewisii</i>	Inter-Subtidal	Protected Sand

All of these environments represent microenvironments that can provide a **variety of shellfish** for human consumption and can represent a particularly optimal location for **large settlements**, probably in protected shoreline areas. Sea-level fluctuations can have a **tremendous influence on molluscan populations** and on the settlement-subsistence patterns of **human populations utilizing these resources**. Fladmark (1975:210; 1983) suggests that changes in sea level **would reduce or expand the extent of intertidal habitats** in direct proportion to the amount of **low gradient terrain** at the land-sea interface. Two factors are directly influenced by sea-level fluctuations: **low gradient slope** on each side of the tidal zone and the degree of equilibrium of **littoral and coastal-riverine geomorphic systems** (Fladmark 1983). Sea-level fluctuations appear to have **stabilized in the lower Northwest Coast ca. 5000 B.P.** This date has been associated with the appearance of **large shell middens** that apparently are correlated with sea-level stabilization (Mathews et al. 1970; Fladmark 1975:145-149).

Grabert and Larsen (1975:235-236) suggests that the development of **stable intertidal zones** and maritime-adapted cultures are linked:

We propose that the maritime orientation of the Fraser Delta aspect of Northwest Coast maritime orientation (as well as that manifested throughout Puget Sound and the Gulf and Vancouver Islands) may have been given its impetus by the **stabilization of local sea level** that would have left the coastal configuration much as it is **today**. Perhaps more importantly, the establishment of **stable and possibly larger, intertidal environments** capable of bearing larger molluscan populations would have **removed one limitation to human populations using these resources**.

It is possible that the necessary micro-environments able to support the **vast richness and diversity of molluscs** did not develop until the sea level stabilized at 5000 B.P. The **development of productive mudflats and estuarine environments** probably would have required **relative sea-level stability**. Substantially more research on the connection between sea-level fluctuations and **intertidal productivity** are necessary. During a time of rapid sea-level fluctuations, the **intertidal zones** may have been productive, but unpredictable. It is possible that mudflats and other **intertidal environments** shifted across the landscape in response to changes in the **land-sea interface**. Additionally, sea-level fluctuations can create drowned coastal sites, when over-run by **littoral sediments** and eventually drowned during a time of transgression, as well as **littoral sites in "inland" settings** during a time of regression (Kraft et al. 1983).

Ozette is not located in Puget Sound, however, Wessen's (1982, 1988) analysis of molluscs offers some interesting insights on prehistoric shellfishing. Specifically, **shellfish collection and utilization** were not random activities. Different collection strategies were used for different species and some seasonal difference occurred. Also intrahouse and interhouse distributions reveal that particular houses were linked with particular shellfish assemblages. Certain households appeared to have access to specific beach areas where particular shellfish originated. Certain households, thus had access to local beaches and only a few individuals were collecting from a single beach area.

Within the house floor deposits, Wessen (1982:195) suggests particular shellfish possessed a **significant social dimension**: "The relative status of individual socially-based collecting groups . . . is reflected not only by their access to decorative/symbolic/ceremonial shellfish, particularly exotic ones, but also by the extent and variety in their use of shellfish foodstuffs."

Using ethnographic analogy, Wessen (1982:195) was able to assign a social/ceremonial value

to particular shellfish species, particularly dentalia. Additionally, other exotic species not available locally are used to examine trade patterns, suggesting that the presence of these "exotics" represents participants in intra- or extra-regional exchange. Although examining issues of status and gender relations, Moss (1993) follows a similar strategy by noting the presence of particular shellfish species that are linked to status, such as dentalia.

Seasonality

In order to understand the settlement pattern and the seasonal round of resource procurement, it is necessary to reconstruct the occupational season of individual sites within a delimited region. It must be emphasized here that although according to ethnographic sources the residential bases broke down into smaller special purpose procurement sites during different seasons, the main residential base was never completely abandoned. During certain seasons, the villages were primarily inhabited by children and the elderly. However, other villages were physically relocated during specific seasons. The historic settlement patterns of this region were marked by their variability and fluidity, mirroring the variability and fluidity of the human decision-making process in relation to the overall availability of subsistence resources, both seasonally as well as annually.

Faunal remains provide the most direct, empirical means for determining the prehistoric season of occupation of an archaeological site. Biological knowledge of a specific indicator (ecological setting, response to environmental stimuli) and its seasonal range, however, are essential for precise determinations. Also, the use of several indicators as opposed to a single indicator allows a greater confidence in the determination (Monks 1981; Sanger 1981).

Most seasonality studies include presence/absence of seasonally abundant species and incremental growth studies of materials such as shellfish or teleost fish vertebrae (Ham 1976; 1982; Monks 1981; Maxwell 1989). Site sampling and formation, as well as post-depositional processes must be understood in order to place the sample within its cultural or natural context. The ultimate origin of a particular seasonal indicator, and its intrasite and chronological association are critical to seasonality determinations. Without these data, issues such as diachronic change in settlement patterns, site function, and seasonality are difficult to address. Shellfish growth phases are the single most important indicator of the season of shellfish harvesting. Oxygen isotope ratios, however, also can be used to determine temperature and seasonality of collection (Shackleton 1973; Bailey et al. 1983). Many species from the Pacific coast (e.g., *Mytilus edulis*) have been studied in detail and seasonal estimates have been obtained (Ham and Irvine 1975; Ham 1976, 1982).

Archaeological faunal studies in Puget Sound have not applied seasonality estimates in a rigorous manner. Primarily, only a few of the largest sites have been examined, thereby reducing the possibility of understanding the complete prehistoric settlement pattern. Ford (1989a, 1989b) suggested that seasonal transhumance is virtually impossible to demonstrate and that archaeologists have incorrectly placed an historical pattern of transhumance on the archaeological record. I agree with Ford that archaeologists are creating an incorrect image of transhumance; however, not for the same reasons. As stated above, the historical and ethnographic pattern of transhumance was fluid and variable both geographically and temporally (annually).

Although not within the Puget Sound region proper, the Glenrose Cannery site offers some insights into changing seasonal procurement of shellfish. Glenrose Cannery is located on the eastern portion of the Fraser River Delta (Matson 1976, 1983). Vertical and horizontal distribution and diversity of shellfish species reflect changes in the local littoral environment (related deltaic sediment deposition) as well as site function. Seasonal procurement has fluctuated through time.

During Component III (Old Cordilleran Phase—around 8000 B.C.), collection occurred **primarily** in the winter or early spring, focused on the silty or muddy beaches. During Component II (St. Mungo Phase—2000-1200 B.C.), however, harvesting occurred at sandy or gravelly beaches **during the late summer**.

A NEW MODEL OF TRANSHUMANCE

A simplistic model of transhumance is prevalent in Puget Sound archaeology. This model basically states that villages are occupied during the winter and then during much of the **remainder** of the year, the populace disperses to various special procurement stations. This **reconstructed** transhumance pattern that has developed in Puget Sound is primarily due to the use of an **improper** and simplistic analogy that has not been tested using archaeological data. For example, it **would be** relatively easy to examine seasonality at a variety of sites using shellfish remains. Shells are **usually** deposited in the area near consumption or processing. During processing, the shells are **discarded** and only the meat is brought back to a base camp. Therefore, shells should indicate the season of occupation of a specific locale. This model suggests the following:

1. **Settlement Patterns.** Based on earlier archaeological assumptions, shellfish **procured** and disposed in a residential base within Puget Sound would probably indicate a **winter** occupation; however, according to the historic record, these areas were **never totally** abandoned for long periods of time. In fact, shellfish collection in Puget Sound was probably year-round (Belcher 1985a, 1985b). Additionally, due to shifts in the **settlement** patterns, residential bases could be underlain or overlain by special purpose **camp**s. These archaeological deposits probably would reflect a different occupational phase in the site's history. Special purpose stations would probably indicate **season of procurement**, if the faunal assemblage remained at the site.
2. **Shellfish Harvesting and Storage.** Food resources found at a site may not **be directly** related to the season of occupation, the resources may not necessarily indicate the **time or place of consumption**, as storage technology adds problems to seasonality studies. Food can be procured, processed, transported, stored, and consumed months apart (Ford 1989a). However, shells from a particular site represent near-site collection and **on-site** use of these animals, as indicated in the ethnohistoric and ethnographic **record**. If shellfish were obtained at a special resource station, some distance away from a **main camp**, usually only the meat was taken back (except in the case of molluscs specifically harvested for the trade value of the shell).
3. **Seasonality and Transhumance.** If a group inhabited a site at different seasons over a number of years, a year-round occupation may be indicated from the available **data**. ethnohistory can make us aware of these patterns, but the application of ethnohistory directly to the archaeological record can be misleading (Wobst 1978; Ford 1989a). Through the examination of the specific contexts of shellfish within a site, problems of diachronic change in settlement function and seasonality can be minimized.

Shellfish were an important resource to the Southern Coast Salish of Puget Sound. Settlement location was influenced by the location of intertidal resources that could be collected year-round, while specialized shellfish procurement camps were present across the landscape during the spring and summer months. In terms of ease of procurement and reliability during famine, these resources would gain importance.

CONCLUSIONS

This is a more appropriate model of shellfish utilization that is generally presented in the relatively scant archaeological research in the Puget Sound region. These simplistic models are based on ill-founded assumptions of site location and seasonal round. The use of the term "winter village" suggests that a bimodal pattern of winter congregation and spring, summer, and fall dispersal characterized the settlement patterns of Puget Sound. By examining the ethnographic and ethnohistoric records in detail, however, one can readily see that the bimodal pattern of settlement in Puget Sound is overly simplistic and probably incorrect in most cases.

A more regional approach to the prehistory of the region is necessary if one is to more fully understand the prehistoric use of this landscape. In this manner, a variety of site sizes can be identified and then examined in order to understand site function and season of occupation. Few sites have been examined in order to understand the season of occupation and those that have been studied are only those large sites such as Duwamish No. 1, Old Man House, and English [British] Camp. Therefore, it is difficult to relate these sites to their local and regional landscapes.

In addition to these concerns, one must understand the stratigraphic context as well as the taphonomy of site in order to develop robust models and reconstruct the seasonal round of the region. Only more detailed regionally-focused research in Puget Sound may help to elucidate some of these vexing issues concerning prehistoric seasonality and settlement pattern.

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NO BONES ABOUT IT: THE EFFECTS OF COOKING AND HUMAN DIGESTION ON SALMON BONES

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Abstract

An experiment was designed to test the resilience of salmon vertebrae to the combined processes of cooking and human digestion, as well as the effects these taphonomic events would have on remnants of salmon meals in the archaeological record. Salmon bones were subjected to boiling and roasting with one raw, uncooked sample to act as a control. None of the bones survived the human digestive process.

Introduction

The problem of differential salmon bone preservation in pre-contact Northwestern sites has been studied by researchers in the past (Butler and Chatters 1994; Lubinski 1996) but experiments where the effects of cooking and human digestion are directly addressed have been carefully avoided by most archaeologists. Although it is not surprising to find that professionals are reluctant to root through their own feces, studies of this nature are required to understand the processes of site formation and taphonomy. Valuable information about human foodways and uses of activity areas in and about dwellings can be gleaned through coprolitic studies.

Methodology

For this experiment, an average sized pink salmon (*Oncorhynchus gorbuscha*) was acquired from a local supermarket. The vertebrae nearest the head and tail were not used as the larger, more uniformly sized centra from the mid backbone seemed most suitable. Following different preparation methods, three sections of the vertebral column were ingested by the author. The use of marker foods to provide indications of when to begin and end each phase of the experiment has been used by recent researchers in similar studies (Jones 1986; Nicholson 1993; Crandall and Stahl 1995). I chose to use sweetcorn (which was common in all cases mentioned above) as well as shelled peanuts for my study.

Stage 1

In preparation for this stage approximately 200 g of sweetcorn was eaten. Two hours later a three inch wide section of fleshy-backbone was boiled for ten minutes and then consumed after the sharp spines were removed from the vertebral centra. Another two hours were allowed to elapse before 200 g of shelled peanuts were eaten. The backbone was ten vertebrae long and was left with flesh attached because "a considerable amount of meat is always left on the backbones" (Hayden 1997:90) as the ethnographic evidence for the interior Plateau of northwestern North America suggests. Mastication was kept to a minimum in hopes of facilitating the bones' survival in my digestive system. Feces were collected for the following three days.

Stage 2

The second stage of the experiment was conducted on an equally sized portion of salmon and only 100 g of corn was eaten during the same meal. This time, the meat was roasted in an oven for 15 min. at 400°C which falls within the range of traditional roasting temperatures in the Lillooet region (Brian Hayden, pers. comm. 1997). The spines were cut away from the vertebrae as in the first example. Peanuts were ingested the following morning in hopes of providing an accurate gauge as to when the meal had passed through my system completely. Again, three days were allowed to pass before the third and final phase of the experiment was conducted.

Stage 3

For the last part of this study, a third section of salmon backbone, ten vertebrae in length, was consumed raw to provide some semblance of control on the experiment. The control was needed so that comparisons between recovered materials could be made to determine the degree to which each cooking method affected digested bone. The meat portion was allowed to thaw at room temperature prior to ingestion as it had been already stored in a freezer for one week. The spines were cut away as in the previous stages.

Fecal Examination

In all cases, feces were collected daily and all contents were screened through a 1 mm mesh screen. It was found that dilution was necessary prior to screening. This was done with warm running water to help the process of disaggregation. The process is long and tedious without the luxuries of laboratory space to allow for overnight soaking as was done in the studies mentioned above (Calder 1977; Jones 1986; Nicholson 1992; Crandall and Stahl 1995). This author would recommend at least one night's soak to fully dilute the samples. Manual disaggregation/dilution provides an up close and personal relationship with the samples that would be wise to avoid.

To facilitate the identification of the sample materials, all matter suspected of being bone was removed from the screen and placed in a solution of rubbing alcohol overnight, to further remove any fecal material.

Results

The morning following the initial course of marker foods and salmon bones resulted in a sample that contained both of the marker foods and no macroscopically visible bones. On none of the following three days were any bones whatsoever found, despite careful scrutiny.

For the second course, the use of marker foods was modified. This proved to be an improvement but both markers were present in all samples so their use was discontinued. Again, there were no bones resulting from the ingestion of the vertebrae.

The third and final run also provided no identifiable materials. As in the previous courses, the material I had initially believed to be cartilaginous remnants of the ingested centra was identified as cellulose matter from incidental meals.

Discussion

As is the case in many scientific explorations, the apparent failure of my experiment has revealed information that I had not considered at the onset of my search. The negative evidence offered by this study is of interest because the effects of cooking and human digestion can be listed amongst the known taphonomic agents that can account for the absence of salmon bones in archaeological sites. Any humanly digested bone elements that do turn up will only be representative of a small portion of the bones consumed, and markedly less than that when various taphonomic factors such as density mediated degradation are taken into account.

Of course, this study is flawed due to a markedly small sample size and no concrete conclusions can be drawn as yet, however, the results of this experiment are stimulating and may prompt further research. When more studies along these lines have been conducted we will have a better picture of the effects of the human digestive system on salmon bones in the archaeological record.

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THE ARCHAEOLOGY OF STRAITS SALISH REEF NETTING: PAST AND FUTURE RESEARCH STRATEGIES

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Abstract

Reef netting of sockeye salmon constituted one of the most important seasonal subsistence strategies of the proto-historic Straits Salish of the southern Georgia Strait. The social relations of this highly productive and labor intensive fishing technique, together with its limited geographical distribution, combine to make reef netting a unique means of production. Despite this importance and uniqueness, however, only a handful of sociological studies discuss reef netting (most only in passing), while archaeologically reef netting has been a largely unknown quantity. A history of research into the political economy and archaeology of reef netting is briefly discussed, recent estimates of the antiquity of two reef net sites by underwater archaeological methods are reported, and several future research strategies that may lead to greater understanding of this unique technique and the role it played in prehistoric Straits society are proposed.

Reef netting as practiced by the Straits Salish has long been recognized as a unique productive technique. Over the years a number of people have described different attributes of its material technology and social importance, but it has only been very recently that attention has been turned to determining the antiquity of this fishing method. The intent of this essay is to review what has been accomplished to date and make suggestions as to what we might do in the future.

The Straits Salish are a linguistic and cultural subdivision of the Coast Salish language family, who traditionally occupied the southern Georgia Strait region: the southern Vancouver and Gulf Islands, the San Juan Islands, and the coast of northwestern Washington. The Straits are comprised of seven dialect groups¹ occupying their own historic territories, from east to west: the Sooke, Klallam, Songish, Saanich, Lummi, Semiahmoo, and Samish (Fig. 1).

The Straits Salish occupied and exploited a maritime-littoral environment, fishing and foraging along the coastline and hunting inland. Like many foragers, they organized their subsistence activities in a yearly round, in which "everything had its time and place" (Suttles 1951:57). Many of these regular subsistence practices were similar to those of their other Coast Salish neighbors, including a reliance on the Pacific salmon species as an important source of their subsistence for much of the year.

Despite the fact that the territories of the Straits did not contain any significant salmon spawning streams, the Straits accessed this resource through a unique means of subsistence production which we know as reef netting. Compared to the salmon procurement techniques of their neighbors, such as dip nets, weirs, and bag nets, the technology of reef netting is highly sophisticated (Fig. 2).

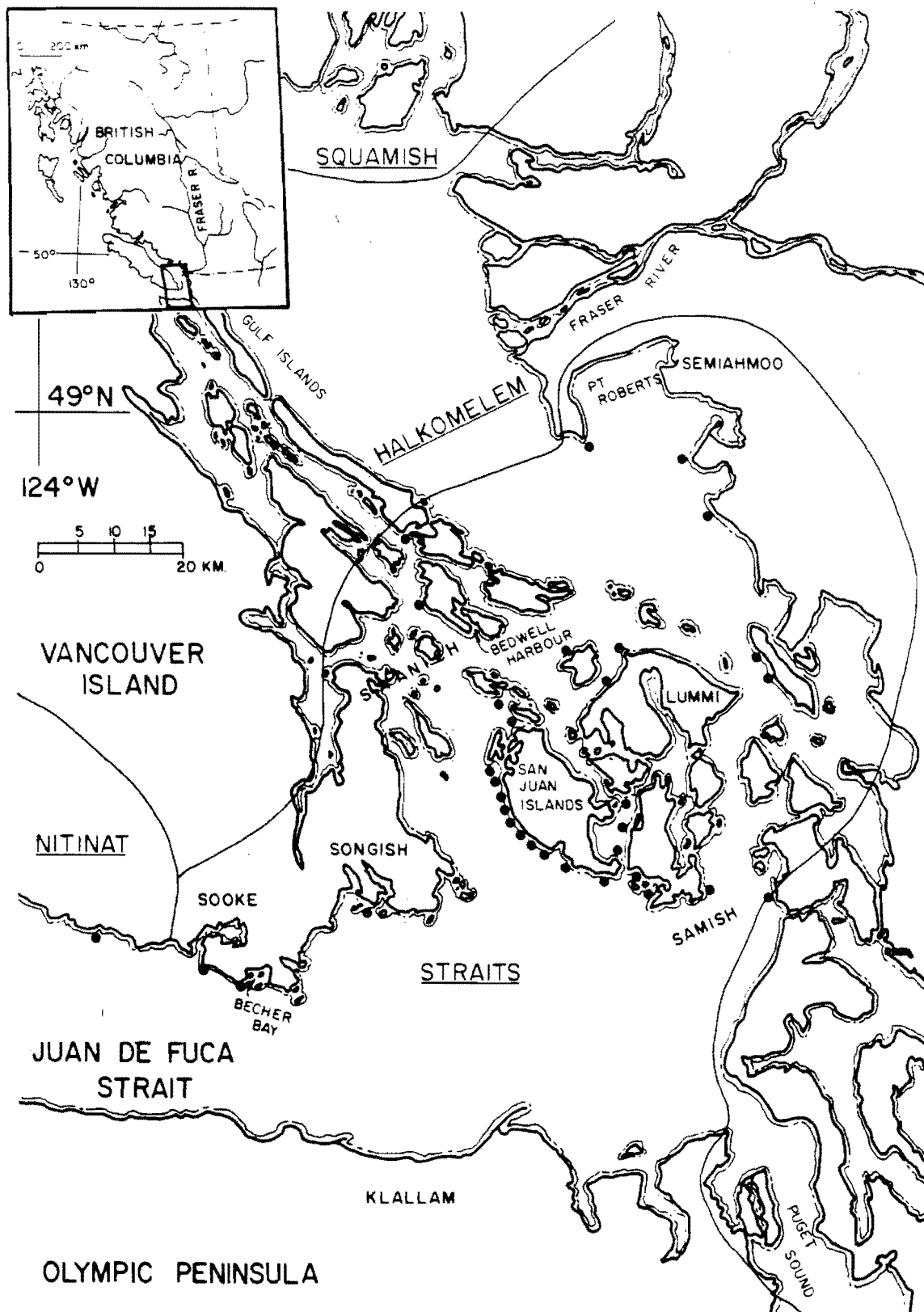


Fig. 1. Territories of the Straits Salish and their neighbors. Language divisions indicated by underlined capitals. Dots represent ethnohistorically documented reef net locations. Base map: Canadian Hydrographic Survey, Chart #L3000-1976.

REEF NET

- ① SINGLE REEF NET...USUALLY SET JUST OFF SHORE OVER KELP COVERED REEF IN PATH OF MIGRATING SALMON. CHANNEL IS CUT THROUGH KELP TO FUNNEL FISH TOWARD NET.
- ② WATCHMEN IN CANOE STERNS KEEP LOOKOUT FOR SALMON ENTERING NET. AT THE RIGHT MOMENT, WATCHMAN IN OFF-SHORE CANOE [THE CAPTAIN] SIGNALS CREW TO RAISE NET
- ③ WHEN NET SIDES ARE UP OVER GUNWALES, MAN LETS OUT SLACK ON ANCHOR LINE, ALLOWING CANOES TO SWING TOGETHER.

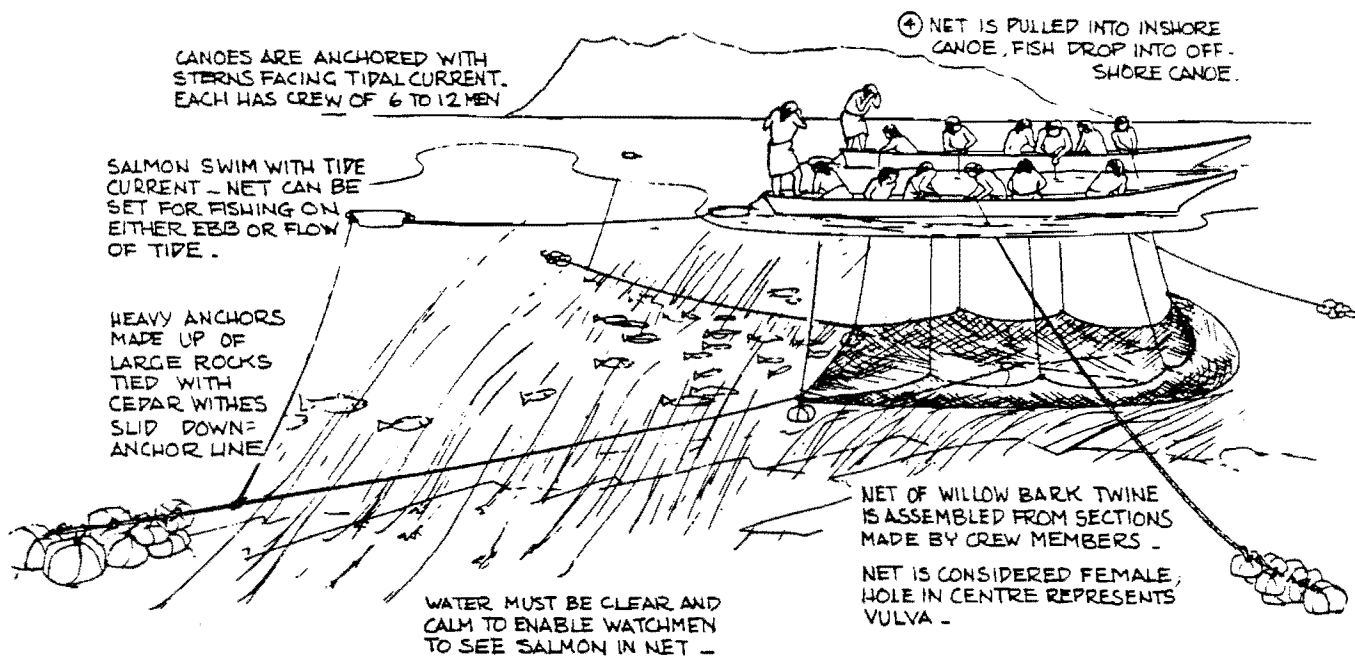


Fig. 2. Artistic reconstruction of a reef net in use. Source: Stewart 1977:93.

The net itself was made of willow saplings, with cedar block floats, cedar-withe lines, and anchors composed of large beach stones. A reef net was placed in the path of the salmon migration, just offshore, often at a headland towards which the salmon would strike, and where the fish would congregate in the back-eddies during the ebb tide. If possible, the net would be set next to a natural reef, which forced the salmon to rise closer to the surface to pass over it. Off those productive headlands without a natural reef, the net was designed to simulate a reef by an ascending series of lead lines; an illusion further enhanced by tying strands of eel grass to the leads.

All of these efforts were directed towards enticing the salmon to enter the area of the net itself, which lay anchored horizontally two to three meters below the surface, between two canoes. The net was closely observed by a "watchman," an experienced reef-netter who directed the crew's actions. When the watchman judged that a good haul was to be made, he gave the command to swing the two canoes together, which pursed the sides of the net, and instructed the crew to raise the net and the catch. Under ideal weather conditions during the height of the run, as many as five to six thousand fish might be caught in this way during a single turn of the tide (Rathbun 1900: 324-315; Kerr 1917).

Thorough analysis of the political economy of reef netting -- that is, its system of production, distribution, and reproduction, which includes both the technology and social relations of reef netting -- reveals that it was a unique socio-ecological adaptation of the Straits. While some of its unique technological characteristics are described above, the known geographical distribution of reef netting corresponds to the limits of the Straits language territories (Fig. 1). In addition, the social relations that accompanied this technology were unique as well, in so far as they were structured upon the principle of unequal access to the surplus product of reef netting. In traditional Straits culture, reef net sites were owned and inherited by individuals; these individuals controlled who gained access to the production of the site, and they also appropriated a significant proportion of the catch for their use. As Suttles (1951:56) has noted, "While everyone can make a living exploiting the public domain, the real surpluses are produced at the owned locations, and the owners thus have a considerable advantage over the other members of the group."

The question that arises from the unique characteristics of the reef netting means of production is whether they comprise "a difference that makes a difference." I believe that they do. There seems to be a structural contradiction in Straits society -- a contradiction between the closed access to the production of reef netting (and several other resources as well, such as camas beds), and the open access to most other materials and ideological resources that dominated the fundamentally egalitarian culture of the Straits, and Coast Salish in general. The fully expanded argument that articulates this contradiction between open and restricted access to Straits cultural resources can be found in Easton 1985a, 1985b.

On the basis of this perceived contradiction, I postulated (1981) that the reef netting means of production was a relatively recent sociotechnological addition to the Straits' subsistence repertoire. Sociological and technological data upon which this postulate is developed come from three main ethnological sources. The earliest is Franz Boas' account of Songish reef netting (Boas 1891) which included descriptions of a Songish reef net camp and canoe,² and information on the division of labor and distribution of the catch. Another anthropologist who wrote on the subject was Bernard Stern, in his ethnography of the Lummi Indians (Stern 1934). But the most important contributor to our knowledge of the social complexity of reef netting is undoubtedly Wayne Suttles (1951, 1954, 1960). Minor sources of information on the subject include Hill-Tout (1907), Kerr (1917), Lowman (1939), Barnett (1955), Duff (1969), Jenness (n. d.), and Bouchard and Kennedy (n. d.). Although there are some discrepancies among these accounts, and they do fail to provide

us with some important social details (such as the role of slaves in production), together they compose a body of evidence that supports the fuller description of the political economy of reef netting in Easton (1985a:181-188; 1985b).

From these accounts, we can archaeologically identify two discrete components characteristic of any reef net site which we should be able to identify in the prehistoric record. One is an underwater component, comprised primarily of the accumulated remains of reef net anchor stones, discussed below, and the other is a terrestrial component that will contain the following twelve distinct archaeological attributes:

1. geographical association with the sockeye migration route;
2. geographical association with an underwater component;
3. geographically situated so as to be provided with adequate exposure to sun and/or warm thermal winds suitable for drying the catch for storage;
4. good foreshore canoe access to the site;
5. a faunal record dominated by sockeye fish bones, particularly vertebrae (as opposed to head bones);
6. midsummer to early fall seasonal occupation;
7. high incidence of ground slate, mytallus shell, and/or deer ulna filleting knives;
8. high incidence of abrasive stones;
9. net weights;
10. net fragments;
11. net gauges;
12. post molds of drying racks, associated with trench hearths.

This battery of attributes has been further defined in order to operationalize them as distinct archaeological indicators of the presence of reef netting with a high degree of probability (Easton 1985a:124-133, 225-228); thus we should be able to recognize a prehistoric reef net camp, as distinct from any other form of seasonal resource procurement site. Unfortunately, a review of the literature for the region with this in mind reveals that it is not likely that any of the archaeological excavations undertaken to date have included a prehistoric reef net camp (Easton 1985a:133-161).

However, despite the long-standing identification of the importance of reef netting to Straits culture by ethnographers, until my own recent efforts no archaeological research had been explicitly designed to determine the antiquity of development of reef netting in time. This has not prevented numerous prehistorians of the region from either explicitly or implicitly arguing that reef netting must be of considerable age, based upon the apparent continuity of many other cultural components of the ethnographic culture with the prehistoric Marpole culture. For example, Carlson's (1954, 1960) synthesis of King's (1950) Cattle Point (45SJ-1) excavations with eight other sites in the San Juan Islands tested by Carlson led him to propose that the ethnographically recorded culture of the Straits, which

implicitly includes reef netting, was "in full swing by AD 1300," (Carlson 1960:565) or earlier (AD 1200) (Carlson 1970:120).

On the basis of excavations at Sucia Island (45SJ-105), Kidd noted that the abundance of fish bone suggests that "the intensive fishing of historic times and even the ethnographically attested practice of reef netting were present" during the time of the late component of this site, stylistically cross-dated at AD 1300, but with a basal radiocarbon age of AD 436 (± 40) (Kidd 1971:54).

In a wide-ranging synthesis, Burley (1980) has argued for the continuity between the prehistoric Marpole culture (ca. 400 BC to AD 600) and the proto-historic/historic Gulf of Georgia cultural traditions, including reef netting. He suggests that the long occupied site at Point Roberts (a notable historic reef netting locale) implies the early practice of reef netting (1980:57). Other theorists, including Maston (1983), Thompson (1978), and Mitchell (1971:46), have also suggested a Marpole origin for many of the technological characteristics of the protohistoric Straits culture including reef netting, by implication at least.

It is clear from the evidence adduced by these researchers that many forms of technology, subsistence techniques and resources, settlement patterns, and even ritual behavior recorded ethnographically in the Gulf of Georgia *do* have antecedents in Marpole assemblages. However, the comparison of the expected archaeological attributes of a reef net camp, referred to earlier, with the site reports on which the assumptions of antiquity of reef netting are based reveal that it is unlikely that any of these excavations were of a reef net camp. Thus, there is no *direct* evidence to support the proposition that reef netting itself has a Marpole origin. Rather, its suggested antiquity is in fact based on the assumption that to find some continuity between the ethnographic and archaeological record is to validate continuity for all aspects of the society -- surely an unwarranted assumption.

There is, however, another concrete means of assessing the antiquity of reef netting -- through analysis of the underwater component of a reef net site. Each corner of the net is anchored by a pile of stones (Fig. 2). These anchor stones were "large beach rocks that took two to four men to lift" (Suttles 1951:167); ten to twelve rocks were needed for each corner anchor.

The distribution of reef net sites is finite; there are a limited number of appropriate ecological niches at which reef netting is possible (Fig. 1). Hence, the same locations were returned to year after year, where each season a new set of anchor stones was deposited, used, and then, for most sites, abandoned. Such a pattern of activity should result in a concentrated accumulation of anchor stones, which reflect both the number of nets and the number of years they were used at the site. For example, at a single gear site, we would expect a mean rate of accumulation of eleven stones per corner times four (accounting for each corner), or 44 stones per year, 440 stones every ten years, 4400 stones every one hundred years, and so on. These reef net anchor accumulations thus provide us with direct evidence of the length of use of any particular site.

It was with this in mind that I designed and carried out field research in 1983, 1984, and 1985 to locate, survey, and extrapolate an absolute date for the initiation of reef netting in Canadian waters. Two locations were discovered and analyzed: DeRt-118, at Bedwell Harbour, Pender Island; and DbRv-11, at Becher Bay, Vancouver Island.

The Bedwell Harbour site is located at the southwest entrance to the harbor, just north of Peter Cove, adjacent and north of a charted reef (Fig. 3). Although a midden,

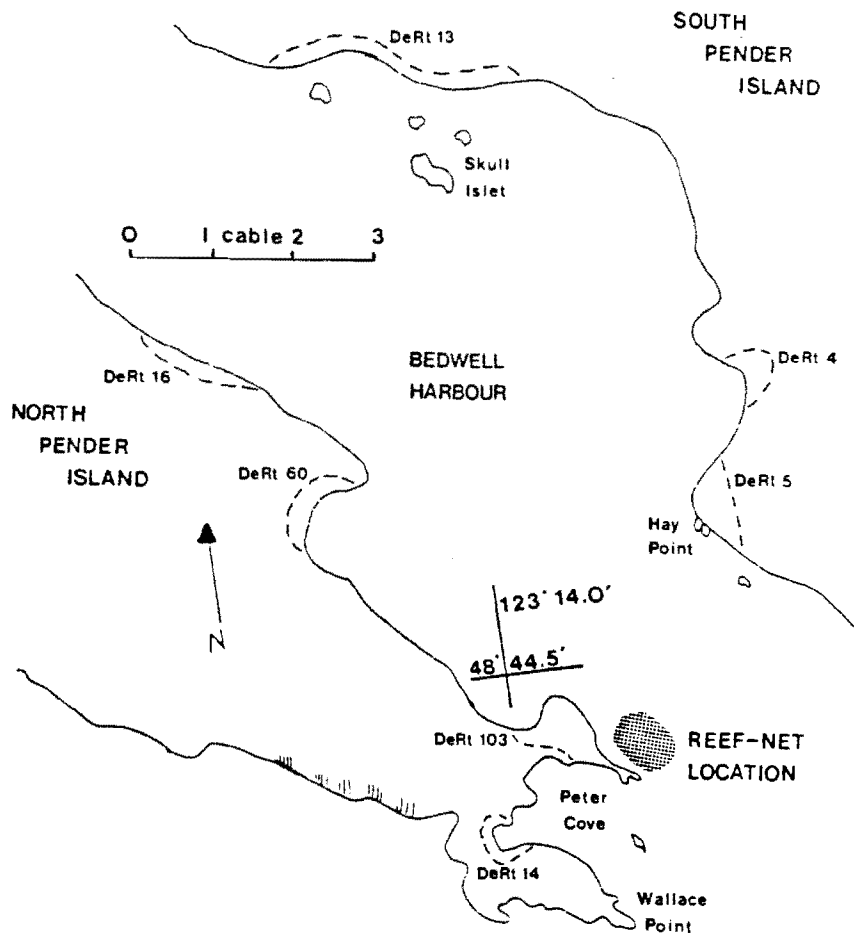


Fig. 3. Reef net location of the Bedwell Harbour site - DeRt-118. Base map: Canadian Hydrology Survey, Chart #3310-1976.

DeRt-103, is located contiguous to the site, it is not the land component; situated on the lee of the island, it is too shadowed from both the sun and wind to locate fish drying racks. Rather the camp is to be found on Hay Point, DeRt-5, east of the fishing site proper, which faces south and in the summer receives warm morning and evening thermal breezes.

Once the site was discovered, the research design was to determine the perimeter of the underwater component and collect a statistical sample of the number of anchor stones present. With these two figures, an estimate of the total number of stones present could be made. After dividing this gross figure by the number of gears operating at the site, the mean rate of accumulation and a number representing the minimal number of years a reef net gear had operated at the location could be generated. In simplest terms, for a single gear site, count up all the stones and divide by forty-four.

Both methods by which this design was carried out utilized on-site inspection of the underwater remains by divers and both differed significantly at each location; the shortcomings of methods employed in the initial survey at Bedwell Harbour assisted in the refinement of methods employed at Becher Bay.

The survey method used at Bedwell Harbour was based on radial measured observations from a central datum along intercardinal magnetic bearings, combined with a judgmental sampling procedure. The sample units were 2 x 2 m squares, centered every 3 m along the measured intercardinals. The sample, made up of the number of observable anchor stones within the unit, was recorded at the same time perimeter measurements were being taken.

A number of difficulties hampered the confident use of the sample in the estimation of the age of this site: no confidence interval can be applied to a judgmental sample; the sample itself may not even be representative of the site as a whole; and the site perimeter, and hence the total area, is a pretty crude estimate, since the further from the central datum the greater the error in site boundaries. But these are things learned with experience; prior to my work there had been no analysis of the underwater remains of reef netting, and such initial shortcomings might be expected.

Nevertheless, I believe that the sample is representative of the site in a relative way, since visual appraisal certainly indicates that the site is not extensive in either area or deposition. After working in several weights to my calculations to account for some of these variables (Easton 1985a:83-87), I finally arrived at an estimate of the initiation of reef netting at DeRt-118 of between AD 1783 and 1814, or ca. AD 1800. At present this can only be regarded as a provisional estimate; clearly a better sample and survey design needed to be developed to increase our confidence in this dating technique.

After unsuccessful searches at several other locales³, an improved design was implemented at Becher Bay, southeast Vancouver Island. Designated DbRv-11, this site is located at the southeastern entrance to the bay, off a point of land known as Smyth Road (Fig. 4). Our first dive confirmed the site's location and extensive nature. There are approximately 61,000 stones here -- demanding a more sophisticated survey and sample design.

The first step was to gain an accurate measure of the site's area. This was accomplished by laying three magnetic compass baselines across the extent of the site -- two at right angles, and the third bisecting the others. The site perimeter was then surveyed by measured observations off these baselines at 10 m intervals. With a well-established area, and a means of locating any point on the site by compass bearing and

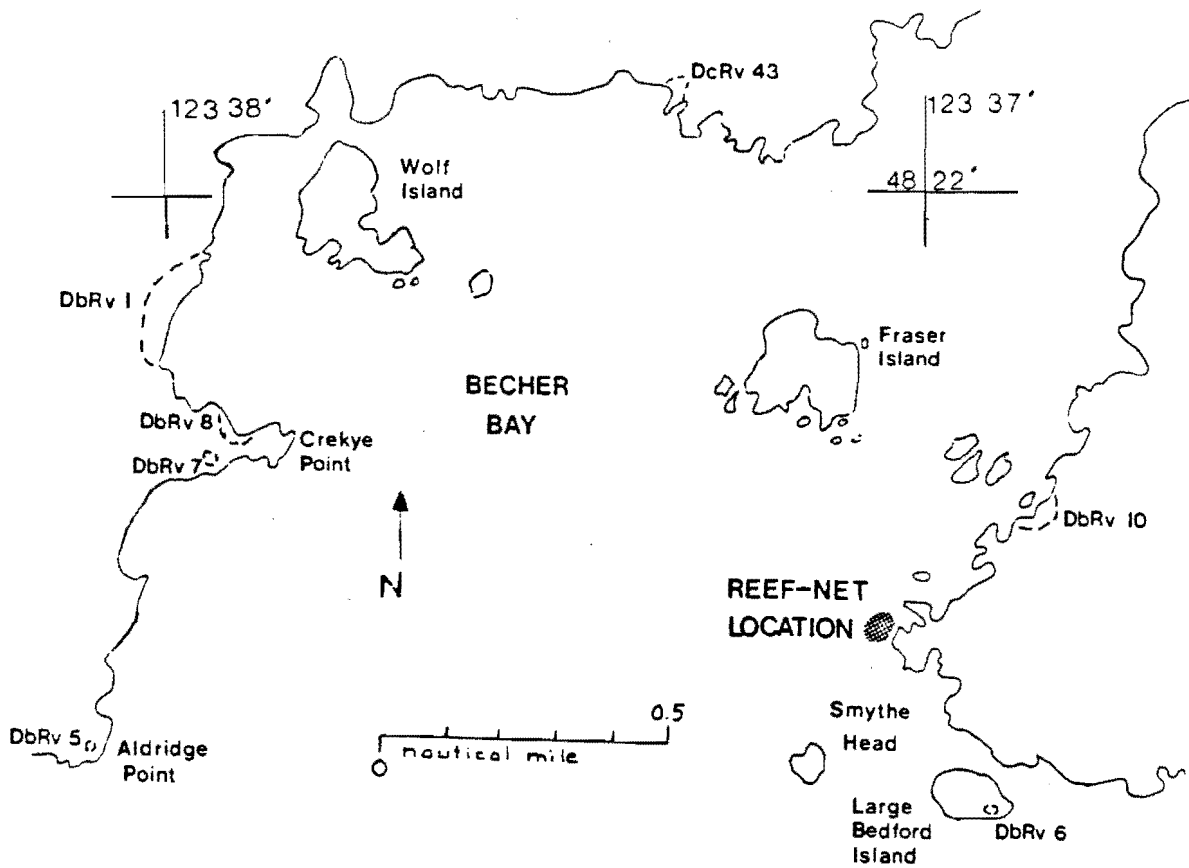


Fig. 4. Reef net location of the Becher Bay site - DbRv-11. Base map: Canadian Hydrographic Survey, Chart #3461-1978.

measurement from the physical baseline across the site, it was possible to apply a truly random selection technique to the sample units (Fig. 5).

The scale is 10 square m per unit; the dots represent 61 square m units chosen using a random numbers table with replacement. Within each unit, the number of observable anchor stones were counted and recorded.

Fig. 5 also provides the numbers of stones found in each sample. It is clear that some areas are quite dense, while others have no anchor stones recorded. In fact, large portions of the site were of natural bottom. In the northern area of the site were found what could only be anchor isolates, that is a single year's deposition, while in the southern portion of the site the accumulations were quite dense.

On the basis of this unequal distribution, along with ethnohistoric evidence that as many as five gears were operating here in the late 1800s, the site was divided into three components (Fig. 6). Furthermore, based on the sample and visual observations, it was possible to delineate major accumulations which may represent the discrete deposits of each corner of the nets. They are represented in Fig. 6 by dashed lines. These divisions were supported by several tests of significance of differences between the relevant samples (Easton 1985a:114-116).

Table 1 represents the results of the calculations applied to the sample from the entire site, and from Areas I and II, separately and pooled. The assumptions are the number of stones deposited per gear per year, and the number of gears within the area. Of importance are the final figures calculated for the pooled Areas I and II, which suggest a date of initiation of reef netting at DbRv-11 ca. AD 1500. Full details of the statistical analysis and argumentation which led to this final set of dates can be found elsewhere (Easton 1985a:103-118). However, I would note that of all the possibilities, this method has the best balance of statistical precision and confidence.

The estimation of a reef net site's antiquity by the analysis of the visible remains of anchor stone accumulations is a method which is sound in theory, but full of difficulties in practice -- many of which are related to working in the underwater environment. Besides the practical difficulties in obtaining data there are several factors which serve to confound data collected. The assumption of the number of anchor stones deposited per gear year is one. The actual number used would be a function of several factors -- net size, the density and specific gravity of the stones themselves, and the possibility of two gears sharing contiguous anchor stone groups, a practice documented ethnohistorically at Point Roberts.

The precise determination of the number of gears working a location and whether the number was constant, waxed, or waned, is another confounding variable. However, by attempting to delimit the location of discrete gear areas, and determining more exactly the rate of accumulation, as might be indicated by isolated anchor accumulations, gains in both precision and confidence can be made.

Despite these problems, several general comments can be made about the research. Though the age estimate of the Bedwell Harbour site is tentative due to the judgment sample and uncertainty of its perimeter, it is clearly either of a much more recent age or of less consistent use than at Becher Bay. I have argued for the former and propose a date of ca. AD 1800 for the start of reef netting at Bedwell Harbour. There is a noted difference in size, shape, and composition of the stones at each site: Bedwell stones were primarily angular sandstone and granitic boulders; Becher Bay stones were relatively rounder, and predominantly composed of sooke gabbro (a regional conglomerate). They were also

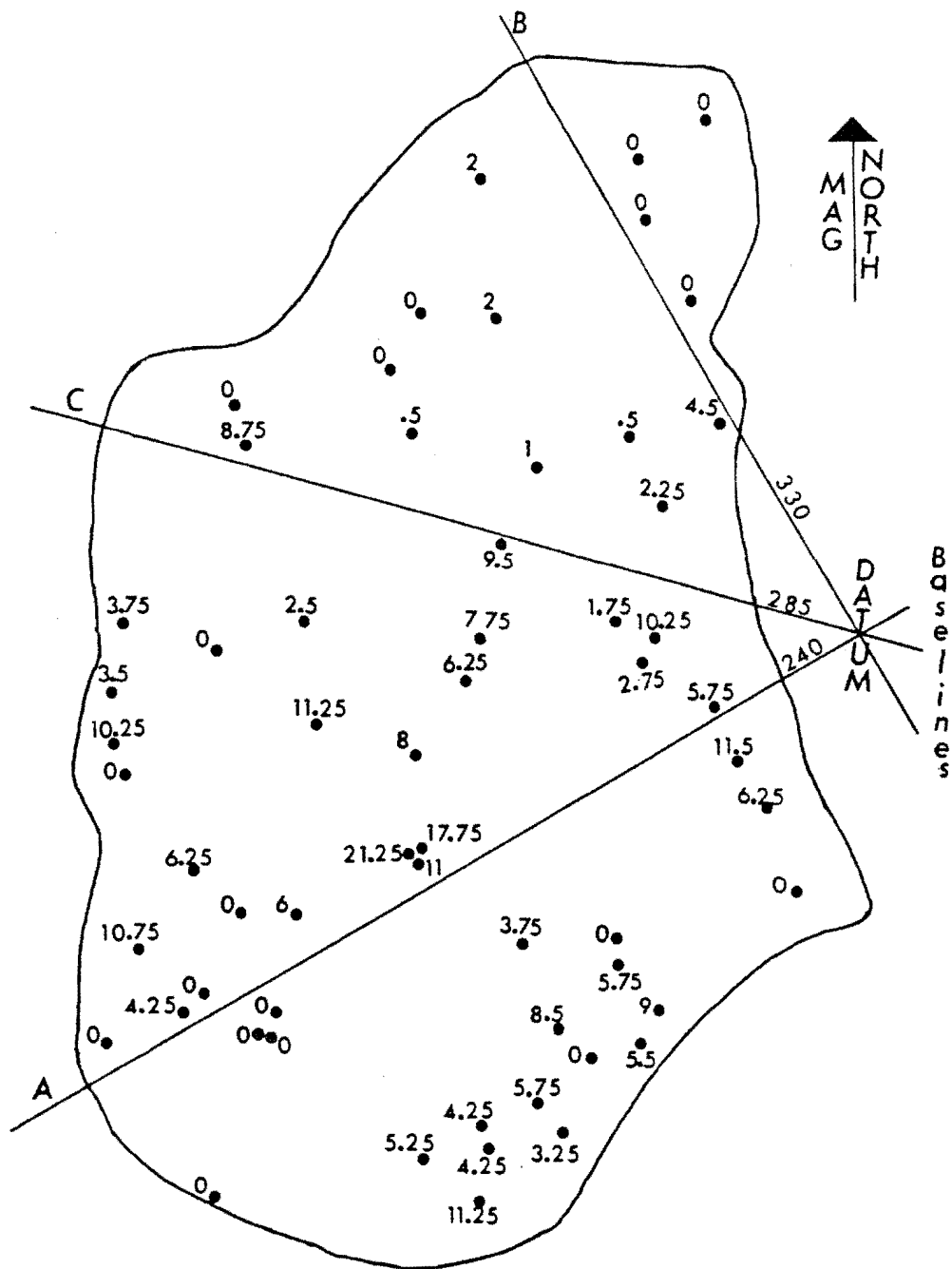


Fig. 5. DbRv-11 anchor stone sample distribution. Dots indicate location of 1 m-square sample units. Numbers indicate numbers of stones observed in sample unit. Decimals reflect total number of stones along border of sample unit (i.e. partly within and partly without) divided by four.

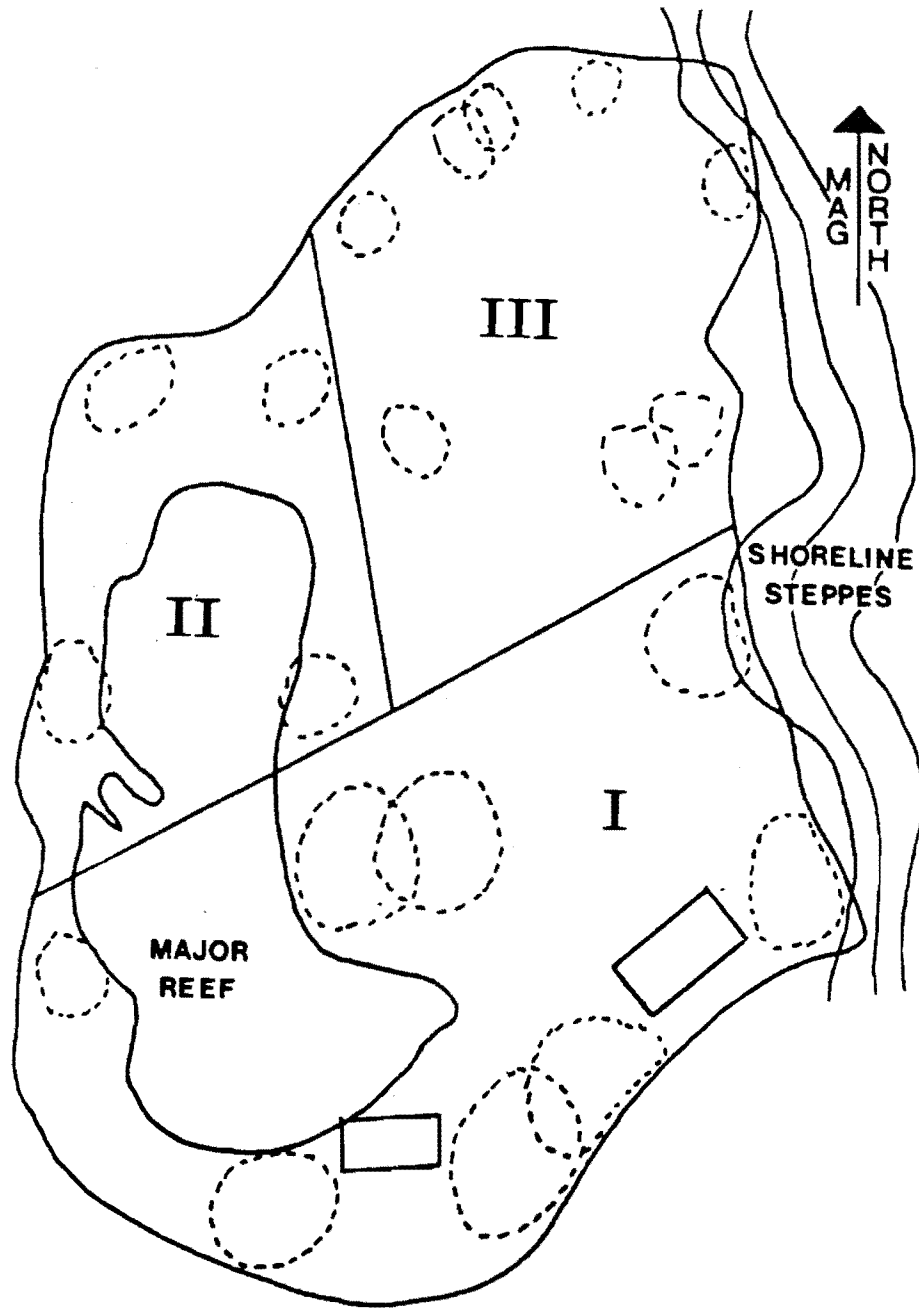


Fig. 6. Hypothesized discrete gear areas, DbRv-11. Solid lines indicate proposed gear boundaries. Dashed circles demarcate discrete anchor stone accumulations. Solid rectangles approximate location of accumulations of possible reef net bunt weights.

generally smaller than at Bedwell Harbour, likely a function of the greater density of the conglomerate vis-a-vis the sandstone.

Table 1

Summary of Use/Age Estimates - DbRv-11.

ASSUMPTIONS	SEASONS OF USE	ABSOLUTE DATES
Total Site Area		
44 S/G/Y; 3 GIS	468 ± 127	1429 ± 127
48 S/G/Y; 4 GIS	429 ± 116	1468 ± 116
44 S/G/Y; 4 GIS	351 ± 95	1546 ± 95
48 S/G/Y; 4 GIS	322 ± 87	1575 ± 87
	RANGE = 235-595	AD 1302-1662
Area II		
44 S/G/Y; 1 GIS	278 ± 22	1619 ± 27
48 S/G/Y; 1 GIS	255 ± 20	1642 ± 20
	RANGE = 235-300	AD 1597-1592
Area I		
44 S/G/Y; 2 GIS	441 ± 4	1456 ± 4
48 S/G/Y; 2 GIS	404 ± 4	1493 ± 4
	RANGE = 400-445	AD 1452-1497
Area I/II		
44 S/G/Y; 3 GIS	393 ± 2	1504 ± 2
48 S/G/Y; 3 GIS	360 ± 2	1537 ± 2
	RANGE = 358-395	AD 1502-1539

Notes: 1. S/G/Y = stones/gear/year.
2. GIS = gears in sample.

Both of these proposed dates might be best tested against excavation of their associated reef net camps. Indeed, in order to move forward with any confidence regarding the antiquity of reef netting, the location and excavation of a number of such terrestrial components is a pressing need, and one I hope will be carried out soon.

We should also note that both of these sites lie on the periphery of the geographical distribution of reef netting. The majority of reef net locations are found in the San Juan Islands proper. Hence, following the application of the wave principle, it is possible that those sites in the center of distribution may be older than AD 1500. How much older is difficult to predict, but I propose that a technology as productive as reef netting would have spread quickly to available ecological niches. Until dates are recovered from the San Juan Islands which indicate otherwise, I postulate that the development of the reef netting means of production occurred sometime during the fourteenth or fifteenth centuries AD. This would place both the technology and its accompanying social relations as a unique and relatively recent adaptation of the protohistoric Straits Salish. It would also support my original hypothesis, formulated through the recognition of the structural contradiction between the restricted access to resources inherent in reef netting, and the open access to resources which dominated Straits and Coast Salish society in general.

There are many questions that arise from this analysis, such as how such a contradictory state of affairs was able to continue over a period of some four or five hundred years. I have related this to "leveling mechanisms" present in Straits culture, specifically demographic flux in the settlement pattern and reciprocity, in particular through affinal exchange and "potlatch" behavior and an ideology of sharing common to many foragers (Easton 1985b). Suttles also addresses the problem from a technological perspective in this issue.

A more directly archaeological question is whether the technique diffused along already existing linguistic relations or whether it was carried by speakers of Straits throughout the area suitable to its use. The archaeological evidence on this question remains inconclusive, but ethnohistoric accounts, at least, indicate a relatively recent general population shift in Straits territory, from the San Juan Islands outward (Suttles 1951:499). The suggested date of initiation of reef netting at Bedwell Harbour (ca. AD 1800) corresponds to oral traditions of a move to South Pender Island by a family from Henry Island (another reef netting locale in the northern San Juans) at about the same time (Hess 1984:personal communication). The continued investigation of the origin and diffusion of reef netting will undoubtedly lead to a fuller understanding of Straits prehistory in general.

It should be pointed out that my reef net fieldwork comprises, to my knowledge, the first systematic underwater archaeological research focused on aboriginal or prehistoric lifeways in British Columbia. With an aboriginal maritime tradition as extensive as was present along this coast, I sincerely hope that it will soon be joined by many others in the years to come.

Finally, I would also like to take this opportunity to acknowledge the fact that the original suggestion for this particular archaeological project was first made to me by Wayne Suttles. Like numerous other archaeological investigations through the years, if not for the impressive ethnological record he has built up, and upon which I drew extensively, it would never have been possible to carry out.

Endnotes

¹Some linguists believe there is a language boundary between Southern Straits (Klallam) and Northern Straits (the remaining language forms) (Thomson, Thomson, and Effrat 1974:184); others disagree and regard all seven forms as regional dialects of a single language (Fleisher 1976:6). The matter remains unresolved, due largely to a lack of data.

²The reef net canoe is another unique technological attribute of reef netting -- the flat transom being found on no other type of Northwest Coast canoe (Easton n. d.).

³The other locations included areas about Mouat Point, North Pender Island, and Beechey Head and McCaulay Point, Vancouver Island. Of the three, McCaulay Point has presented some evidence (in the form of a single perforated net weight) which may represent reef net activity, although, like the other two locations, convincing evidence of anchor stone accumulations was not located within the area surveyed. This does not preclude the existence of anchor stone accumulations at these locations -- it is, after all, a big sea. Full details of the areas surveyed to date may be found in Easton (1986).

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FRASER LILLOOET SALMON FISHING

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Abstract

Salmon fishing and preservation techniques of the historic and current Interior Salish Lillooet of British Columbia are described, including rights to fishing rocks, relation to social stratification, trade of salmon, Plateau regional organization ("cross-utilization" of resources), and recurring technological and social adaptations in the Coast and Plateau to drying conditions and fishes' fat content.

Introduction

This ethnographic report describes how the Lillooet Indians of British Columbia's Fraser River have caught, processed, and distributed salmon, both historically and today. They continue in 1970-1971, at the time of fieldwork, to capture and preserve salmon as a basic food, using traditional techniques at their fishery outside of Lillooet, British Columbia.

The aboriginal inhabitants of the Northwest Coast and Plateau culture areas depended on salmon to such a degree that their population density may have varied with its availability (Kew 1976). Complex social institutions, such as the potlatch, functioned to evenly distribute the supply of salmon--a critical and variable resource (Suttles 1968). However, fishing techniques were only part of the cultural repertoire needed to take advantage of salmon. Since each run was available for only a few weeks or months each year, and since there were months when no other major food resource was available, preserving the many fish caught in a short period was also a critical task.

Those interested in calculating the amount of food that was available to aboriginal peoples from salmon should take note that not all fish caught can be preserved using aboriginal techniques. On the Fraser River some fish are too fat to preserve and some days are too hot. Sometimes the fish come so fast that women cut them in a way that wastes some of the flesh and sometimes men stop fishing to help with the cutting. In short, the requirement that fish be preserved reduced the amount that people could eat. In the Interior, wastage or inability to dry was a relatively modest problem; it was a more serious one on the Coast.

The superior drying conditions in the Interior have been a reason for coast people to trade with interior people or move inland to fish. The large gatherings at Lillooet, like those at other seasonal interior sites, have resulted from the quantity of salmon there and from the relative ease with which they can be preserved. Further, though fat salmon are generally tasty and a reason for people further inland to come to Lillooet, they do not preserve as well as lean salmon. On the Coast there was actually competition for low quality, but very preservable, salmon. These and other modestly important adaptations will be described in this report.

The activities described here reflect the general pattern of economic organization in the "Plateau" culture area, in that people from many ethnic or linguistic units had access to resources, and in that products were passed across social boundaries (Anastasio 1955; Walker 1967). Several aspects of aboriginal Lillooet culture were functionally linked to this general Plateau pattern--for example, the pattern of hostile relations with distant people while mutually sharing resources with near-by people and the pattern of using resources of affinal relatives.

Both the Lillooet fishery and Plateau-style social relations between Lillooet and non-Lillooet have continued. Though they have lost what was their major resource, spring salmon, to ocean or downstream fishermen, they continue with sockeye and a few springs, and in the hundred years since large numbers of whites came to the Lillooet area, the Lillooet and other Indians who fish at the Six Mile/Bridge River Rapids have provided themselves with food and have maintained a cultural tradition.

The fishing and drying techniques used today by the Fraser Lillooet are only modestly changed from their aboriginal counterparts. People dry fish in substantial amounts for their own consumption, and while I was visiting the Lillooet, home-produced salmon and deer, either fresh or preserved, were their main sources of protein.

Despite a gold rush, boarding schools, migrant labor in extractive industries, long trips to work as pickers, and other factors that might have disrupted the fishery, it has continued because its intensity or brief duration makes it compatible with other activities and because it supplies a real benefit. Government policy of recognizing Lillooet fishing rights, while banning commercial exploitation and net-fishing by whites, has also contributed to continuation of the fishery. Finally, fishing has become symbolically important as a marker of identity, with Lillooet people coming back from as far away as Vancouver to fish and visit kin.

Background

The aboriginal territory of the Lillooet lies in the Coast Range of British Columbia, running for 100 miles from the Fraser River Canyon to Harrison Lake (Fig. 1) (Teit 1906:195). Today their reserves are located near the rivers and lakes of this area.

Lillooet cultural affinities also stretch from the Plateau culture area to the Northwest Coast. The neighbors of the Fraser River Lillooet (part of the "Upper Lillooet") are Plateau groups like the Shuswap, Thompson, and Chilcotin; but the neighbors of the "Lower" Lillooet are the Coast Salish.

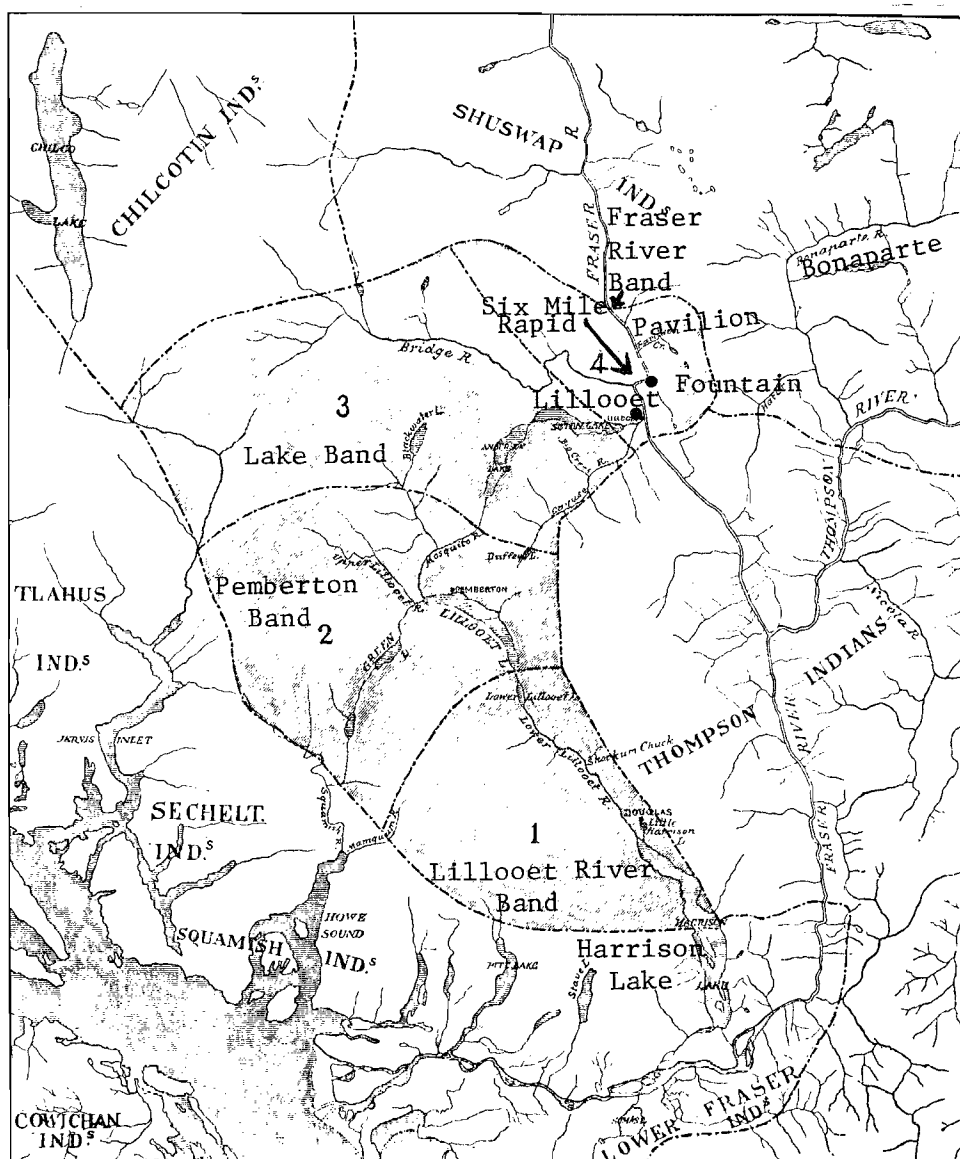


Fig. 1. Map of the Territory of the Lillooet Indians (after Teit 1906).

The ancestors of those Lillooet who live near the coast had a majority of the standard Northwest Coast culture traits, including residence in plank houses and preservation of salmon by smoking. The Fraser River Lillooet, on the other hand, have fewer coast traits and are firmly in the Plateau; their ancestors lived in semi-subterranean houses and dried or powdered salmon (Teit 1906; Ray 1939; Kennedy and Bouchard 1978).

Fishing was the base of aboriginal Lillooet diet. The Fraser Lillooet ate salmon in several forms (such as powdered salmon and oil), dried berries, roots, deer meat, and a wide variety of less important foods (Turner 1972). Deer meat and buckskin clothes were critically important secondary resources, though neither was plentiful. In fact, dried deer meat was a potlatch item and several people had to contribute to put together a full buckskin suit for someone going outside in winter. The special status of the hunter and his ecological significance are the subjects of a special study (Romanoff 1972).

In the nineteenth century (my earliest data), women and men worked at different, but coordinated, subsistence tasks, and there were some special statuses related to work. Boys could train spiritually and physically to be hunters, warriors, gamblers, or shamans, while chiefs and women had special forms of training, according to informants. Chiefs played an important role in scheduling subsistence activities, as Sam Mitchell, on whose accounts most of the following report is based, reported:

In this particular reserve where I am now (Fountain), before the priests came, these people have clans like, families, but it seems to me that there's always more than one or two families in the clan. They always say, "We have a chief. He's the head." He tells them when to get ready to go and fish, when to get ready and go and hunt. He leads his people to everything they do to make their living. When it's early in the year, the women do the digging the roots, the picking the onions, and they barbecue them. Later around about June they start to pick the saskatoon berries, and they dry quite a bit of that. They bake some of it. From there on it's a continuous laboring for living. After that, when the fish start to run, then of course the men do the fishing. They have their nets ready, and they go fishing. Of course, the women do the butchering, drying the salmon, making the powdered salmon. . . . In the fall of the year, around September, they cut lots of spetsunul when its dry ("milk weed," for fiber). Then they also bundle it up; when they get good and dry, that's another work. They do that in winter time (make fiber for fishing nets, among other things).

It's the chief's direction all this goes on. And them earlier days, them earlier people, the son of a chief always becomes a chief again because the learning is supposed to be from the father. I know on this reserve . . . in later years they got on the white man's way, they vote. They nominate their chiefs now and vote for them.

"Potlatches" involved gifts of food and, later, manufactured objects. Aboriginally, they involved dried deer meat, and they continued after formation of reserves. Sam Mitchell provided accounts of: 1) a week-long, deer meat give-away for "Indian doctors" who helped a man find his lost son; 2) the general pattern of hunting to get dried meat to give away; 3) post-funeral meat give-aways to thank people for attending; 4) feasts/meat-give-aways on becoming chief; 5) a sugar, flour, and candle give-away soon after contact with whites; 6) a rum give-away in which the host told the guests, "I'm the boss."; 7) a rum give-away around 1860 to make guests drunk and find a killer; and 8) Christmas feasting on the reserve after the priests came--"the old potlatches sort of changed to Christmas."

Aboriginal and nineteenth century Lillooet of the Fraser River maintained friendly relations with the people whom they might meet while out berrying, hunting, or fishing. In fact, they intermarried with neighboring peoples, so that there were Lillooet-Shuswap marriages, Lillooet-Thompson marriages, and border settlements of mixed parentage (Kennedy and Bouchard 1978:34-35). Marriage outside immediate kin (and hence to people with somewhat different resources) was mandatory; Sam Mitchell estimated that the closest one could marry was third or fourth cousin. Hostile relations with distant people, on the other hand, are noted for the nineteenth century (Teit 1906:210, 236).

Today, Fountain is the main reserve of the Fraser River Lillooet. Sam Mitchell described some aspects of its history. Aboriginally, the village was on a flat place on the side of the canyon (a "bench"). Two related families lived there in two pit houses. When the first miners came in 1858, the bench became a watering place on the trail to the gold fields. The chief of the Fountain residents told his people, "Let's move on the top of the ridge." Then they moved to the site of the present Fountain village. There was no reserve at that time, and the old village site was taken over by a farmer. Later the Canadian Government bought the farm and restored it to the reserve.

Soon after, priests came and under their influence the chief called his friends and relatives to come to the new Fountain village. Depopulation due to smallpox probably promoted this aggregation of settlements as well. They came from the Bridge River area, Lillooet, and small sites down the Fraser River. Sam Mitchell's parents were among those who came. "I should have been a Lillooet because my mother belonged to Lillooet and my father to Lakes."

After the turn of the century, Fountain Reserve had 40 or 50 families living in hewn-log houses. Like Bridge River Reserve, Fountain is located several miles outside the town of Lillooet. The reserve had a school and church and priests played a central role in its organization. With the arrival of large numbers of whites and Chinese in the last half of the nineteenth century, Lillooet men took up work as miners, farmers, loggers, and carriers, either on their own account or as paid labor. For example, Jimmy Rodesket, chief of Lillooet Band and son of the Lillooet chief who saw Simon Fraser drift down the river, was a guide for sports hunters and had several four-horse teams to carry freight from Lytton to Lillooet. Later, Lillooet people started working as migrant labor to harvest crops.

Contact history is reflected in population figures. Teit estimates aboriginal Lillooet population at 4000 and an Upper Lillooet population of 1200. At the time he wrote, he estimated a Lillooet population of 1200, a Lakes Lillooet population of 200, and a Fraser Lillooet population of 500 (1906:199). The diseases that reduced the population were smallpox, tuberculosis, and venereal disease (Kennedy and Bouchard 1978:53) and--after Teit's estimates--influenza. In 1963 there were four Fraser Lillooet bands, whose populations were Bridge River (135), Fountain (385), Cayuse Creek (58), and Lillooet (88). The two Lake Lillooet bands were Anderson Lake (97) and Seton Lake (289) (Duff 1964). The Upper Lillooet thus suffered depopulation in the nineteenth and twentieth centuries; they are now recovering and are just reaching Teit's estimate of aboriginal population.

Sources of Data and Fieldwork

The principal ethnographer of the Lillooet was James A. Teit, a shopkeeper who spoke the Thompson language and married a Thompson woman. He advocated Indian claims to large reserves in their aboriginal territories, and he was involved in Indian organizations with that end. Franz Boas edited Teit's monograph (1906) as part of the Jesup North Pacific Expedition, and it bears the editor's mark in organization, subject matter, and style.

Charles Hill-Tout wrote an ethnographic sketch of the Lillooet (1905), mostly based on data from a man who was both Halkomelem and Lillooet (Boas 1906:252). Randy Bouchard and Dorothy Kennedy of the British Columbia Indian Language Project conducted linguistic and ethnographic fieldwork with the Fraser Lillooet (Kennedy and Bouchard 1978). Randy Bouchard works in the Lillooet language, giving his data special value. Turner (1972) provides basic data on Fraser Lillooet ethnobotany. Arnold Stryd conducted archaeological digs near Lillooet (Stryd and Lawhead 1978).

I based the original of this report, a Bachelor's thesis, on fieldwork done in the summer of 1970. My goal was to discover what I could of the Plateau social system, Plateau ecological relations, and the place of salmon in social and ecological relations. Wayne Suttles suggested that I concentrate on salmon preservation as a phenomenon which had social and ecological importance, and which had not been adequately described for the Plateau or the Northwest Coast.

When I started my fieldwork, I knew only that Indians were drying salmon on the Fraser River, and I did not know that I would be working with the Lillooet. As I drove up the Fraser River Valley, I stopped for a day or two at various places to talk with people who were drying salmon. Each referred me to a new contact--someone else drying salmon, a council member, a librarian, or a shopkeeper. Where possible, I spoke with members of a Band Council before proceeding. On the whole I was well received, but some told me that I was not welcome. Finally, people told me that the place for me was Lillooet. After settling in there, I made one side trip to the North Thompson area.

I stayed in Lillooet for several weeks. William Adolph allowed me to use a cabin that he had built; I often ate with him and he loaned me a horse. Sam Mitchell invited me "for tea" (a generous dinner) on several occasions. Except in a few cases, I did not pay informants, having no outside financing. I did give rides, provisions, and copies of photographs. Later, I typed my field notes and sent back some of the texts.

I spent several days at the Six Mile fishing camp, watching people fish and dry their salmon. Most of my data, however, are from tape recorded interviews. As I reflect on this experience, I see too many leading questions and not enough precision in dating informants' stories. I relied too heavily on my camera to record fishing routines that I should have described in writing, and I lost two of my best interviews when my tape recorder broke down.

My major Lillooet informants were Sam Mitchell, Tommy Napoleon, Mrs. A. Zabatel, and William Adolph. Sam Mitchell is a member of the Fountain Band born in 1894. He did not attend mission school. Mr. Mitchell has been very generous with many people seeking information on Lillooet culture. A man who taught himself to read, by his willingness to take on students Mr. Mitchell has put some of his knowledge into the historical record. Tommy Napoleon is a member of the Lillooet Band and about 65 years old. He learned about aboriginal Lillooet culture from his uncle, who grew up in a semi-subterranean house. Mrs. Zabatel is Sam Mitchell's step-daughter. She lives near Cache Creek and is in her forties. Although she attended the mission boarding school at Kamloops, she attended meetings of chiefs in her childhood. William Adolph was one of the first to attend mission school, and he spent a long time away from Lillooet as a logger. He is a member of the Fountain Band. All of these people catch and dry salmon. Among the others with whom I talked about salmon drying and who dry their salmon are Mrs. James of the Lillooet Band, Francis Bill Edwards of the Pavilion Band, Irene McKay of Pavilion, and Ernie Jacobs of Fountain.

In the summer of 1972, I again visited Lillooet; the results of that trip are in my paper on Lillooet hunting (1972). In the winter of 1978 I was in Lillooet briefly.

Fishing and Preservation Techniques

This description is of Lillooet salmon fishing which I saw upstream from the town of Lillooet at the Six Mile/Bridge River Rapids (Fountain Reserve). At the rapids there are several good places to fish with a dip net, and there are 21 drying racks. Every summer, Lillooet people from all their reserves come to camp and fish there, along with Indian visitors from other groups.

Salmon Taken

Starting in June, according to Sam Mitchell, there is a salmon run every lunar month. The first are spring salmon runs, while the later ones are sockeye salmon.

Today, sockeye salmon (*Oncorhynchus nerka*), also called red or blueback salmon, comprise the bulk of the Fraser Lillooet catch. These fish run from late July to early September. The salmon of the early part of the run are the fattest, while those that come later are leaner and have red skins. Sockeye are relatively easy to catch because they run in pulses near the surface; they may be abundant at one time of day and scarce at another. Adult sockeye weigh between 3.5 and 8 lbs. (Carl and Clemens 1948:50).

Families that regularly fish take an average of two to three hundred sockeye. In 1970, the run was poor, so few families reached the two hundred mark and others refused to fish at all. The quantity of sockeye declined precipitously in the early part of this century. Sam Mitchell said that before that decline a man with a large family would dry about four hundred sockeye, but at that time spring salmon were the main catch.

Spring salmon (*O. tshawytscha*), also called king, tyee, or chinook, are much larger and fatter than sockeye. Their run in June and July is more individualistic than sockeye migrations, and each fish averages over 20 lbs. (Kelez 1938:795). Though springs are still important, they formerly were the bulk of the Fraser Lillooet catch, and a man with a large family might take five or six hundred (Sam Mitchell).

Humpback or pink salmon (*O. gorbuscha*) are caught in small quantities by a few people. Some informants say that they did not run as far as Lillooet until some fish ladders were installed downstream. They weigh between three and ten pounds and enter the Fraser in September and October (Carl and Clemens 1948:45).

Informants also said that coho or silver salmon (*O. kisutch*) do not run by Lillooet. Others, however, said that they run in September, but not every year. The names "dog" and "chum" salmon (*O. keta*) elicited no reply, and informants mentioned no other kind of salmon.

Steelheads (*Salmo gairdnerii*) are anadromous trout that run in fall and winter, but they and Dolly Varden trout are not currently important. Francis Bill Edwards said that they throw back Dolly Vardens if the salmon are running. Aboriginally, trout fisheries at some of the smaller rivers or lakes were seasonally very important.

Fishing Gear and Techniques

Current Techniques

The techniques currently used by the Lillooet for salmon fishing on the Fraser River are gill netting, set netting, and dip netting (some informants used "set net" for what I call "gill net" here).

Gill nets are large-mesh, nylon nets set across an eddy where the current moves upstream. Usually, the owner suspends the net from a steel wire running between two spikes driven into rock; I saw one case of a net suspended from a pole slung over the river. Salmon enter a gill net as they

follow the current of the eddy. Usually they cannot see the net in the muddy water, but if the sun casts a shadow towards them, they leap over the net. Larger salmon can only get their heads through the mesh, and their gills prevent them from backing out.

Gill nets may be set at any time. Often the fisherman (or woman) leaves the net out all night. People tend the nets about twice each day, or more often if the fish are plentiful or if the user of the net is staying at a fishing camp. If they are not tended enough, the struggles of several fish tangle the net.

A "set net" is the larger of two kinds of hand-held nets. It has a long pole handle, a roughly oval rim or "bow," a bag-shaped net, and a long line tied to a rock to steady the net against the current. The bow is usually a little over five feet long and slightly narrower, while the pole is over ten feet long. The net is attached to the bow with metal rings that are free to slide. When the pole is held upright, the fisherman keeps the net open by looping a string from the net to his little finger. When he releases the string, the rings slip down the bow and the net is closed.

When I saw Sam Mitchell make a set net, he used two young fir trees because fir bends easily and holds its shape once it is dry. He measured each piece to be one length from palm to elbow, plus one arm's span. See Romanoff (1971) for a fuller description and photographs. Mr. Mitchell also made his own net, using twine and a rectangle of wood to space the mesh. He had a netting needle but did not use it.

The dip net is a smaller, simpler version of the set net. The net does not close and there is no anchor line. The fisherman puts the net in the water, swings it downstream against the eddy current, and withdraws the net. I saw dip nets used only when and where there was an abundance of salmon; in such a situation a single sweep with a dip net could catch two or three fish. People make unusually small nets (1.5 x 3 ft.) for very swift places where the salmon hug the walls of the river bed.

Men use set nets in small, swift eddies. The fisherman holds the pole steady against the current, aided by the long anchor wire attached downstream (the current in the eddy is running upstream). When he feels a salmon strike the net, he releases the string that holds the net open and jerks the whole net upward and out of the water. Then, if his wife is present, he hands her the pole and grips the net, trying to hold the salmon still and get it to stick its snout through the mesh. When the fish cooperates, he clubs it with a stick (undecorated) and hands it to his wife.

The woman now takes the fish to a crevice in the rock while her husband returns the net to the water. She breaks the head off the backbone (but the head remains attached to the body by the tissue over the backbone), and she holds the fish vertical while the blood pumps out. Then she lodges the fish in the crevice, where it continues to drain, and she returns to her husband. In the fishing that I saw at Six Mile site, there was a rope hanging down to the narrow rock ledge (a seasonally exposed part of the river's bed) where people stood to fish. When a couple down on that ledge had accumulated three or four fish, the helper strung them on a coat hanger attached to that rope. Then children hauled them up the rock wall to the camp.

Cooperation among family members was very important at the Six Mile site because there was no room to maneuver on the fishing rock. In fact, fishermen tied themselves to a safety line. Where footing is more ample, people often fish alone.

I did not see any Lillooet fisherman use either hook-and-line or wire traps, though whites do use the former at Bridge River and one non-Indian poacher used the latter at an eddy.

Historic Changes

The set net and dip net are aboriginal, observed by whites in the nineteenth century. Teit (1906:228) mentions a "bag net" and Milton and Cheadle (1865:339) saw Thompson who "grope untiringly." Aboriginally, set net rings were made from the horn of mountain sheep; later, people used cow horn and finally steel (Sam Mitchell). The coat-hanger hook that children now use to pull salmon up from the fishing rock is the new version of a large, wooden hook. Netting was made from "milk weed" which was dried and rolled on the thigh to obtain fibers (Tommy Napoleon).

Sam Mitchell described the cords used for fishing.

They sew reeds together with the only string they can get. In my language we call it sp'etsen. That's the same weed they use to make fish twine. It's along the river. In English, I'm pretty sure they call it milkweed. There's some higher up on the higher benches. When these weeds get dry, around in the fall, maybe in September or October . . . they make lots of them, and they pound it up (to get the bark off). I've seen my grandmother making them. They pound it up on wood to get the bark out of it . . . then they weave it. They weave it and make string out of it. . . . That's mostly for thread and its also used for fishnet.

There was no such thing as wire or cable or rope or anything. No nylon ropes then. But there are certain kinds of willows they call nuxtin. They make ropes out of it. They use that on the fishing racks they have. . . . They tie the cross pieces with this. . . . Certain places you can get this kind of willow they call nuxtin. They just twist it and make a rope out of it. The full length of a bush may be 10 or 12 feet long. . . . There are four or five kinds of willow, but there's just this one kind of willow that'll make nuxtin. That's a rope. . . . They can also use it to anchor a net [see also Turner 1972:18].

These changes in material are relatively minor, though an observer at that time might have noted status changes for, say, old women who no longer produced twine.

More significantly, the Lillooet used to make small platforms to fish for spring salmon but they no longer do so (Sam Mitchell and others). Gosnell (1903:281) shows a picture of such a Thompson platform. A second major change is adoption of gill nets, which substitute for spring salmon fishing platforms. It appears that fish traps were not an aboriginal

alternative to gill nets. Though James Teit's discussion of fish traps is not sufficient to rule out the possibility that they were used on the Fraser River, it appears that they were confined to smaller streams (Teit 1900:250-254, 1906:228, 1909:524). Perhaps they were used on the Cayuse River near Lillooet, where Indians fished in the nineteenth century (Canada Department of Indian Affairs 1902:88).

The change from spring to sockeye salmon, the increasing use of gill nets, and the declining use of fishing platforms are related to each other and to another major change: a decline in the number of fishing sites. In the early part of this century, according to Sam Mitchell, there were family fishing sites along the Fraser; a fisherman could build a platform at any place where the swift current forced spring salmon to hug the river's shore. These sites were not as productive as the major rapids and they were good only when the water was at the right level. However, a family might take six springs per day. With the decline in spring salmon, set netting for springs became unrewarding, and people shifted to gill nets. Accordingly, they shifted to large, slow eddies, and there are few such sites near the town of Lillooet. (Thompson Indian fishermen south of Lytton have no major site like the Six Mile Rapids, but they have more minor sites than the Lillooet.) Further, those are the same sites where sockeye are easily captured.

Consequently, the only fishing sites near Lillooet are "Six Mile" and "Bridge River" on opposite sides of the river at the rapids about five miles above Lillooet, "Linktown" or "the falls" just outside Lillooet, and "Three Mile," a minor site. Informants can recall a number of other sites that formerly yielded springs (e.g. Eleven Mile).

The following account provided by Sam Mitchell refers to several of the technical changes so far described.

[In those days] they don't dry them sockeye. Its just got to be spring salmon. The spring salmon run deep in this part of the river. So [bikol Tom] makes a platform way out from the rock; that's a big platform. That's where he sets his net. His net is four or five feet wide and it's about six feet deep in length. He'll push it down so the top end of the net is about five feet below surface. That will put the net all of ten feet down. And he's got his platform way out.

The net was made out of this milkweed or sp'etsumul. They weave the net for one purpose, just for spring salmon. If there's any sockeye that go in, they'll go right through because the mesh on the net was wide enough for the sockeye to go right through. Only a spring salmon will be caught there. . . .

The bow was always made out of fir. They don't make it and put it in the water [the same day] like we do now. Them days they have it ready. They make these bows so it will dry out and harden before the fishing season starts. I've seen them. That way when you get your bows real dry and hard, it will stand lots of pressure.

. . . That trip on the net--there's a trip that goes to the finger on the pole when he's sitting up there. That net is way down there ten feet. If a spring salmon hits, he knows it's a spring salmon, he lets that trip go. He pulls his pole up, and that net falls down to the bottom of the bows. That holds whatever fish is in that net. . . .

These platforms that the old Indians used to fish--them days they don't dry sockeye, which we do now. Mostly spring salmon they dry. They always go deep. They build platforms out. They put the net down maybe six or seven feet from the surface [below the surface eddies to where the current is steady]. . . . They learn the current down there is going in the right direction. . . . It doesn't matter how much sockeye is on the surface. The sockeye go on the surface. Deep down, when they get one they'll get a spring salmon. That's the ones they dry. . . . They dry a few sockeye, maybe.

. . . now there's no such thing as spring salmon. They were all caught before they get this far. So that way the people now have to dry the sockeye, which is a good fish if you do it the right way.

Beyond the technical changes in salmon fishing, there have been changes in its role in an over-all subsistence strategy. Soon after the turn of the century, when Teit's Lillooet ethnography was published, the Fountain Band lived in about 25 hewn-log houses. Though the people of Fountain purchased some staples, having income from packing and extractive industries, they produced much of their own diet. They cultivated potatoes in their gardens and continued to gather roots, berries, and other wild plant foods. Sam Mitchell, a boy at that time, fished at the Six Mile site for his mother to get a substantial supply of salmon.

He said that people fished harder then, going from daylight to dusk; and they did not go home after five or six days, but rather stayed until they had enough food. Also, spring salmon were plentiful enough that you could get them at the falls with a dip net. Other things that he mentioned--the tents at the site, taking turns on a productive rock, children carrying fresh-caught salmon to their mothers, keeping the camp clean, and the drying techniques--are much the same now as they were then.

There is also a governmental aspect to salmon fishing that is new. The fish that reach Lillooet are there because a government agency limits downstream fishing, effectively allocating fish between ocean fishermen and river fishermen. The Cayuse Band of Lillooet lost its fishing spot on the creek when the hatchery went in. Agents check to make sure that fish are not being sold, and they are reasonably effective. Indians, however, can still fish at the falls, as Sam Mitchell explained.

[The visitors] are Indians. When the people from Vernon come over, they have to go to the fish warden here and they get a permit. As long as they prove that they're Indians, they can take any amount of fish back home, whether it's dried or not. They can

dry some themselves. The check station, I'll say at Cache Creek, they check them. They show their permit, and that's theirs. They're gone. . . . This is legal to any Indian, if he proves he's an Indians.

Salmon Preservation and Storage

There are only a few basic principles for food preservation, and the variegated salmon preservation techniques of the Coast and Plateau correspond to their permutations in particular environments. The first essential element of all of them is to reduce the amount of water available to bacteria, yeast, and molds. Though there is probably nothing dangerous about eating "rotten" food *per se* (Tanner and Tanner 1953), decomposing food may contain disease-causing bacteria, and microorganisms may consume the food before humans do. If salmon flesh has less than 12% available moisture, it is stable and safe to eat (Krumperman 1971:personal communication). This is approximately the level of moisture in some Indian-dried salmon (Rivera 1949:31; Sinnhuber 1971:personal communication). The Lillooet use all the standard ways of reducing available moisture: dehydration, freezing, and salting (Frazier 1967:109, 122; Lee, J. E. 1971:personal communication). Modern Lillooet also "can" salmon in jars, which involves sealing the meat in a container and killing its microorganisms (Frazier 1967:101).

The second general principle of preservation is to reduce rancidity or oxidation of fats. Rancid salmon oil is not acceptable to Lillooet consumers and there is some evidence from laboratory trials that rancid oil can cause health problems (Matsuo 1962; Sinnhuber 1971:personal communication). Lillooet fish processors select less-fatty fish to preserve, reduce the fat in some fish before drying, use techniques other than air-drying for fat fish, keep drying fish in the shade, and store fish in cool places.

The third principle is to protect the salmon from animals such as flies, bears, and mice, and from thieves or (aboriginally) raiders.

Drying Racks

Drying salmon filets hang from the poles of a drying rack. The drying racks that I saw commonly had eight parallel poles resting on two beams, with the beams in turn supported by four posts or tripods. The largest ones were 15 x 25 ft. Fir is the usual wood for the rack's frame, and plywood or planks make a roof. In the past, fir boughs served for a roof. Rocks stabilize the posts or tripods, and occasionally people use wire or nails. Though crudely built, racks are sturdy: families use the same one each year.

Since the wind always blows along the river, the rack is built so that its poles are perpendicular to the river (or, the supporting beams are parallel to the river). That way, the filets hang parallel to the river, allowing free air movement over the drying flesh.

The most important function of the rack's roof is to protect the salmon flesh from the sun. Sam Mitchell explained that if the fish is exposed to the sun, the oil runs out and become rancid. Of course, roofs also keep off the rain, but rain is infrequent. Further, the roofs provide shelter for the families that come to fish. If a family does not have a tent, its members sleep and cook at their rack; and they store their nets, utensils, clothes, bedding, and other articles there. Once it has a dry surface, the salmon has no unpleasant odor, nor does it attract flies.

Air-Dried Salmon

There are two kinds of fileting techniques for air dried sockeye salmon. The more common yields a single filet of the whole fish; the filet remains attached (at the tail) to the backbone and ribs. In the second technique, the backbone is discarded; it results in two filets (the left and right sides of the fish) attached at the tail. I will call the first a "single filet" and the second "side filets." Women cut and dry the fish; a man helps if the run is heavy.

In both techniques, the first step is to cut off the head and gills. Then the slime is scraped off with a knife. For a single filet, the cutter cuts twice along the backbone, separating the skin and most of the meat from the bone, but leaving the spine attached at the tail. For the first cut, the fish's tail is towards the woman, and for the second the tail is away from the woman. Both times, she cuts towards the tail. Between fileting cuts, the fish is eviscerated. The blood and veins along the backbone are scraped out and the belly cavity is wiped with a cloth. After the fileting cuts, the woman grasps and pulls the backbone/ribs from the filet.

Then she lays the flesh out and scores it every three-quarters of an inch, being careful not to cut the skin. This exposes more of the flesh to the drying air. The next step is to attach an aspen or saskatoon twig to keep the filet open and flat. The twig has a natural fork on one end and is split on the other. First the woman makes two holes in the filet and then she inserts each end of the stick in its hole.

A few sprinkles of salt keep the flies off until the flesh is dry. Then the woman puts the backbone over a pole, with the filet on the other side; the split end of the aspen/saskatoon twig protrudes far enough so that its tines can reach the backbone. When the tines are stuck in the backbone, the filet is firmly attached to the drying rack pole.

The second method of cutting salmon is similar to the first, but cuts are made from both the dorsal and ventral sides, and the backbone is removed and discarded. The two side filets are scored and hung, skin side down, on either side of the pole; no sticks are used.

The side filet method is quick, but the meat of the backbone is lost. People use it when the run is heavy and the cutter cannot keep up with the fishermen. Others use this method all the time because they do not like the bony backbone section and because it is easier than the single filet method.

Mrs. James said that a woman could cut 50 or 60 salmon per day, but from my count of last year's catches and from informant statements, it seems that a fisherman could easily catch more sockeye than this limit while the run was at its peak, if he worked steadily.

Either kind of filet is dry after four days, but they stay on the rack for six or seven days. The person taking them down removes the stick and the fins and separates the backbone from the filets. Then he or she piles them up and puts them in burlap bags for transport. If several families have used a rack, they can tell their fish by distinctive cuts on the filets. At Six Mile, people use horses to pack them home or up the steep, long path to the road; on the other side of the river, people bring a car to the site.

Air-dried salmon is tasty and may be eaten raw, boiled, or roasted. The backbone sections are for soup.

Insects and Drying

Flies are dangerous because the fish may develop maggots. Freshly cut salmon are susceptible, but salmon which have dried for a few minutes (Sam Mitchell) or for a day (William Adolph) are in less danger. Salmon which have not been cut are not in danger unless they are left lying about for a long time, as they were when people used to make salmon skin bottles or pulverized salmon. The danger from flies is greater after 20 August when a large gray fly appears. There are dangers in places along the river that are too moist and in places away from the river that do not get enough breeze.

The most common measures taken against flies are sprinkling salt on the filets, keeping the camp clean, and discarding infested parts of the fish. Tommy Napoleon said that cedar and juniper kept flies away before there was salt. To avoid the flies, Mrs. James tries to dry her fish before 20 August. William Adolph said that the only way to avoid yellow jackets, which eat fish, is to dry at a very arid place along the river; Sam Mitchell said that to make salmon skin bottles or pulverized salmon (described below) you had to find a spot where flies would not get the fish.

Perhaps the most interesting aspect of the fly problem is that it provided one motivation for the fine slicing that costs women so much work. If the filets are not scored finely enough, they dry slowly and attract flies.

Preservation of Fat versus Lean Salmon

Fat fish present several special problems. They can go rancid; they dry slowly and, hence, attract flies; and, finally, in the heat the filet may fall apart.

Tommy Napoleon said that in the past the fattest fish of each run, and particularly springs, were dried with the aid of a fire. He did this himself. First, the fish were cut into single filets and then put by a fire

to broil slightly. He turned them occasionally so that the flesh would not cook and fall off the stick. After an hour or so, they were placed on a rack above the fire to dry.

Currently, Tommy Napoleon air dries some springs. He cuts out the fattest part (the belly) lest it become rancid, and his wife salts it. Then he scores the flesh with slanted cuts (versus straight cuts for sockeye--the slanted cuts make the flesh hang open and exposed) and scores the backbone many times. The flesh adhering to the skin has to be cut thin. If these things are not done, the springs dry slowly and flies lay their eggs on them. Even if dried properly, the springs become rancid if they are not stored in a very cool place or if the weather becomes very hot.

Sam Mitchell, however, generalized that spring salmon were dried the same way as sockeye, though he also told stories about people bringing him springs to cut.

The first sockeyes of a run are also fat. No informant said that he or she dried the first sockeyes; instead, they canned them, salted them, froze them, or kept them for immediate consumption. Some people just kept the fattest parts for such uses and threw away the rest, according to Ernie Jacobs. Tommy Napoleon said that in the past such fish were broiled before drying. Francis Bill Edwards said that they would become rancid.

While he does not dry the fattest sockeye, William Adolph does dry some moderately fat ones. He scores these filets on a slant, makes more cuts than usual, and slashes the belly to let the grease come out. Sam Mitchell said that the early fish (before August) are too fat--they rot and get moldy. He said that they have too much oil, but if one know how to cut them, it is possible to dry them.

At the end of the run, said Tommy Napoleon, the lean sockeye can be dried without scoring the filets. However, several informants said that they did not dry lean fish, which dry like a board and do not taste as good as the fatter fish.

Thus there is a contrast between fat species and lean species, between the fat part of the run and the lean part of the run, and between fat versus lean parts of the same fish.

Special Parts and Products

Salmon heads, according to Tommy Napoleon, are as fat as bellies, even when the rest of the fish is lean. The "old timers" split the heads, roasted them on a stick stuck in the ground by the fire, and then put the heads on a rack to dry. He said that they were not smoked, however. If the heads were not broiled, then the oil would run out of them in storage and they would go rancid. If broiled and stored in a cool place, they would keep as well as any salmon.

Sam Mitchell differed on this point; he said that heads used to be dried, but that there was no special technique (note, however, his description of making salmon oil). They were soaked before being boiled to eat. Three informants kept heads for immediate use, not for storage; only William Adolph had tried to dry heads recently, and they went bad.

Salmon skin bottles were tight enough to hold salmon oil. Sam Mitchell explained the technique that his grandmother used to make them. You take a whole salmon and lay it by the fire, turning it occasionally until the inside swells. The fire has to be smokey to keep the flies away. Then you cut the tail off, pull the bones out, and scrape out the meat. You soak the skin. Then tie one end, cut off the bone around the neck, and fill the anus with slime from a fresh fish. When the skin dries, the bottle is ready. Tommy Napoleon noted that when glass bottles became available, they replaced salmon skin as a container for salmon oil. Dried salmon skin was also an ingredient in paint for rock painting.

Powdered salmon was one of the foods that Sam Mitchell ate as a child, and he is still enthusiastic about a meal of salmon powder and saskatoon (service) berries, topped with salmon oil.

The best feed I used to have was the powdered salmon. I never forgot that yet. The powdered salmon my grandmother used to have and mixed with saskatoon berries and salmon oil--boy, that's the stuff. I get a handful of that--we never use a spoon, we just grab it by the handful. Couple of handfuls of that and you can run all day; it will never bother you. . . . I still think that's the best grub I ever ate in my life, maybe because in them days that's the only thing I ever eat.

It took several days to make the powder: two days by the fire to soften the fish and another day in the sun to dry it. Women processed the fish like those for salmon bottles, but they cut the skin to get out all the flesh. Then they pounded it with a stone hammer and put it in the sun to dry; and, when it was dry, they pounded it again to get the bones out. The meal, with the consistency of sawdust, was stored in bags. Tommy Napoleon added that the meal was dried on either grass mats or rocks. The grass is a long variety that grows in swamps, and the mats are the same kind that people used for a "table cloth" or seat. Sam Mitchell described the mats:

Them days there was no such thing as rice sacks, burlap, or anything. My people used to get what they use for a sort of table--well, even on the ground. I've seen this and I have ate off it. It's made out of reeds--I'm pretty sure they call it that in English. If you go along close to a lake there's a long . . . sort of straw, sort of coarse, $\frac{1}{4}$ inch or $\frac{1}{2}$ inch thick. My people used to cut them. They'll sew it close together. Not all one end that way; they'll change ends and they'll sew it. I've seen it maybe three feet wide and five or six feet long. And that's where they used to make the powdered salmon.

Salmon eggs sometimes dry on a string hung from a drying rack or, less often, on the end of a pole. The ones I saw were almost always in the sun, as were some strips from over the backbone. I could elicit no reason for

this practice. In the past, according to both Sam Mitchell and Tommy Napoleon, salmon eggs might be put in a birch basket and buried for the winter. The next spring, their odor was very strong. After being washed, they were made into soup with tiger lily roots, wild potatoes, and dried saskatoon berries.

Sam Mitchell said that people once made salmon oil near the falls at Lillooet. There, the river had worn depressions into bedrock. People dumped in "everything that is the fattest part of the salmon" (heads, eggs, innards) along with water and fire-heated rocks. This boiled until the next morning, when people skimmed and discarded the foam and then skimmed the oil to put into salmon skin bottles. An elder directed the work, and everyone got a share of the oil. Sam Mitchell said that this occurred in September (the last salmon).

The men make the oil because it's a big hole in this rock. On one end of the rock, it's kind of low, so he went and mudded it and made it even. That's where he built a fire and heated the rocks. He heated the rocks there. When the rocks got hot, that's where he dumped everything, mostly salmon heads and guts and everything that's got oil in it. Mostly salmon heads. They save them. Then he poured water in it and it boiled there for one afternoon to the next afternoon before the whole thing kind of settle down and cooled down.

I seen it because I was curious when I was a kid. I used to always hang around. After this big hole--I'll say six foot diameter--cooled down, I noticed a kind of yellowish layer on top. It looked like a sort of a cream on a milk pan. When it did cool down, this particular man that I watched work on this had a pretty good size spoon. In my language we call it ploxwa. It's big, sort of a ladle. This ladle is either made out of driftwood roots (polished down) or it could be made out of sheep horn. That holds damn near a cup in this big ladle. It's a wooden ladle. He skims this yellow stuff off, then he starts on the oil itself. That oil on top of the water is maybe two or three inches thick, and its kind of a real brownish color. He skims from there and that's what he fills. . . . I don't think there was such a thing as a funnel. But these salmon skin bottles, you can open it pretty wide. It will open out, stretch out. So the ladles that they use, they'll just skim the oil out and pour it in the bottle. . . . Whatever bones there are in there it just cooked like canned fish. It's cooked. You can just chew the bones. There's nothing to it. . . . We used to eat that when we were kids. A whole bunch of us go down and just grab them by the handful from that big hole. We ate until we couldn't eat anymore.

Tommy Napoleon described a different technique for early, fat salmon by which they cooked salmon in baskets and then skimmed the oil, making powdered salmon from the leftover flesh. Teit (1906:215) provided a picture of the type of basket used.

[This picture] represents an oval basket with spout and a wide rim, which gives a firm hold. This kind of basket was used in making fish-oil. The fish were boiled in a boiling-basket, the oil skimmed off with spoons and poured into the basket here described, from which it was finally poured into skins or bladders.

Finally, two minor practices end the catalogue of drying. Salmon eyes were dried after the pupil was cut out. Fat strips from over the backbone are now put out in the sun to dry with eggs.

Modern Lillooet people have added several ways of preserving salmon; they salt, "can" (bottle), and freeze the fish. These techniques work best on fat fish.

One day I watched Sam Mitchell salt some sockeye salmon. He put them in a large plastic garbage can, an innovation brought by Baptiste Richie of Mount Currie in 1970. He laid the fish in layers, each at a right angle to the ones below, and on each layer he threw rock salt. He said that when the container was full he would cover it with burlap and put a weight on top. This weight would squeeze the liquid out of the fish and create a brine. Already, he had several wooden barrels of salmon in his storage shed.

Ernie Jacobs said that the fat fish were the best for salting, and William Adolph put spring salmon up in mason jars using a pressure cooker. Those people who had freezers put salmon in them, mostly springs. Fortuitously, the fat fish most appropriate for nontraditional preservation are the ones most difficult to preserve by air drying.

Storage

Preserved salmon are stored today in sheds and cellars where they will be dry and cool, usually in wooden or cardboard boxes. When Sam Mitchell and Tommy Napoleon were young, people usually stored salmon in "little houses" on four posts, of which a few (built differently) may still be seen.

Sam Mitchell described these box-caches. They were made of criss-crossed fir poles of about one inch diameter. Fir was used because it was the most available. The caches stood about five feet off the ground and were 4-6 x 6-8 ft. The salmon were stacked inside in piles 3-4 ft. high. The houses were not locked.

Before Sam Mitchell was born, the box-caches were by the river. When people needed salmon, they got a week's or two week's supply from the cache. Usually, this was not difficult since there was little snow by the river. Tommy Napoleon said that there was always a wind by the river so keeping them there helped to keep them dry. Mrs. Zabatel said that there were two ways of storing salmon: the little houses and in "pine boughs."

Teit (1900:215) mentions both methods:

The caches of the Upper Lillooet were mostly cellars, like those of the Upper Thompson; while the Lower Lillooet used the elevated box-cache made of boards or cedar-bark. Some of the Upper Lillooet also used elevated box-caches made of poles.

When Tommy Napoleon's uncle was a child, he lived in a semi-subterranean house and used cache pits for storage.

The dangers to stored salmon were stealing, insects, animals, mold, and rancidity.

Both Sam Mitchell and Tommy Napoleon said that local people did not steal while the box-caches were in use. Outsiders did steal salmon, though raiders might be repulsed or they might fail to find the cache.

William Adolph said that if you put the fish away before it is completely dry "black bugs," which look like centipedes, will breed in it. You can shake these off and store the salmon somewhere else. In July, some of Sam Mitchell's salmon from the previous year were filled with such bugs. Tommy Napoleon thought that white pepper would keep bugs away, though black pepper would do. Juniper berries had the same effect before pepper.

Most animals could not get into the box-caches. Pits were lined with grass and pine needles to keep the mice out, according to William Adolph. Tommy Napoleon said that they were lined with grass and pine needles just to keep the fish clean.

The box caches were built in a way meant to reduce mold. Sam Mitchell said that they needed a good roof to keep most water out. The sides of criss-crossed fir boughs were intended to let the air blow through; otherwise the fish would get moldy in a wet fall.

Rancidity could not be avoided once the fish were in storage. Storage in cold retards oxidation, but it does not prevent it entirely.

Access to Fishing Sites and Salmon Distribution

Aboriginally, individuals owned rocks that one or a few people at a time used to catch spring salmon. Stretches of the river were associated with particular semi-subterranean villages, but my data on the nature of this association are not detailed. The most productive sites--the falls of Six Mile and Bridge River--were open to all the Fraser Lillooet and to outsiders. These were the sites for large fishing congregations and for selling or trading dried salmon.

Internal to the Fraser Lillooet of that period, differential access to salmon sites was the basis for a system of distribution and prestige. For people who were not Fraser Lillooet, access to dried fish and fishing sites varied with their distance from the Fraser Lillooet and the degree to which their home resources differed from those of the Lillooet.

Today, both Fraser Lillooet and others continue to use salmon taken from the Fraser Lillooet area. Because the sockeye season is short, people are able to combine participation in the fishery with other work.

Historic Access to Fishing Sites

Individually Owned Rocks

According to Sam Mitchell and Tommy Napoleon, access to spring salmon was important because it was the preferred species and it was a major article of trade. The sockeye runs did not begin until late July and there were no other important exploitable resources in the earlier part of the summer.

Men fished for springs from platforms built on "rocks" beside swift-flowing, small eddies. According to Sam Mitchell, who provided the information for the rest of this section, the rocks had names; "an anchor" (because one had to brace the platform), "boiling water rising," "shallow," and "something that hangs" (because the platform hung well over the water).

Each rock was owned and inherited and ownership was well-known. Even today, some older people might say, for example, "that's Tom's rock."

The rock's owner built its platform and supplied the net that he and visitors used there. It took a full day to make the platform. The owner camped and had his drying rack there. When he was done fishing he dismantled the platform because the materials were reusable and otherwise the river would wash them away.

The owner of the rock had preference in its use and he caught most of the fish there, but other people could use it with no payment to the owner. When someone went, for example, to Tom's rock to fish for springs, he was said to be "going to wait for Tom." The norm of sharing access to a rock appears to have been very strong.

When a person was old or dying, he would tell his heir to "look after the rock." Sam Mitchell said that the heir was usually a son, but could be any "relative." Teit (1906:255) writes that when a man died "his fishing station was the property of all his sons."

The following account summarizes ownership/stewardship:

A fishing rock can't be sold from way back. It can be handed down to relations like son, nephew, or anybody else, whoever the older guy that owns the rock, that fixes the platform, whoever he thinks will be capable to keep doing it, keep fixing it. But it doesn't mean for just himself. When he fixes that platform or that rock where he fishes, it's not only him that fishes. Everybody. When he sees anybody come and set, they wait for him, and he just calls them over. He tells them, "Come on and fish." They don't hog one rock. If he gets what he needs, the other fellow gets a share, and everybody else gets a share [Sam Mitchell].

Of three rocks that today are used by individuals, one was passed from a man to his son and then to his son's son; the second was passed from a man to his daughter and then to her son ("He had a grandson . . . by his daughter."); and a third was passed from a man to his son and then to his son's daughter. In all three cases the third user is alive but detailed questions about current usage simply elicited the response that today anyone can use a rock. In any case, people are not building platforms anymore. Certain people do use the same gill net site every year, but for these also questions elicited the answer that anyone could use the site.

The following anecdote does not identify the old man as a rock owner, though he owned the net.

There's one particular rock they call *ts'ut'*. These fellow knew where to fish in June, so they went there. They seen this one old guy fishing there. He didn't come from this side of the river; he came from across the river. He knows this rock was pretty good. They seen he had three or four spring salmon already, laying out on the rock. So they sat down and waited for him.

He got another one, he clubbed it, and he brought it out. He goes back on his net. This particular guy was sort of a joker, too. Billy Diablo and him and another guy. They were young guys then. He says, "We just watch him. If he brings out another one and he wouldn't let us have his net, we'll fix him."

This old guy brings out another one, pulls out another salmon, clubs it, packs it out. He wouldn't ask these guys to go and use the net. So Billy Diablo says, "OK, we'll fix him. Come on." He told his partner, "Go and get your sack. We'll take two apiece. We got the horses. He hasn't got a horse here himself. He'll have to pack it to town if he's going to sell it."

So Billy and his partner went over there. They had those sacks and they shove it in. Two apiece, the biggest ones, and they tie it on his horse. And this old guy looked around. These fellow were loading the horses with his salmon and everything. Boy, he jumped up and he started to holler. They told him to go to hell. "Go ahead," they told him, "keep fishing. It's alright. We're going. We have our share."

Residence-Group-Associated Sites

Each aboriginal-style village of semi-subterranean houses was associated with a stretch of the river, according to Sam Mitchell. A man could get access to the village's sites by marrying in, as I later discuss. My data on this type of ownership are scanty and I cannot distinguish the rights of settlements' individuals from the collective rights of a settlement.

By 1870, the Canadian government was gathering data to codify the relation between bands and stretches of the river. Canada Department of Indian Affairs (1902) sets out these data on "privileges." Anderson Lake

Band was fishing on that lake and on Mosquito River; Seton Lake Band at the juncture of Seton and Anderson Lakes; Lillooet Band on a stretch of both Cayuse Creek and Fraser River; Cayuse Creek Band on lower Cayuse Creek and the west bank of the Fraser; Bridge River Band on both sides of the Fraser at the mouth of the Bridge River; and upstream from there, in order, Fountain Band, Pavilion Band, Clinton Band (Shuswap), and High Bar Band (Shuswap). Governor Douglas' policy was to "leave the extent and selection of lands entirely optional with the Indians who were most immediately interested in the reserves . . ." (LaViolette 1961:105), but it is not sure that Lillooet social organization in 1870 reflected aboriginal organization. By that time, missionaries were trying to make them sedentary farmers (Sam Mitchell) and they did sell salmon in the nineteenth century (Teit 1906:259). Walker (1967:15) has noted for the southern Plateau that a money market for salmon (plus the policies of government and missions trying to restrict people on reservations) influenced "tribes" to claim fishing grounds, in contrast to fairly unrestricted aboriginal access.

Public Sites

The falls at Six Mile and Bridge River were never owned, according to Sam Mitchell, though some individuals had rocks there. He and Tommy Napoleon agree that this site has always produced most of the Fraser Lillooet's sockeye salmon and much of the spring salmon as well. When the river's level falls quite low there are between six and a dozen productive rocks at the Six Mile/Bridge River site.

This site has been a point of congregation. Sam Mitchell said that it seemed that the only time when all the residence groups got together was during the sockeye run at Six Mile. Moreover, as we shall see, many outsiders came to fish or trade here. His tradition is confirmed by Simon Fraser's journal.

On 15 June 1808 Fraser found what seems to have been a fortified fishing camp opposite the present site of Lillooet town (Fraser 1960:82). This would have been before the start of the sockeye run while springs were still in the river. Returning to the spot on 17 July he found the camp, but the "Chief" and many of the residents had gone up the river to what must have been Six Mile. There, Fraser rested in the Chief's "*shade*," which I presume to have been his drying rack. At that date--just before the sockeye run--there were upwards of a thousand people in the camp (Fraser 1960:120-121).

As we see in later sections on salmon distribution, the people who came to Six Mile during the nineteenth century included Lower Lillooets, Shuswaps, and non-Indians and they came to trade as well as to fish.

Historic Salmon Distribution and Stratification Within Settlements

Access to Sites and Stratification

The "old timer" Lillooet society that Sam Mitchell and other informants describe was stratified (see also Teit [1906:255]). This stratification included differential access to food. Thus, Sam Mitchell said that a rich man was one who had a lot to eat.

In some years--when the runs were largest--public sites produced a great deal of salmon. Rounsefell (1938:760) estimated that at the turn of the century, the Indian catch in "big" years at Bridge River averaged 40,000 fish. Hewes (1947) estimated that the Lillooet consumed an average of 600 lbs. of salmon per person per year. If outsiders did not take a large portion of the catch, then the average "big" year catch at public sites could have supported a large portion of the approximately 500 Fraser Lillooet of the turn of the century. However, that catch would not have supported a presumably much larger aboriginal population.

Further, the runs were not always plentiful (Teit 1906:199); as told to Tommy Napoleon by his uncle (who lived in a semi-subterranean house), it was often hard to keep the families going in aboriginal times. Sam Mitchell put the problem into a comparative perspective: the Lower Lillooet could get food anytime they wanted it, but in the Interior things were rougher because people had to preserve food for the winter.

Having privileged access to a spring salmon rock and the labor to dry fish, some individuals could produce much more than they could eat. Sam Mitchell estimated that in this century some people took as many as 600 spring salmon and 400 sockeye, which (using a 23 lb. average for the spring salmon and the Hewes consumption estimate) would feed 24 individuals or allow for trade. The number of such "rich" people was limited by the scarcity of productive fishing rocks (Sam Mitchell, Mrs. Zabatel). On the other hand there were "moochers" or "lazy buggers"--poor people who did not have enough to eat.

The Distribution of Salmon Within Settlements

The residents of semi-subterranean houses shared their dried salmon (Tommy Napoleon), though it was dried and owned by kinship units smaller than the extended family that used the house (Sam Mitchell). Those who produced little or no salmon were called lazy or moochers, but they could beg at many different houses. In times of shortage they went hungry (Sam Mitchell, Mrs. Zabatel). Certain families always produced large quantities of spring salmon and they made sure that people who lived nearby had enough (Sam Mitchell).

Dried salmon was only rarely distributed at a potlatch feast "because every family had their own" (Sam Mitchell). The usual potlatch good in aboriginal times was deer skin or meat; later, goods from white traders became important.

An extended family short of salmon could borrow from neighbors (Tommy Napoleon) with consistent giving rewarded with prestige and consistent borrowing castigated with the moocher title. The relation between such unbalanced giving or getting and prestige is illustrated in the following myth. One of the notable features of the myth is that the chief could not expropriate salmon, but rather would have to send a child to ask for it.

In the myth of the deserted boy, recorded by Charles Hill-Tout (1905:201-204) among the Seton Lake Lillooet, the son of a chief goes to several houses where "he told the inmates that his father had sent him to borrow some cured salmon" and other food. In fact, the boy is gluttonous and eats the food himself. After he did this for several days,

the people begin to talk about the chief begging food each day, and the boy's aunt, hearing the gossip, suspects what has happened, and comes to the boy's parents and tells them, asking if their son is borrowing food with their knowledge and consent.

The chief is angered and contrives to have the boy abandoned on the opposite side of Seton Lake. When he is deserted, a few people leave some scraps of dried salmon in storage pits, and his grandmother slips away from the deserting party and lives with the boy. In a short time, the boy learns to be a man and acquires magic to attract trout to his camp. Meanwhile, there are hard times back at the village. People hear of the youth's prosperity and come to his camp.

Those who had felt sorry at the desertion of the boy, and had left him some scraps of food in their [storage cellars] now reaped their reward. They found their cellars stocked with quantities of dried fish, but the cellars of the boy's father and uncles, and of those who had not been friendly disposed to him, contained nothing, and they had to go to bed hungry that night.

The next morning the youth . . . calls all the people and bids them help themselves. He now becomes a great man among them.

In this story, as in informants' reports, men gain prestige by producing and distributing fish, but those who receive fish lose prestige. Also, just as Sam Mitchell described it, recipients of food saved face when children brought it. Gifts of fish, as Tommy Napoleon said, were usual so long as they were not too unbalanced; getting fish too often became "begging." Finally, this myth illustrates how normal giving could escalate into potlatching.

Historic Inter-group Relations and Access to Fraser Lillooet Salmon

The aboriginal Plateau peoples developed a remarkable regional system of access to each other's resources, of trade, and of seasonal congregations. Anastasio (1955) documented this system for the southern Plateau and showed that patterns of intergroup hostility and cooperation

have survived until today, expressed now by group gambling games. The Fraser Lillooet were part of this system and Six Mile/Bridge River was a typical Plateau fishing/trade center (but the Lillooet did not play *lahal* games at the fishing camp).

The special attraction of the Lillooet area resided in the quality of the dried salmon that could be obtained there. People came because they needed preserved food, not just because they needed fresh fish. Conversely, the labor requirements of preserving salmon were what made it impossible for the Lillooet to use all the salmon that they could catch at the height of the run. To the people living far upstream of the Lillooet, the Lillooet represented a source of relatively fat (and tasty) dried salmon. To the lower Lillooet, the Fraser Lillooet were a source of air-dried fish.

Reciprocally, the Lillooet used the contrasting fish resources of some of their neighbors. The people who lived to either side of the Fraser were stewards of the trout runs that the Lillooet needed in their time of hunger.

Social relations between the Lillooet and their neighbors varied depending on the neighbor's resources and their distance from the Lillooet. We shall now examine some of these relations in more detail, starting with people whose resources were like those of the Lillooet and proceeding to the those with unlike resources.

TABLE 1

Access to Lillooet salmon, by environmental differences and distance:
aboriginal to nineteenth century

Environment/distance	Group	Access to salmon
Similar environment	Shuswap to Clinton	Friendly, have access;
Short distance	Thompson to south	marriage
Greater distance	Shuswap	Friendly, no fishing or
	Thompson	trade
Different environment		
Short distance	Lakes Lillooet	Seasonal, cross- utilization (trout, fat salmon)
	Shuswap Bonaparte	Trade Marriage
Greater distance	Lower Lillooet	Trade
	Shuswap and Thompson in Thompson R.	Some fishing
	Okanagan	Theft
Even greater distance	Shuswap	Raids
	Chilcotin	

Some neighboring groups had resources similar to those of the Fraser Lillooet; if they lived close by, they could use Fraser Lillooet fishing rocks on an occasional basis. According to Sam Mitchell, there were Shuswap residences to the north of the Lillooet on the east side of the river to a bit north of Clinton, and there were Thompson to the south on the west bank (the east bank to the south was unoccupied). These Thompson intermarried with Lillooet on the west bank and the Pavilion Band married with the Fountain Band (Boas 1906:292; Teit 1909:469; Sam Mitchell; Tommy Napoleon). Although they had their own fishing rocks, they could come to the Fraser Lillooet area at any time to fish and dry salmon, generally staying on their own side of the river. Neither informant said that they had to be related in a particular way; perhaps their attitude was like that of a modern resident of Pavilion, who said, "Well, sure, I'm related to everyone at Fountain." Teit (1906:536) reports that the Lillooet traded salmon to upriver Shuswaps, but my data generally indicate visits to fish.

If they lived at somewhat greater distances and still had resources like those of the Lillooet, there was no motivation to use Fraser Lillooet salmon. The Thompson and Shuswap who lived at greater distances along the Fraser did not come to trade or to fish, though relations were generally good (various informants). They had access to resources similar to those of the Lillooet and they could get trade goods elsewhere (Teit 1900, 1909).

The people who had dissimilar fish resources, but who lived at a short distance from the Fraser were the Lillooet of Seton and Anderson lakes to the west and the Bonaparte Shuswap to the east. The Lillooet of the lakes had trout runs, and they could take spawning salmon, while the Bonaparte Shuswap had access to Thompson River salmon and to large numbers of trout. Mrs. Zabatel said that the Thompson River salmon dried like boards, had no fat, and did not taste as good as the Fraser River salmon.

These people used Fraser Lillooet resources and the Lillooet used their resources on a regular, seasonal basis. The Lakes Lillooet regularly came to fish and dry salmon with the Fraser Lillooet, according to Tommy Napoleon's uncle. They cached their salmon on the shores of Seton Lake before they went home. On the other hand, Fraser Lillooet (Lillooet Band) took trout from Seton and Anderson lakes.

The Shuswaps of Bonaparte River traded with the Lillooet for salmon and intermarried with the Lillooet (thus gaining access to salmon). Teit (1909:536) describes the trade:

The Bonaparte and Lower Fraser River bands obtained from the Lillooet salmon, oil, woven blankets, goat hair robes, skins of small Columbia deer, a little wa'xaselp (*Philadelphus Lewisii* Pursh.) and yew wood, giving in exchange dentalium-shells, skin robes, dressed buckskin, a little paint, and in later days horses.

Mrs. Zabatel noted that in an early period there was quite a bit of marriage between the people of the Bonaparte River and the Fountain Band. Sam Mitchell commented on such marriages.

If the head guy has daughters who marry out the sons-in-law live there because that's how they fish and gather. That's how they get grouped up. [The husband always comes to live with the wife?] If they like the country. That's how Shuswap came here. They came down and saw lots of fish and girls. Well sure they stay. I know that in the beginning our village [Fountain] had lots that spoke the Shuswap language. [If the husband doesn't like the wife's country?] Well they'll go home, and they got a better home somewhere else. But lots of them settle down here. That's the only thing I can answer.

For their part, some Fraser Lillooet went to the territory of the Bonaparte River Shuswap for the first trout runs of the year. The Loon Lake and Hiiume Lake runs lasted two weeks and were plentiful. The fishing was collective. Mrs. Zabatel said that the oldest person at the camp, who was usually a Bonaparte Shuswap, distributed the fish every morning (Tommy Napoleon also mentioned the runs). Every head of household got an equal share. So far as I know, the Lillooet did not travel to the more distant Green Lake trout fishery described by Teit (1909:450).

For people who had different fish resources than the Lillooet and who lived at a greater distance, the Fraser Lillooet fishing camps were a place to trade for dried fish that was fatter or better-preserved than their own or to trade for fish when their own runs failed. The main way that such people got Fraser River fish was through trade. They included the Shuswap and Thompson to the east of the Lillooet in the Thompson River drainage and the Okanagan at the north end of Okanagan Lake.

A noted resort for trading and fishing was at the "Fountain," near the borders of the Shuswap and Lillooet territory, where also the Lower Lillooet came. Here, on Fraser River, salmon were caught in abundance. Later on, a pack-train from Hudson Bay company came here once a year to buy salmon and to trade. When fish were scarce in Thompson River, the Spences Bridge and Nicola bands, Okanagan, and eastern Shuswap came here for salmon [Teit 1900:259].

The Lower Lillooet also came to trade.

. . . large numbers of the Lower Lillooet went with the Lake band right to the Fraser River, where every August and September a great deal of trading was carried on along the river between Lillooet and the Fountain, at the time when the Upper Lillooet were congregated there for fishing salmon. Here they also met Shuswap and sometimes Thompson Indians, and in the later days traders from the Hudson Bay Company [Teit 1906:232].

If they came in August and September then they were there for the sockeye run, including its lean end, and not for the spring salmon run. Trade with the Lower Lillooet is described by Teit (1906:232):

The large fat variety of Fraser River salmon, when cured in the dry climate of the region of the upper Fraser River and of Thompson River, was considered much superior to the same salmon

cured in the damp countries of the Lower Fraser and Lower Lillooet, and brought a much higher price than any other kind of dried salmon. Although the Lower Lillooet put up in their own country more than enough salmon for winter use, still they always liked to obtain, besides, a quantity of the superior Fraser River cured salmon.

From far upstream, Shuswaps came to Lillooet:

Frequently some of the Kamloops people went over to The Fountain and traded with the Lillooet directly [Teit 1909:536].

The trade relation also predominated with the Okanagan, but Sam Mitchell did not mention the Thompson in our discussion of trade and fishing.

The visitors to the upper Lillooet did catch some fish for themselves, but this was mostly for food while at the camps. "Anybody wants to go rustle something to eat, that's their business; lend them a net" (Sam Mitchell).

The benefits to the Lillooet from this trade were substantial. According to Sam Mitchell and Tommy Napoleon, horses first came to the Lillooet area in trade for dried salmon. This trade lasted into the twentieth century, when the rate was 15 to 20 dried spring salmon for a horse. A major source of deer skins for the Fraser Lillooet were the Shuswap who came to Six Mile, and the Lillooet suffered in the winter from an inadequate supply of buckskin clothing.

Speaking of his parents' generation, Sam Mitchell said,

You don't have to be related to a trading partner. But once you trade with him, it can be a horse or anything, dried salmon or anything at all, in my language you call it nukulux. Whenever he sees you, when you see him, or you go and see him, he knows you go there for some business of trading or something. If you want a horse, you'll get a horse from him.

From even farther away, and also living in dissimilar environments, others came to get Fraser River salmon by raiding. Shuswap and Chilcotin raiders came in the fall when the fish were dried and many Lillooet were out hunting. They were different people than those who came to trade, and appear to have been unfamiliar with some Lillooet practices: they "didn't have the idea that the salmon would be stored down there" by the river (Sam Mitchell). There is a grave on a ridge near Fountain where two Shuswap raiders killed with arrows are buried. Teit (1906, 1909) records several stories of raiding. After 1850, friendly relations prevailed with the Chilcotin (Teit 1906:233; Sam Mitchell).

The more spectacular adaptations of the coastal people to the variability of basic foods--particularly the regional potlatch/wealth object complex--are not replicated among the Lillooet. The Lillooet did have give-aways associated with some changes in status, but nothing so striking

as those found on the Coast. Further, Lillooet potlatches were a direct part of their aboriginal food-getting system: they gave away dried deer meat, a critically important produce when salmon runs were poor. Thus, the function served by wealth objects on the Coast appears to have been served more directly by deer meat. As has been shown, salmon fishing and gifts of dried salmon were related to local stratification, not to a regional highly developed ceremonial system. The functional alternative to the coastal system was cross-utilization and the other elements of the regional system just described.

Access to Salmon in the Twentieth Century

The current regional system of access to salmon retains similarities with that of the nineteenth century (Table 2). The annual fishery at the Fountain (or Six Mile/Bridge River) fishing site is still a major event and a multi-tribe gathering. The fishing and drying techniques in use are largely the same as those used aboriginally, and the Lillooet still depend on dried salmon for a substantial part of their diet.

TABLE 2

Access to Lillooet salmon, by environmental differences and distance:
twentieth century

Environment/distance	Group	Access to salmon
Similar environment		
Short distance	Shuswap Pavillion	Friendly, have racks at Six Mile
Greater distance	Thompson	Friendly, no fishing or trade
Different environment		
Short distance	Shelath Shuswap Bonaparte	Have racks at Linktown Have access
Greater distance	Lower Lillooet Shuswap Okanogan	Have access Take home in ice Trade
Even greater distance	Vancouver Fraser Valley Yakima (1 case)	Purchase Have access

Each Lillooet band that lives along the Fraser River is associated with a fishing and drying site. Fountain Band fishes and dries at Six Mile, Bridge River Band at the mouth or just south of the mouth of Bridge River, and Lillooet Band uses the west bank to the north of Bridge River's racks.

The partially-Lillooet people of Pavilion and Texas Creek also "have their own rocks" to the north and south respectively of the Fraser Lillooet. The association of bands with sites is shown in the ownership of drying racks: 11 of the 16 racks at Six Mile belong to Fountain people, and four of the five racks north of Bridge River belong to Lillooet Band people.

All informants said that any Indian could fish at any particular fishing site. When asked why they fished at a site, most informants mentioned cooperative aspects of fishing at a site (rides to and from the site by car or horse, for example), the quality of fishing at a site, or their ownership of a rack. Most of the sites are on reserves, and people normally use the site on their reserve.

Today, some people fish only for sockeye and others fish for both spring and sockeye salmon. The spring run lasts for a long time, but the daily catch is not large. To fish for springs, one has to give up the alternative income available from migrant harvesting, and there is the expense of a gill net. My impression is that those who fish for springs tend to be older, reluctant to go harvesting or more sedentary because they are involved in local farming. On the other hand, during the peak of the sockeye run the daily catch is large, so people forgo other activities to fish.

Although rocks and eddies are not owned by individuals, certain people habitually set their gill nets at particular places. Further, the nets themselves are owned. The Bridge River people formerly would leave a gill net at their site for anyone's occasional use, but they stopped this practice after finding the net tangled and damaged. Sam Mitchell habitually uses a certain rock, but he lays no claim to it. Mrs. Zabatel said that it all depended on who got there first, yet there seems to be consensus about who uses which eddy.

Nuclear families, sometimes augmented by older relatives, catch, store, and consume salmon. I saw one case where the households of a woman and her unmarried brother shared a storage shed. Outside the nuclear family, people give salmon to relatives, old people who cannot fish, and visitors. Mrs. James, for example, gave salmon to her mother and her aunt. Sam Mitchell sent children with fish to members of the Fountain Band who were too old to fish, even though they were not related. People often visit for dinner, and reciprocity is expected.

The Shuswap of Pavilion Band still fish with the Fountain Band Lillooet, just as they did in the nineteenth century. Two of the 16 racks at Six Mile are owned by Pavilion residents, and Pavilion people visit and eat salmon at Fountain. At least some of the residents of the settlements to the south of Lillooet come to fish at Bridge River. One of the five families that dry at Bridge River is from Texas Creek. Of the people living in a similar environment, but at a greater distance, almost none come to get fish at the Fraser Lillooet sites.

Of those who live nearby but who have dissimilar fish resources, the Shelath (formerly designated Seton Lake) people have their own site by the town of Lillooet, Linktown, with two drying racks. The name derives from that of the Link family of Shelath. In the 1902 schedule, the Seton Lake

people used Seton Portage, but since then the Cayuse Canal has blocked the run to Seton Portage. Other people with dissimilar resources come to fish. The Lillooet of D'arcy were said to come frequently to fish along the Fraser. People from the Bonaparte Shuswap Band also come. Mrs. Zabatel, Sam Mitchell's step-daughter, and now of the Bonaparte Band, stayed for a good part of the season and dried on his rack.

From a greater distance quite a few Lower Lillooet from Mount Currie come to fish and dry at both Bridge River and Six Mile. They usually stay with relatives and dry on relatives' racks. The salmon they have at home in the Lower Lillooet area comes later than that at Lillooet and it is lower in fat because it is nearer to spawning. Of non-Lillooet, very few Thompson Indians come to fish at Lillooet today, but large numbers of Shuswap from Kamloops, Chase, and Chu Chua, as well as some Okanagan from Vernon, fish at Bridge River or Six Mile. They use the nets provided by the Fraser Lillooet. Generally, they take their fish home packed in ice. In the recent past, those with dried salmon traded it for fruit, deer skins, or, less often, money. When they come only to fish, with no intention of trading, they may also bring gifts of fruit for their friends. When I was at Lillooet I saw no eastern Shuswap or Okanagan; the poor run explains their absence.

When large numbers come from the east to fish the sites are crowded. Mrs. Zabatel said that there were sometimes six people waiting in line to fish from a particular rock. When this happens they set a limit of five or ten fish per turn. The total catch for the outsiders who pack fish home in ice may reach 50 or 100 fish.

Of the people from even greater distances, the ones whose ancestors raided the Lillooet, none come to Lillooet to fish, so far as I know. However, now there are some who come from Vancouver and the lower Fraser Valley, and even one man who comes from Yakima. These people usually come to purchase dried salmon. Those of the Fraser River Valley, who have their own access to salmon, say that they cannot dry them the way the Lillooet do, instead having to smoke, salt, or freeze them.

In summary, we have shown that among themselves, the nineteenth century Lillooet had individually owned fishing sites, residence-group sites, and public sites. The Fraser Lillooet shared their sites, but not to the extent that everyone had equal access to salmon. Stratification of access was the basis for a distribution system which, in turn, resulted in prestige differences.

The Fraser Lillooet were part of a typical Plateau system of trade, cross-utilization of resources, inter-marriage, and raiding. This regional system involved other divisions of the Lillooet, as well as Shuswaps, Thompson, Chilcotins, Okanagans, and whites. Their relations with other people varied depending on the fish resources that those other people had including their ability to preserve their fish and their distance from Lillooet. The special place of the Fraser Lillooet in their Plateau social system resulted from the dry air, prevailing breeze, and modestly (but not excessively) fat salmon at the Six Mile/Bridge River fishing site near the Fountain village.

The nineteenth century patterns of access to Fraser Lillooet salmon--with functionally equivalent substitutions--have survived to a degree that would be astonishing were it not for two factors. First, we know from Anastasio (1955) that many patterns of Plateau social organization have survived. Second, the basic technology and goals of the fishery remain as they were in the nineteenth century. Salmon is still fatter downstream than upstream and people are still more willing to go short distances than long.

Comparative Cultural Ecology and Salmon Preservation

For the Northwest Coast,

The techniques for preserving food are certainly as important as those for getting food. Thousands of salmon swimming upstream in September would not make winter a time of ceremonial activity if people lacked the means of preserving them [Suttles 1968:63].

The data so far presented show that salmon preservation was no less important for the Plateau Lillooet; since their winters were more severe than the Coastal winters, perhaps preservation was more critical. Comparison with coastal drying will highlight features of both areas.

Most of the techniques of salmon drying described in this report are the ones appropriate to the constellation of natural factors found in the Lillooet area, the most important of which are its summer abundance of modestly fat salmon and its hot, dry summer wind. The social environment (the demand for trade) probably promoted powdered fish production, as it did at Celilo Falls on the Columbia.

Environmental differences resulted in other aboriginal techniques elsewhere. The environmental contrast between Coast and Interior was also the basis for trade and migration. The regional system described above is a consequence of such environmental factors.

The ways in which the Lillooet themselves respond to environmental variations suggest the factors that, writ large, explain differences between groups living in different environments. Lillooet technique varied in accord with salmon species (principally, sockeye or spring), part of the salmon (head, eyes, eggs, dorsal strip, tail, backbone, ribs, skin, oil, guts, eggs, belly, flesh, and others), fat content of the part or species (or, early/late in the run), condition of fish (e.g. spent), size of the fish, number of fish on hand, weather conditions (rain, temperature, clouds, wind), presence of pests (flies, yellow jackets, mice), other natural features (e.g. rock depressions for boiling), storage conditions, and human actions (trade, theft). Of these, I will deal with two general factors: drying conditions and fat content.

Drying Conditions

Sam Mitchell noted the exceptional features of the Lillooet area.

This is the only country that can dry that fish like that. . . . You go further south and it's too wet--they get moldy. The further you go down the river the more moist the climate, well, they get moldy. Even down here you have to make your poles toward the river so the wind goes up and down and the wind will go through your fish. You can't make it cross-wise . . . it would rot.

(What about upriver--can they make it this way?) Yes, but the further you go north from here there is no more rocks to fish. This is the best country from here on down. Down the river there is lots of places you can fish. But you go further north and the country levels out and there is no more rocks. There may be one or two places like High Bar--not too many, not like here. But up north, they fish differently. Like around Quesnel--when the fish gets up there they drift down just like down in the Fraser Valley. They drift down there too. You know, they put down a gill net and they drift. That's the way they fish down there.

Even within their generally favorable environment, modern Lillooet driers search out the places with constant wind. At the regional level, the Coast Salish put their fishing camps where the breeze was best (Suttles 1951:165). The people of the lower Fraser River search out wind, putting their racks on rocky outcrops below Yale (Stewart 1977), though only upriver from Hope is the wind good enough for air drying (Duff 1952:17).

Where (or when) people did not have such good drying winds, they had to smoke fish (fat content also contributed to the need to smoke, to be discussed). Smoking is basically a form of drying, though the smoke may also leave chemicals on the fish that inhibit bacteria (Frazier 1967:140-141) or decrease rancidity (Sinnhuber 1971:personal communication). Smoking might be restricted to a particular season (Suttles 1968:63), but some recourse to it was general on the Coast, as noted in Drucker's (1950) Northwest Coast culture trait lists. The more-usually-adequate drying conditions in the Interior required only an occasional smudge fire.

More striking, using residential houses for smoking (Suttles 1968:63), largely as a seasonal expedient, was also a widely distributed practice (Coast Salish--Suttles [1951:145]; Sanpoil and Nespelem--Ray [1932:75]; Sinkaietk or southern Okanogan--Spier [1938:14]; Northwest California generally--Driver [1939:315]; Lower Chinook--Ray [1938:130, plates 2, 3]). Storing dried fish in a residence, where a fire kept relative humidity down, was also common. Suttles (1966) notes that these practices bind nuclear families to their extended family co-residents.

The most striking adaptations to the difference between coast and interior drying conditions were trade and travel between the two zones. This is a case of parallel cultural adaptations because it occurred on all three of the major rivers south of Alaska--the Columbia, the Fraser, and the Stikine.

Deward Walker (1967:13) reports on the Columbia River,

Gibbs . . . early noted the substantial dried fish traffic between the coast peoples and those of The Dalles-Celilo region. Thus although fish are in their best condition at the mouth of the Columbia, they can be cured somewhat more easily somewhat further inland where the warm, dry winds of the interior dry them quickly. Both factors contributed to the substantial upriver and downriver travel and trade in salmon products.

I would agree that salmon are in their best condition at the mouth of the river in terms of fat content, taste, and appearance; but I would add that for long-term preservation, they were better when they had lost some fat.

For the Fraser River, we have Duff's (1952:25-26, 67) report that large numbers came up the river to fish for sockeye (which lose fat on the way upstream) and that downstream people stored their fish upstream. Teit (1900:259) also notes that the Lower Thompson sold dried "Kwoi'a" salmon to the Coast. Since these sources of interior fish were located between the Fraser Lillooet and the Coast peoples, direct contact between the two was not major, though the Lower Lillooet, living in a coast-like climate, did come to Lillooet.

Going to the north, Emmons (1911:6-7) states that the Tlingit claimed a 15 mi. stretch in the interior for the advantageous drying conditions that prevailed there, as well as for certain berries.

In all of these cases, the interior sites had better drying conditions than the coast sites. They also had lower-fat fish, which were more easily preserved. To hammer home the importance of the latter factor, we shall examine cases where Coastal people showed their appreciation of low-fat fish.

Fat Content

The Lillooet treat the early, fat part of the sockeye run differently than they treat the later, low-fat fish. They also treat fatter spring salmon differently than they treat sockeye, which do not eat on their run and so lose their fat. Moreover, they use fatter parts differently than the rest of the fish. These differences result from two problems with fat fish: they are more difficult to dry (and so can rot or become fly-blown) and their oil goes rancid.

The following list collects instances from the Coast and Plateau to show that lower fat species, parts, and individual fish were easier to dry for long periods. Use of roasting/smoking to get rid of excessive oil is notable.

Low Fat Salmon Favored for Preservation

1. Lower fat species for longer or easier preservation

- a. Northwest California (Kroeber and Barrett 1960:101): steelhead fatter than salmon and molds more easily; steelhead used first while salmon lasted the winter;
- b. Puyallup-Nisqually (Rivera 1949:236): dog salmon, the least rich and not appreciated fresh, kept over indefinite periods of time;
- c. Kwakiutl (Boas 1921:223): dog salmon important;
- d. Thompson (fieldnotes): sockeye dried, spring salmon canned;
- e. Tlingit (de Laguana:personal communication): dog salmon (skinny, less fat) last long time but not liked, "like a board;"
- f. Sanpoil, Nespelem (Ray 1932:75): spring salmon spoil more easily than other species, so kept well shaded;
- g. Nez Perce (Spinden 1908): sockeye salmon preferred for drying;
- h. Haida (Curtis 1911[4]:131): dog salmon principal storage food on account of its keeping qualities;
- i. Tahltan (Emmons 1911): sockeye the major dried fish, "being a dry fish it cures readily;" and
- j. Yukon (Warner:personal communication): fatter and larger springs cut into 10-20 slices for smoking as human food; smaller, less fat chum air dried for dog food.

2. Higher fat part treated specially

- a. Upper Stalo (Duff 1952): heads sometimes baked over open fire before drying;
- b. Chilkat Tlingit (Drucker 1950:240): spring salmon bellies cut off and dried separately when very fat;
- c. Thompson (field notes): backbone (fat) smoked, other parts air-dried; and
- d. other cases not so explicit--Kwakiutl consume backbone immediately (Boas 1921), Tlingit putrify heads (Niblack 1890), Bering Eskimo putrify heads (Nelson 1899).

3. Lower fat part of run selected for preservation

- a. Lake Eyak, Kaydas; old women collect spawned salmon that are said to last longer because of their lower fat content;

- b. Northwest California (Kroeber and Barrett 1960): less oily fall fish could be eaten by sick people;
- c. Thompson (fieldnotes): early sockeye too rich to dry, too greasy, tastes strong; early eggs not stored (tastes strong, too rich);
- d. Upper Stalo (Duff 1952): lean fish easier to dry;
- e. Kwakiutl (Boas-Hunt): "old" sockeye and dog (not fat) sun dried while others smoked or roasted;

The selection of lower fat fish is exemplified by the Puyallap-Nisqually. They dried their fat spring salmon and consumed them quickly because they would not keep. They smoked their dog salmon and these would keep indefinitely. The flesh of the dog salmon had deteriorated and had little fat when the fish were taken (Smith 1940:236, 238).

One of the most striking cases of selecting low-fat fish is found in Boas' (1921) Kwakiutl texts. The Kwakiutl obtained spawning (and hence very low fat) dog salmon on upstream spots that were hereditarily owned and so jealously guarded that, if anyone but the owner fished at a man's spot, the owner would attack the fisherman with a club. Hunt's texts, gathered for Boas, states that the fish taken at these sites were roasted and dried like other dog salmon, but they were not roasted as long. The text continues, "even if it is kept a long time, it does not get moldy, and it does not get a bad taste [Lillooet: "strong" taste-rancid], for it is not fat. Therefore it is liked by the Indians" (Boas 1921:223-235).

Fat fish are more tasty than lean ones. In the Lillooet case, people who had access only to low-fat fish which "dry like boards" came to Fountain to get delicious food. However, low-fat fish are sure to last the winter, so coastal people needed an auxiliary supply of such fish. They selected low fat fish in their own territories, went to interior sites to fish or traded for well-preserved salmon.

Conclusions

1. Salmon preservation, in addition to salmon fishing, was an essential part of aboriginal Fraser Lillooet subsistence and it continues to be regionally important today.

2. Aboriginal Fraser Lillooet salmon fishing and preservation were typical of the cultural ecological basis for the Plateau system in the following points: 1) in each Plateau locality there were some rich resources that, at least in some years, surpassed the needs of the local population; 2) these resources were only seasonally available; 3) some resources could be preserved and populations relied on preserved foods; 4) the resources were variable from year to year; 5) the residents of each area suffered seasonal or occasional hunger--most areas could not be self-sufficient all the time; and 6) sometimes people could mitigate shortages by visiting a different area to get fresh or preserved food.

3. Adaptations to the conditions for drying had social consequences. Their unusual, but not unique, conditions for salmon preservation made the Lillooet fishery a center of trade and travel for other Plateau groups. The requirements for drying dictated that there be a coast/interior trade, as it did on all three major rivers of the Northwest coast. Locally, the requirements of "cross-utilization" of resources resulted in friendly relations with near by people, with hostile relations limited to distant people. While salmon-fishing was related to local stratification, and while the local potlatch was related to subsistence, the system was different from that of the coastal potlatch system.

4. The requirements of preservation reduce the number of salmon that can be preserved, so that any estimate of the relation between available salmon and population density should take into account climate (need for warm, dry winds, but not excessive heat) and fat content (wastage of high fat fish and need for some lower-fat fish).

5. Drying conditions and fat content throughout the Northwest Coast and Plateau, with corresponding technological changes.

6. Salmon preservation has continued to be a vital part of Lillooet subsistence for one hundred years (1870 to 1971) of intense contact with Canadian society.

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SHELLFISH UTILIZATION AMONG THE PUGET SOUND SALISH

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ABSTRACT

The importance of shellfish is often denigrated in the ethnographic picture of the Northwest Coast cultures due to the vast salmon resources found in the area. Different aspects of shellfish are examined in the Puget Sound region to derive a model for shellfish use. Optimal foraging theory is used as a theoretical basis for these data.

Since the earliest anthropological investigations on the Northwest Coast, molluscs have often been denigrated and even ignored in the literature. The hypothesis present here is that shellfish were the most biologically reliable, cost efficient, and second most important resource to the groups inhabiting the Puget Sound area in the immediate protohistoric period (ca. mid to late 1700s).

The most important assumption of optimal foraging theory is that hunters and gatherers will behave so as to obtain a high net rate of energy acquisition while pursuing such activities. A form of "procurement fitness" as well as natural selection are the basic assumptions in this body of theory. Direct and indirect competition for resources give advantages to organisms that are efficient in acquiring the energy and nutrients which can be transformed into offspring and/or predator avoidance behavior. The focus of optimal foraging theory is behavioral variability *not* genetic variability (Winterhalder 1981:15).

It has been shown that many hunters and gatherers rely primarily on food gathered by women. Although this statement must be modified in relation to a fishing/hunting/gathering economy, the contribution of women was significantly higher than is usually indicated in the ethnographic record. But now there are considerable data concerning coastal adaptation and fishing/hunting/gathering in these environments. Most researchers agree that the coastal environments are extremely productive (Lee 1968; Lee and DeVore 1968; Osborn 1977; Perlman 1980; Yesner 1980; Whitlam 1983).

Shellfish are low in calories but offer a good source of protein. Shellfish can be highly concentrated in certain areas and are easily collected by all segments of a society. In addition to these qualities, molluscs can be used in times of relative food scarcity as a "famine food." They are a low energy output and low foraging time food item with low risk involved during the collection. Shellfish would fit into a category of

foods which have the qualities which determine village location. Such village sites are located to take advantage of several resources, specifically low cost and easily obtainable resources (Perlman 1980:286-290; Yesner 1980:729-730).

Puget Salish Ethnography

The Puget Sound region can be defined in hydrologic terms as that area including all of the drainage basins flowing into southern Puget Sound: the Deschutes and Nisqually to the south and all basins northward to the Pilchuck River basin on the east side and the northeastern tip of the Olympic Peninsula (Campbell 1981:3-5; Greengo 1983:77).

Kroeber (1939:30) defines the Puget Sound culture areas as a sub-region of the Northwest culture area. It is considered distinct in terms of sub-culture as well as environment. Those groups of people who inhabited this area were situated in an area of protected salt water. All of these groups were Salishan speakers save for the Chemakum on the northeastern tip of the Olympic Peninsula.

The groups inhabiting Puget Sound, like others on the Northwest Coast, were semi-sedentary. Permanent houses were built along the Sound at the mouths of rivers or small streams. Three to five houses at such an area made up a village. The houses were usually arranged in a single row facing the water with a number of smaller structures surrounding them. It should be noted that politically the village was the highest unit of organization. Villages served as bases of operation for the annual subsistence round. During the year, according to individual seasons, these villages were periodically "abandoned" as people went to different areas in search of certain types of food. In the southern parts of Puget Sound the permanent village was not left for any long periods of time and often was still inhabited by elderly people and children (Haeberlin and Gunther 1930:20; Smith 1930:7).

The permanent houses were abandoned by the women in the spring in order to gather shellfish, roots, tubers, and berries. This usually lasted until mid-summer when fishing became the major activity for all members of the community. This fishing activity usually lasted until late fall and sometimes early winter. Hunting occurred in the fall, but sometimes seals and ducks were taken in the winter (Haeberlin and Gunther 1930:20; Smith 1940:271; Suttles 1951:67; Elmendorf 1960:123).

During the various seasons temporary camps were set up at resource sites. These temporary camps usually consisted of structures covered with mats and/or bark, thus permitting extreme mobility. At these camps resources were taken and processed into a storeable form, usually by smoking and/or drying.

Generally the gathering and processing of shellfish were considered the tasks of the women of a village. The tools which were used were usually the digging stick and/or the hands. The shellfish were gathered into open-work baskets which allowed the water to drain out. No special rituals were associated with shellfish gathering (Smith 1940:271; Elmendorf 1960:123).

Women would leave the village to gather shellfish at certain productive areas. These sites were often "owned" by individuals through hereditary or stewardship rights. Individuals maintained the right to utilize these resources as long as they did, in fact, use the resources. Women would often work together in task oriented groups at a single locus. Villages on the Sound were often situated near large tidal flats and estuaries, often no more than a few minutes walking distance away (Gibbs 1877:187; Haeberlin and Gunther 1930:20; Suttles 1951:67-68; Elmendorf 1960:57).

The shellfish that are consistently mentioned in the ethnographic literature are the larger species of clams and oysters, particularly *Saxidomus giganteus* (butter clam), *Tresus capax* (horse clam), *Tresus nuttallii* (horse clam), *Venerupis staminea* (thin-shelled clam), *Mytilus edulis* (blue mussel), *Protothaca staminea* (native littleneck clam), and often *Panope generosa* (geoduck). Also collected were various species of sea urchins, octopi, and chitons (Smith 1940:271; Suttles 1951:65, 505; Elmendorf 1960:123). Shellfish had value other than as a food resource. The accumulation of food was a sign of prestige and was often thought of as wealth. Dried clams were traded for other goods from various parts of the Coast. There existed a trade of dried clams from the Puget Sound Salish to the Sahaptin speakers across the Cascade Mountains (Gibbs 1855:38; Haeberlin and Gunther 1930:20; Smith 1940:245; Elmendorf 1960:291). There is some indication that the Nisqually and Puyallup may have acted as the "middle men" in the distribution and trade of clams between southern Puget Sound and the Columbia Plateau (Elmendorf 1960:291). Menzies (1923:28) mentions the trade of fresh clams by Puget Sound Indians for bits of copper and other trinkets to the crew of the *Discovery* and *Chatham*. Also of value was the shell itself, which was used as a trade item and is often equated with money in the literature. As these shells moved across the Cascade Mountains their value increased. Dentalia shells (*Dentalium pretiosum*) from the area around southern Vancouver Island were particularly desired. Clam shells were often made into discs and strung into long strands. Haeberlin and Gunther (1930:29) note that such strings are only half as valuable as the dentalia. Large mussel shells could be sharpened and used as knives and adze blades.

Historical Information

The various journals which were kept on Vancouver's expedition into Puget Sound in 1792 include a large amount of information concerning shellfish procurement. Vancouver's ships were the first European vessels to enter the Sound past what is now known as the Tacoma Narrows. The *Discovery* and the *Chatham* explored the various arms and inlets of Puget Sound during the mid- to late-spring.

Vancouver records (1798:261-262) the location of a village on Restoration Point in which the curing of clams and other shellfish is discussed. He mentions that fishing was not a prominent activity. Menzies (1923:19, 28, 412) mentions the use of shellfish as a trade item. Scarce mention is given to the fishing activities of the seasonal round while an emphasis is given to gathering and processing activities of shellfish and vegetable resources. It must be remembered that the *Discovery* and *Chatham* entered Puget Sound in May so it would be most likely that gathering activities would be observed while fishing, as a major activity, had not yet begun.

The United States Exploring Expedition of 1838-1842 under the direction of Lieutenant Charles Wilkes explored much of the western United States and eastern Polynesia. During 1841 the Wilkes expedition entered the Puget Sound region and recorded ethnographic and cartographic data. Wilkes and his naval entourage entered Puget Sound in late April so the time of their visit and any observations made of aboriginal life would those of the spring cycle of the seasonal round. Wilkes was impressed by the great abundance of shellfish in the area (1844:298-299). In a general discussion of the Nisqually Indians Wilkes (1844:418) makes the following comments:

They are all of a wandering character, and change their residence in search of their food, which consists principally of fish, particularly shellfish. Clams are seen in great quantities among them, strung on sticks, upon which they have been preserved by drying and smoking . . .

Gibbs (1855:38) mentions the collection of shellfish in the winter. Also he implies that villages may have been located near areas having productive shellfish beds.

The tribes living upon the eastern shore [of Puget Sound] possess also the territory upon the islands, and their usual custom is to resort to them at the end of the salmon season - that is, about the middle of November. It is there that they find the greatest supply of shell-fish, which form a large part of their winter stocks, and which they dry both for their own use and for sale to those of the interior . . .

Food Shortages

The historical and ethnographic sources state that in some areas of the Northwest Coast there is evidence that, although there was a large and varied resource base founded on seasonal procurement of certain resources, the available amount of resources varied from season to season and year to year. Miscalculations in the food which was to be saved for winter use may have caused famine and starvation in some cases (Jewitt 1967:115; Eells 1887:216; Suttles 1968).

Stores foods though were not always available for use during the winter. Suttles states (1968:58-60) that we should pay special attention to those foods available in and through the winter. As shown in the historical record (Jewitt 1967:115; Eells 1887:216) the population of this area would often fall back on shellfish to fill this need.

Ecology of Molluscs

There are three interlocking factors which roughly determine the distribution of intertidal invertebrates. These factors are: degree of wave shock, type of substrate, and tidal exposure. Certain topographic features will modify wave shock. Among these are rocky headlands, closed bays, and estuaries. Rock, sand, and mud will determine the species which

are adapted to live in such a substrate. These conditions will also influence the accumulation of organic debris in such a substrate. Tidal exposure determines the zonation of species according to relative lengths of exposure to air and water (Ricketts and Calvin 1948:3-4; Kozloff 1974:203).

An important aspect determined by the various forces mentioned above is intertidal zonation. The vertical zonation of this intertidal area, as well as other subdivisions of the neretic zone, is not only adaptation to physical conditions. The borders between these zones are somewhat arbitrary and should be thought of as a type of continuum. Competition and predation play a large part in the zonation (Kozloff 1974:116).

Kozloff divides the intertidal area into four zones: supralittoral fringe, upper and lower midlittoral zone, and the infralittoral zone. The supralittoral fringe is that area which is affected only by the higher tides. The uppermost portion of this zone may not be wet except from spray or rain (Kozloff 1974:119). The midlittoral zone is divided into an upper and a lower with the former being between four and seven feet above mean lower low water (MLLW) and the latter being four to zero feet above MLLW. In these zones wave action is felt by the organisms (Kozloff 1974:128, 136-137). The infralittoral zone is the lowers zone and therefore only exposed by the very low tides (Kozloff 1974:147-148).

Among the categories of environments which could be devised must be included the various types of beaches such as sandy beaches, quiet bays, protected sandy beaches, muddy sand, mud and gravel, and rocky shores. These beaches encompass the various types of environmental constraints on molluscs (Table 1).

The productivity of Puget Sound as an environment is based on the fact that this area is a geographically sheltered basin of water and is not dramatically affected by the wave stress which occurs on open coast areas. Such an environment will support a greater diversity and richness of shellfish species than would an open coast environment. Puget Sound is the recipient of nutrients from a large number of rivers. The productivity of the intertidal area is greatly increased by these nutrients, the substrates carried by the rivers and streams and the development of bays, tidal flats, and estuaries (Schink and others 1983:8).

Washington state annually provides approximately 95% of the Pacific Coast commercial harvest of shellfish. Schink and others (1983:308) attributes this to the large suitable habitats of protected bays and estuaries and coastal environments necessary for significant clam production. There have been major fluctuations in the harvest for individual species but overall harvest appears fairly stable for the Puget Sound area. Most of the Washington's bay clam fisheries are located in various parts of Puget Sound. Aboriginally as well as commercially important species are found in these estuaries and bays: native littlenecks, butter clams, horse clams, some soft-shell clams, and geoducks. The average hardshell clam production remained stable at one to two million pounds per year throughout much of the history of the industry.

Molluscan Habitats (after Campbell 1981)

SUBSTRATE	Open	Protected	HABITAT	Estuary
Rock	Mytilus edulis Mytilus californianus	Mytilus edulis Balanus spp		
Gravel	Mytilus edulis Mytilus californianus Balanus spp.	Mytilus edulis Balanus spp. Tresus capax Saxidomus giganteus Protothaca staminea Ostrea lurida¹	Tresus capax Saxidomus giganteus Ostrea lurida¹	
Sand			Clinocardium nuttallii Saxidomus giganteus Panope generosa² Macoma secta	Clinocardium nuttallii Saxidomus giganteus Macoma secta
Mud			Clinocardium nuttallii Panope generosa² Protothaca generosa Ostrea lurida Macoma secta	Clinocardium nuttallii Macoma secta Ostrea lurida

¹not preferred habitat²subtidal species

Conclusion: A Model for Shellfish Use in Puget Sound

The Puget Sound area was a very productive region with many different and overlapping microenvironments for a wide diversity of shellfish species. Between one and two million pounds of meat has been taken annually in the commercial industry of Puget Sound since the very early years of the twentieth century. It is possible much more meat could have been taken by the Puget Salish when one takes into account the larger range of shellfish which were utilized aboriginally.

As has been shown, shellfish were a highly desirable food resource because of their abundance and ease of procurement. With the exception of the paralytic shellfish poisoning months (usually during the summer) shellfish were available for consumption throughout the year. Gathering shellfish entails a greater amount of food value per amount of effort. Shellfish in Puget Sound were gathered in the spring and early summer for winter storage, but were also important in the winter and early spring.

Ethnographically the main thrust of shellfish gathering occurred during the spring and early summer. The winter villages would break into family units and collect and process shellfish and vegetables in productive areas away from the winter village. These were processed for trade and winter use and taken to be stored in the winter village locales. Many women from various groups gathered at particularly productive areas and formed task groupings in order to process the shellfish.

Shell middens are often equated with winter village locations. However, not all shell middens are necessarily indicative of winter village sites as some shell middens are remnants of shellfish processing stations mentioned above. Due to the presence of shell middens and the historical and ethnographic description of the seasonal round, shellfish can be stated to have been gathered at times other than the spring and early summer. To be specific, shellfish were gathered during the winter at large winter village sites and gathered in spring and early summer at the winter village sites and at specific shellfish collection loci.

In Puget Sound it has been shown that large shell middens can be correlated with certain environments. In a sample of survey data used by Greengo (1983) 59% of Puget Sound sites are located in protected shore environments while 11% are found in estuarine environments. Together these two microenvironments account for 70% of recorded Puget Sound sites. It is probably no accident that these two areas are the richest, most diverse, and most productive environments in terms of shellfish species. It seems as if the winter villages were located to be near dependable and productive shellfish beds.

Through winter and into early spring shellfish would gain importance as a resource as winter food stores became diminished or non-existent. Although modern commercial data have been used to demonstrate the productivity of Puget Sound, a vast potential resource was available for immediate consumption by the Puget Salish. Through winter and early spring the population of Puget Sound (about 10,000 according to Taylor [1961])

could have easily been supported by the shellfish resources at hand. Suttles' (1968) picture of doom may not have been so severe in Puget Sound because of the vast shellfishery. Some authors (Osborn 1977) feel that shellfish were not important except as an item in times of famine and starvation. I feel that this fact would make shellfish a very important resource item. It is unlikely that the Puget Salish were starving towards the end of winter. The use of shellfish in the winter was probably a normal part of the subsistence cycle, a part which is ignored in the literature. Fresh shellfish would have been a welcome part of a diet composed mainly of dried and processed foods.

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SAHAPTIN FISH CLASSIFICATION

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ABSTRACT

The value of fish for the pre-contact subsistence economy of Sahaptin-speaking peoples of the middle Columbia River is reflected in their fish nomenclature and classification. Nomenclatural recognition is extended to nearly every native species known from the region. Twenty-one basic level folk taxa subsume 26 of 32 native species as well as two extralimital forms known through trade. Thus Sahaptin fish classification provides a clear example of the empirical adequacy of native natural history in describing a local fauna. However, the existence of a general term inclusive of all fish is questionable. A general class of anadromous fish is found in all dialects. This contrasts in many dialects with a "residual small fish" category. Collectively this pair of taxa subsumes all but two extraordinary fish, the lamprey and the sturgeon. In the Umatilla and John Day dialects the contrast between "anadromous fish," typified by the Chinook salmon, and "residual small fish," typified by the suckers (*Catostomus* spp.), is shown to reflect the key economic roles of these two kinds of fish in the traditional subsistence economy of that section of the Columbia Plateau.

Introduction

Unusual nonmenclatural elaboration is often cited as evidence of the variability of cultural perspectives on the phenomenal world. Such elaboration is also taken as indicative of areas of particular cultural significance. In one frequently cited example, Eskimos are said to see not "snow" but rather "falling snow" or "drifting snow" or "melting snow," etc. The fact that Eskimos hyperdifferentiate what to us is a unitary phenomenon is explained by the ubiquity of "snow" in their lives, its importance for cultural persistence in the arctic. However, such examples remain merely suggestive in the absence of any more explicit method for evaluating degrees of nomenclatural elaboration or of cultural significance. Why not simply count the number of distinct terminologically recognized categories which pertain to a realm of experience as an index of the cultural significance of that realm? The Eskimo group with the largest number of terms for snow would be judged the most snow-conscious. Alternatively, if the Eskimo recognized eleven kinds of snow but only six of wind, we might judge wind of lesser cultural significance. Clearly it is not so simple. A key fault is the lack of a comparative standard. Is snow inherently more diverse than wind? Do certain Eskimo experience an absolutely

greater diversity of snow than do others? Such questions may border on the absurd in ethnoclimatology, but they are quite reasonable for ethnobiology. Scientific biosystematics defines an ethnobiological standard for flora and fauna.

The relevance of Linnaean classification for cross-cultural comparisons may not be immediately apparent. Though biosystematists consciously seek to label every *significant* distinction they perceive among plants and animals, the significance of a distinction is justified by evolutionary theory, which is a cultural phenomenon peculiar to our Western intellectual tradition. Why then should we expect Linnaean distinctions to have universal validity? That they nevertheless do have a measure of universal validity is demonstrated by recent empirical studies on several continents which document a striking degree of correspondence of basic folk taxa (the "folk generic taxa" of Berlin, Breedlove, and Raven [1973] and the "speciemes" of Bulmer [1970]) to scientific species (Hunn 1975). If the Linnaean standard be accepted, we may proceed to *measure* degrees of cultural focality within ethnobiological domains.

For example, the Sahaptin-speaking people native to the basin of the middle Columbia River name some 60 kinds of birds (Hunn n.d.). They name about 20 kinds of fish (Table 1). However, birds are by no means of greater cultural significance for Sahaptin-speakers than fish. Their 60 birds are selected from a potential inventory of more than 250 Linnaean species known to frequent the Sahaptin home range, while their 20 fishes correspond to about 30 of the ichthyologist. Thus, they formally recognize over 60% of the diversity of fish named by full-timed specialists, compared to only 25% of the avian diversity by reference to the common standard. So fish may be judged as having nearly three times the significance of birds in Sahaptin culture. It would be unwise to treat these numbers as more than rough indices of cultural significance, since they will vary with the relative size and abundance of the organisms involved. Nevertheless, the index supports the ethnographic record in according fish a high value in Sahaptin culture and birds a lesser role.

The Sahaptin-speaking People

Sahaptin is a complex of some 15 dialects (Rigsby 1965) once spoken by nearly 15,000 people (Gibbs 1855; Mooney 1928:13-18). It is still spoken by nearly a thousand individuals, mostly on the Yakima, Warm Springs, and Umatilla reservations. Sahaptin speakers once occupied 60,000 square km exclusively and utilized another 30,000 jointly with their Nez Perce, Salishan, Chinookan, Waiilatpuan, and Northern Paiute neighbors (Fig. 1). Their average density was thus approximately 20 per 100 square km (or 2 mi.² per person), relatively high for a land-locked foraging society. Such density was made possible by a displaced "piece of the Pacific Ocean," the Columbia River anadromous fishery. Hewes has estimated that on average every Sahaptin man, woman, and child pre-contact consumed some 520 gm of fresh salmon (*Oncorhynchus* spp.) each day (1973:131), or some 300,000 fish per year for the entire Sahaptin-speaking population. At this rate, salmon alone could have provided the estimated average human protein requirement of 60 gm per day with a 28% surplus. Lacking salmon, the Columbia Plateau could have supported but a fraction of the human population we have cited, with consequent reduction in the scale and complexity of social organization.

TABLE 1

Native Fish of the Sahaptin Life Range

Scientific/English Names	Sahaptin Name/s	Cultural Role
PETROMYZONTIDAE/lampreys		
<i>Lampetra richardsoni</i> <i>Entosphenus tridentatus</i>	asúm [NW, rc], asm [tt] k'súyas [CR]	avored food; myth character
ACIPENSERIDAE/sturgeon		
<i>Acipenser transmontanus</i>	wílaps [NW, CR] xíla _x [NE], xíle _x [pl], qíla _x [ww]	usually avoided; called "swallow- ing monster's pet;" myth char- acter
SALMONIDAE		
<i>Oncorhynchus gorbuscha</i> /pink salmon	ḵ'k ^w áy [uc] mac'ya [kl], wac'ya [kl]	eaten; little known, range re- stricted to west- ern fringe of area
<i>O. keta</i> /chum salmon	mít'úla [NW, CR], áy _x [NE] č'ilí [pl]	eaten; /mít'úla/ also refers to spawned-out salmon generally
<i>O. kisutch</i> /coho salmon	sínu _x [NW, CR], sín _x ^w [NW], sínu _x ^w [Ws], sín _x ^w [NW], sún _x [CR], sún _x ^w [ce], súnu _x [Ws]	eaten; myth character
<i>O. nerka</i> /sockeye salmon	kálu _x [NW, CR], kál _x ^w [ce, rc]	eaten; myth char- acter; jacks may be known as /kaluxkálux/ [tt]

TABLE 1 continued

Scientific/English Names	Sahaptin Name/s	Cultural Role
SALMONIDAE (continued)		
<i>O. tschawytscha</i> /Chinook salmon	tk ^w ínat [NW, CR]	avored food; myth character; first foods ritual
jack Chinook salmon	tk ^w iláttk ^w ilat [NW, CR] k ^w 'lii? [uc]	eaten
<i>Salmo gairdneri</i> <i>S. clarkii</i> sea-run/steelhead	šušaynš [NW, CR], šušáyš [NE]	eaten; available in winter; myth character
resident/trout	ayáy [NW] aytmín [CR], aytmín [rc] píckatyu [um] xúlxul [tt]	eaten; some infor- mants distinguish two or more kinds of trout (see below and Note 2 for more detail)
<i>S. gairdneri</i> /rainbow trout, in particular	ayáy [yk?] t'alát'ała [Ws] wawálam [pl]	
<i>S. clarkii</i> /cutthroat trout, in particular	aytmín [yk?]	
<i>Salvelinus malma</i> /Dolly Varden	číwa [NW] ášćinš [CR], ášćns [tt] híšlam [um, pl?]	sometimes eaten, sometimes avoided; myth character
<i>Prosopium williamsoni</i> / mountain whitefish	sámay [NW, CR], sámay [Ws] səxawní [uc]	eaten, available in winter

TABLE 1 continued

Scientific/English Names	Sahaptin Name/s	Cultural Role
OSMERIDAE/smelt		
<i>Thaleichthys pacificus</i> / eulachon	wálxína [NW]	eaten, extralim- ital, obtained from the west by trade
CATOSTOMIDAE/suckers		
<i>Catostomus columbianus</i> / bridge-lip sucker	yáyk [NW, CR]	eaten, available in late winter; myth character; first foods rit- ual (both species)
<i>C. macrocheilus</i> /large-scale sucker	xún [NW, CR], xúun [Ws] x ^w ún [yk], x ^w ún [NW, CR]	
<i>C. platyrhynchus</i> /mountain sucker	none recorded	present but un- recognized
<i>C. luxatus</i> /Lost River sucker	č'wám [Ws], c'wám [kl?]	eaten, extra- limital, obtained from Klamath Basin by trade
CYPRINIDAE		
<i>Ptychocheilus oregonensis</i> / northern squawfish	luq ^w 'áya [NW], luq'á [yk], luq ^w 'á [CR]	eaten, available in winter
<i>Achrocheilus aleuticus</i> / chiselmouth	lálapti [CR]	eaten
<i>Mylocheilus caurinus</i> / peamouth	čúks [jd]	eaten; little known; name means "obsidian"
<i>Richardsonius balteatus</i> red-sided shiner	[t' _p la ^l _s a ^l _n]í [NW, CR], pałaní [um]	eaten
<i>Rhinichthys cataractae</i>	none recorded	present, appar- ently unrecognized

TABLE 1 continued

Scientific/English Names	Sahaptin Name/s	Cultural Role
CYPRINIDAE (continued)		
<i>R. falcatus</i>	none recorded	present, apparently unrecognized
<i>R. osculus</i> /speckled dace	muk ^w 'iyá [jd, um]	no use cited; little known though common
GADIDAE		
<i>Lota lota</i> /burbot	none recorded	present in some lakes but apparently unknown; a large, distinctive fish
PERCOPSIDAE/sand roller		
<i>Percopsis transmontanus</i>	none recorded	uncommon and local; apparently not known
GASTEROSTEIDAE/stickleback		
<i>Gasterosteus aculeatus</i>	none recorded	rare; apparently not known
COTTIDAE/sculpins		
<i>Cottus</i> spp.	k ^w 'ašlá [CR], k ^w 'ašláy [yk]	not eaten; an "Indian doctor fish," feared and respected; seven species occur

The dialect provenience of Sahaptin name variants cited here are indicated as follows: Northwest dialect cluster [NW]: Kittitas [kt], Yakima [yk], Upper Cowlitz [uc], Klickitat [kl]; Columbia River dialect cluster [CR]: Celilo [ce], Tenino-Tygh [tt], Rock Creek [rc], John Day [jd], Umatilla [um]; Northeast dialect cluster [NE]: Wallawalla [ww], Snake River [sr], Palus [pl], Priest Rapids [pr]. Indeterminate Warm Springs Reservation dialects (either [tt], [ce], or [jd]) are cited as [Ws]. The dialect boundaries follow Rigsby (1965: 35-65). A few terms of indeterminate provenience or meaning have not been cited. Primary sources consulted include Jacobs (1929, 1931, 1934, 1937), Rigsby (n.d.a), Hymes (1975), David and Kathrine French (personal communication), and my own field notes. The phonemic orthography is based on Rigsby (n.d.b). Major stress accent is indicated unless freely variant. Phoneme symbols joined by brackets are free variants.

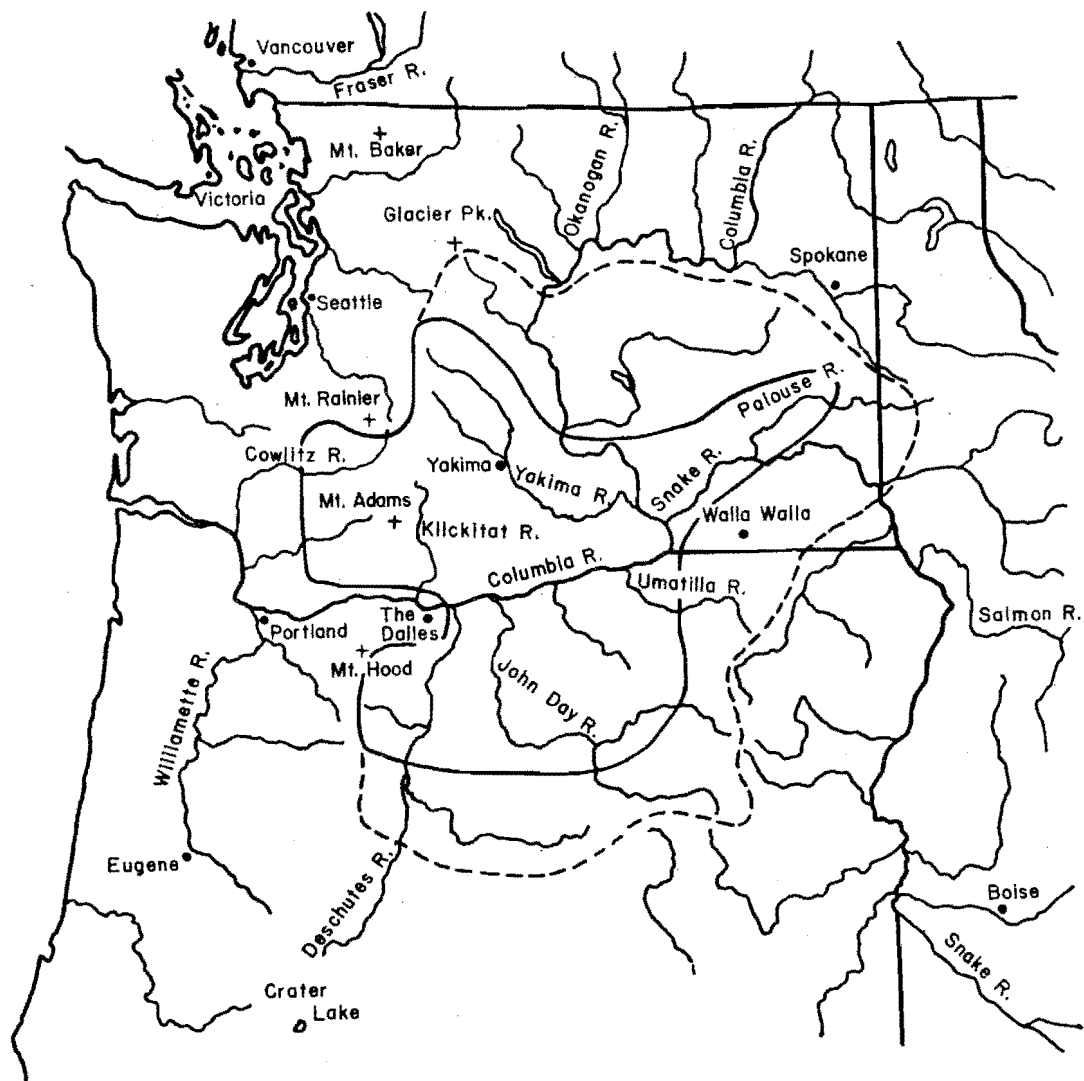


Fig. 1. Map of the Pacific Northwest showing territory utilized by Sahaptin speaking peoples. The central area indicates territory used primarily by Sahaptin speaking peoples and under their control. The peripheral area indicates territory used annually by Sahaptin speaking peoples but in common with neighboring groups of other linguistic affiliations. Both areas are approximate.

Though salmon was a critical resource, its role in Plateau subsistence has been exaggerated. Hewes is wrong to state that "other natural foods available in the area [referring to the entire Pacific salmon area] in quantity are notoriously low in fuel value" (1973:134). In the Columbia Plateau, at least, the bulk of the calories was no doubt provided by the abundant and varied edible roots (Hunn 1980; Hunn and French 1981). Nor were salmon the only fish of value to the Sahaptins. As we will see, Sahaptin-speaking people were well acquainted with nearly all native fish and most were sought as food, including the 10 cm long red-sided shiner (*Richardsonius balteatus*), considered a delicacy. Though salmon are honored in ritual, so are the suckers, lamprey ("eel," especially *Entosphenus tridentatus*), sturgeon (*Acipenser transmontanus*), Dolly Varden (*Salvelinus malma*), and trout (*Salmo* spp., in part) (Jacobs 1929, 1934, 1937); while the sculpin (*Cottus* spp.), a little gnome of a fish, is accorded deep respect. To fully appreciate the Sahaptin-speaking people's interest in and knowledge of fish will require a survey of the entire native fish fauna with regard to the role of each species in Sahaptin folk taxonomy. The following account reflects, in particular, those versions reported to me by John Day, Umatilla, and Yakima consultants.¹

Sahaptin Fish Taxonomy

Sahaptin fish taxonomy corresponds to the scientific in numerous elements of both content and structure. Both taxonomies are sets of organisms hierarchically arranged (Fig. 2). The superclass Pisces of the scientist may be equated with the Sahaptin life-form /waykáanaš/ with certain qualifications. The term /waykáanaš/ is sometimes used to refer to fish in general, inclusive of the jawless, boneless lampreys--known in the local vernacular as "eels"--but excluding such so-called "fish" as crayfish and shellfish. In this, Sahaptin nomenclatural usage better reflects the scientific point of view than does lay English. Yet /waykáanaš/ may also mean either "edible fish" or "salmon" (D. H. French:personal communication), particularly in the religious context of the thanksgiving feast (/káʔuwit/); at least the term strongly connotes fish as a sacred food; /waykáanaš/ is often described by informants as a "religious word." This type of double entendre appears elsewhere in Sahaptin folk zoological terminology. The term /iwinat/ refers either to "native ungulates" or to the "meat of game as sacred food." The term /kákyá/ may mean "bird in general," "animal" in the sense of the Animal Kingdom (Rigsby:personal communication), or "animal pet." In each case, a category defined morphologically and a largely overlapping category defined in terms of the cultural context of use are polysemously labeled. Though it is difficult to tease apart these senses in Sahaptin usage, the fact that, in certain contexts, /waykáanaš/ may be used to refer to a category inclusive of all and only fish suggests that "fish" is a legitimate domain for ethnoscientific analysis in Sahaptin. We will now examine the internal structure of that domain.

Scientists recognize two classes of fishes locally. So do my Sahaptin consultants. The ichthyologist sets the lampreys apart, since they lack both jaws and bone. The Linnaean class of bony fishes includes the remainder. My Sahaptin consultants also set the "eel" aside as well as the sturgeon, each in a class by itself. Lamprey and sturgeon, the most primitive of native fish, are thus left unaffiliated with either /núsuʔ/ "salmon" or /xúlʔul/ "residual small fish," the basic dichotomy within their version of Sahaptin fish classification.

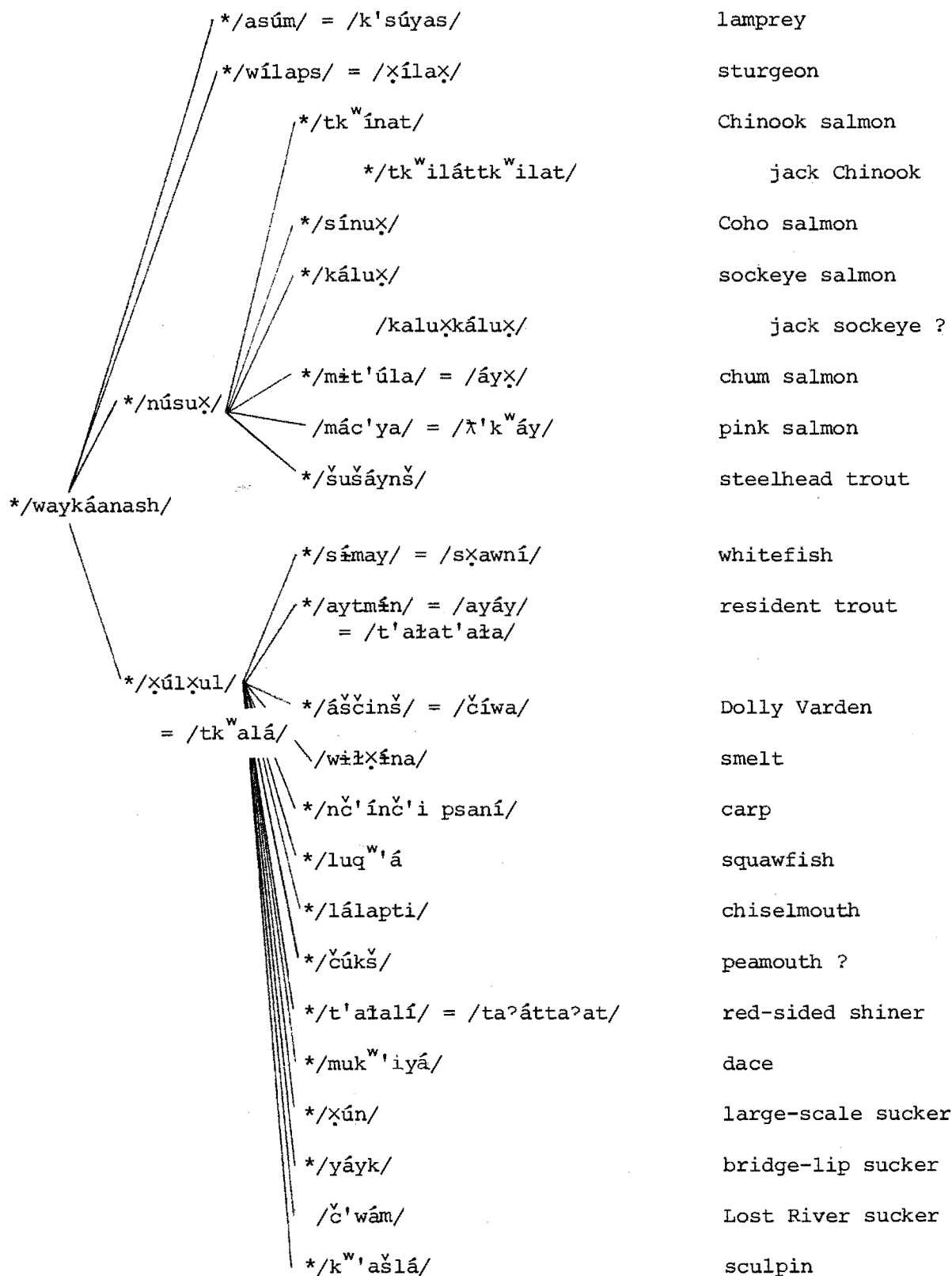


Fig. 2. Sahaptin fishes: taxonomic structure. Terms in the repertoire of James Selam are marked *. Dialect variant equivalent terms are indicated by =. Minor phonological variants treated in Table 1 are not cited here. A question mark indicates that the term or its gloss is inadequately established. For further discussion of Sahaptin resident trout terminology see note 2.

Following Mary Douglas's lead (1966) we might expect these two kinds of fish, set apart as they are in this Sahaptin classificatory system, to be accorded exceptional ritual potency, perhaps to be tabooed as were swine to the Hebrews. They are certainly anomalous fish with respect to this binary division within Sahaptin classification. They are also extraordinary by our own standards, one an oddity, the other a giant. However, lampreys were much sought after as food; that is, unless they had five rather than the normal seven gill slits, in which case, it is believed, they might turn into snakes. Yet that involves another sort of anomaly, that of the freak individual. Sturgeon are ambiguous as food; they are an important food fish on the lower Columbia and Fraser rivers (Stewart 1978) as well as at Kettle Falls on the upper Columbia in Salishan territory (Bouchard and Kennedy 1975) but were not eaten by most Sahaptin speakers (Thwaites 1904-05 4:290). Some who avoided sturgeon viewed them as a nuisance, interfering with salmon harvesting activities. Others referred to them as the "swallowing-monster's pet" (/nəyʃlanmí kákya/), fearing that they might be man-eaters, an unjustified allegation but one suggested by their huge bulk. In any case, sturgeon may be compared in this respect to the Dolly Varden, considered by my consultants as a member in good standing of the class /xúlɬul/. Dolly Varden were considered questionable as food, since one might occasionally find a frog or a mouse in their stomachs, yet another kind of anomaly, a confounding of aquatic and terrestrial realms. Since this is not the place to resolve the ambiguities of the structuralists' notion of anomaly, let us return to the basic dichotomy within this version of Sahaptin fish classification, that between /núsuɣ/ "salmon" and /xúlɬul/, the remainder.

Folk biological domains are frequently divided with respect to polar coordinates of size. For example, some Shoshone divide their birds in this way (Hage and Miller 1976), and the near universal distinction in folk botanical systems between trees and herbs may be interpreted as basically a size distinction (Brown 1977). Yet the division between /núsuɣ/ and /xúlɬul/ is not with respect to size alone. My consultants consider the northern squawfish (*Ptychocheilus oregonensis*) to be a kind of /xúlɬul/, though it may grow to be larger than sockeye (*O. nerka*) and pink salmon (*O. gorbuscha*), both kinds of /núsuɣ/. Nor does the distinction precisely reflect a contrast between the scientific genus, *Oncorhynchus*, the true Pacific salmon, with other fish, since trout (*Salmo* spp.) are split between the two, the sea-run forms or steelhead (/ʃuʃaynʃ/) is a kind of /núsuɣ/, while the resident trout are /xúlɬul/. The etymology of the term /xúlɬul/ may provide a clue; it appears to have been derived by diminutive reduplication from /xún/ (Jacobs 1931:133), by which the large-scale sucker (*C. macrocheilus*) is known. Though this association is not explicitly recognized by contemporary Sahaptin speakers, it suggests that all but the two most extraordinary fish were once aligned either as "salmon" or "sucker." Let us examine each of these divisions in more detail before attempting to account for this peculiar contrast.

Salmon present a real challenge to the folk taxonomist. Five species might be encountered; each undergoes radical morphological changes through the life cycle, and several may move upstream to spawn as "jacks," half-sized replicas of typical spawning adults; top this off with the sea-run transformation of trout, distinct spring, summer, and fall runs of Chinook salmon (*O. tshawytscha*), and the subtle but consistent morphological differentiae of each home-stream population, and one can appreciate that the recognition

of species among salmon cannot be taken for granted. Nevertheless, contemporary Sahaptin speakers extend nomenclatural recognition to each and every species, ignoring in the process whether the fish run in spring or fall, whether male or female, whether fresh from the sea or torn and twisted by the rigors of spawning, whether "jack" or full adult. Though special terms for male and female and for post-spawning males may be used, they are applied within the genus irrespective of species. Subspecific distinctions are formally recognized in only one instance; jack salmon may be distinguished by diminutive reduplication of the appropriate species name. For example, Chinook salmon are /tk^winat/, their jacks are /tk^wiláttk^wilat/, literally "little Chinooks." Other sub-specific distinctions may be informally noted. For example, one octogenarian Yakima informant claimed that Chinook salmon of the Tieton River were darker than those of the Naches-American drainage. In fact, just such subtle but consistent differences between local populations first suggested the "home stream theory" of salmon migration to fisheries biologists (Rich 1948). This Yakima elder attributed the difference between Tieton and Naches river salmon to contrasting gravel color in each stream, an observation lacking only a notion of natural selection to be Darwinian. Thus knowledge of fish may go beyond distinctions formally named.

The inclusion of sea-run trout as "salmon" is, of course, in contradiction to Linnaean principles. Curiously, American English speakers likewise refer to steelhead as salmon, even in at least one authoritative guide to North American fishes (Schrenkeisen 1938). The concept "salmon" in both English and Sahaptin is clearly defined in part with regard to the value of these fish as food--which is a function of their common anadromous behavioral adaptation--and as such is not strictly equivalent to the scientific taxon labeled *Oncorhynchus*.

Turning now to /xúlɣul/ "residual small fish," we find 12 folk generic taxa are so classified by my John Day and Umatilla consultants. As with salmon, this category is not comparable with any scientific taxon. However, as with salmon, the folk generic taxa it includes faithfully reflect individual species distinctions with but a few exceptions. Ten of the 12 kinds of /xúlɣul/ map in a one-to-one fashion to scientific species. Two involve "lumping" or the ignoring of species distinctions within a genus. For example, my consultants call all species of resident trout either /ayáy/ or /aytmín/ depending on dialect.²

Our second case of "lumping" involves the sculpins, the so-called "Indian doctor fish." Though Sahaptin speakers might have encountered as many as seven species of sculpins (*Cottus* spp.), at least two of which are rather abundant, the category is perceived as homogeneous. All sculpins are alike in their grotesque bulging eyes, squat profile, leathery skin, and pouting lips (Fig. 3). And all are alike from the Sahptin perspective in their special power. As "doctor fish" (/twáti/, literally "shaman") they are one of a curious set of animals treated with special care and respect, not harmed and never eaten. Sculpins, horned lizards, rattlesnakes, ravens, and owls are among those so respected and feared for their influence over the weather or for their powers of foresight.

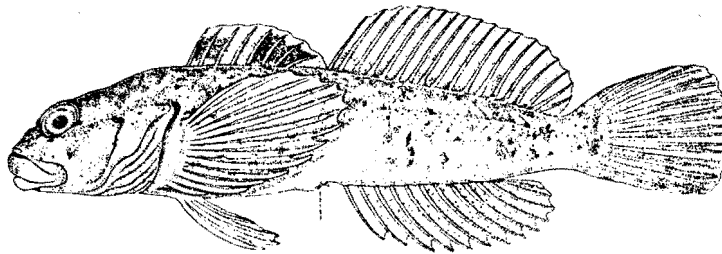


Fig. 3. The sculpin /k^w'ašlá/, or "Indian Doctor fish." Example illustrated is *Cottus confusus* from Bailey and Bond (1963:111).

The lumping of scuplins might simply be explained by reference to the dramatic character shared by all individuals of the genus and the elusiveness of the species distinctions. In fact, this genus has long been a challenge to the evolutionary scientist (Bailey and Dimick 1949:1). However, the lumping of the scuplins may be assessed from a different angle. A minority of Sahaptin basic folk taxa actually differentiate between species of a Linnaean genus. Nine Sahaptin basic folk taxa which perfectly match a scientific species, nevertheless do not subdivide the genus; rather they correspond to species with no close relatives in the region. Geographic limits thus eliminate the opportunity to differentiate congenetics. In light of this, the lumping of sculpin species in favor of recognizing the genus is rather according to rule than an exception. The real exceptions involve the "splitting" of a scientific genus between two or more Sahaptin basic folk taxa. There are but two cases in my data, salmon and suckers, the same two fish that I have argued define the contrasting poles of this Sahaptin fish classification.

A final observation is in order; how do we explain the six fish species known to occur in the region for which no Sahaptin name is recorded? Though names may exist or may once have been in general use, the informants I consulted indicated no knowledge of their existence. Considerations of size, range, and abundance of these species seem sufficient to account for most of these Sahaptin "blind spots."³ It is certain that there has been some loss of detail in the Sahaptin classification of fish since European contact. Yet the loss of knowledge is not sufficient to obscure the empirical adequacy and fine detail of traditional Sahaptin folk science.

In sum, Sahaptin fish classification corresponds rather closely to the independently developed scientific scheme, most notably at the level of basic folk taxa. Though not identical, the two perspectives are sufficiently in accord that they must be seen as products of a common logic operating on a common reality. Thus culture here faithfully reflects empirical reality.

The Reflection of Cultural Significance in Sahaptin Folk Classification

I began by suggesting that the elaboration of Sahaptin fish nomenclature reflected the peculiar cultural utility of fish for aboriginal Sahaptin-speaking peoples. Yet I have just concluded that this folk ichthyology rather closely reflects an order given by nature. Is this not paradoxical? In fact, the roles played by nature and culture in Sahaptin folk classification are complementary; there is no opposition. Fish in general are important to these people for their livelihood, thus close attention is directed to that aspect of nature resulting in a classification closely modeled on empirical reality. However, certain fish are of outstanding cultural importance. Salmon were paramount, with the Chinook salmon "king," both the largest, the most abundant, and offering runs in spring, summer, and fall. So the Chinook salmon is singled out on three nomenclatural levels. It is /núsuχ/ "salmon" epitomized and is not infrequently so called. It is /tk^wínat/ or /tk^wínat núsuχ/ (using binomial nomenclature) in contrast to its congeners. Finally jacks are /tk^wiláttk^wilat/, "little Chinook salmon." Nomenclatural elaboration is reinforced in myth and ritual. The gift of salmon is explained in myth (Jacobs 1934:86-91, 106-107, 195-197; Johnson-O'Malley 1974:34-35), and thanks are ritually offered to the first spring Chinook by the whole community (Thwaites 1904-05 4:302).

Yet salmon is not alone in this honor. As suggested above, two poles may be seen to define the basic structure of this fish life-form; with salmon and suckers as coordinates. Only two Linnaean genera are split according to species lines in Sahaptin. Those genera are salmon and suckers. There are myths of origin for both salmon and suckers, and the two kinds of fish honored at first food feasts are, once again, salmon and suckers. The traditional value of salmon was clearly ultimately economic. But what proves the parallel value of suckers? I believe it is equally economic. The first spring-run Chinook salmon arrived at Celilo Falls shortly after mid-April (varying to early May), and their arrival occasioned ritual and feasting, a tradition still honored at Columbia River longhouses. Today a combined spring salmon and root feast held in mid-April marks the ritual high point of the Indian religious calendar. However, some longhouse congregations also hold a feast in February to honor the first "Indian celeries" (*Lomatium grayi* Coult. & Rose) and the spawning runs of suckers. These fish crowd into the small streams adjacent to winter villages such as those at Rock Creek and Alderdale in Klickitat County, Washington, at a critical phase of the seasonal cycle, when winter stores may be nearing exhaustion with the spring salmon still six to eight weeks away. The timely arrival of suckers may have meant the difference between life and death if the previous year's harvest had been meager or the winter especially severe.

Sahaptin people today still love their suckers, nor do they complain about their many bones. In fact, "How the Sucker Got His Bones" is a favorite story widely recounted throughout the Plateau. It exploits a peculiarity of suckers in that their skull bones never fully ossify, so the skull disintegrates in cooking. As the family enjoys its first fresh fish of the season, the old people tell the children the name of each bone, identifying the mythical animal which contributed each piece to the sucker's creation (Figs. 4-5) (Bouchard and Kennedy 1975:14-15).

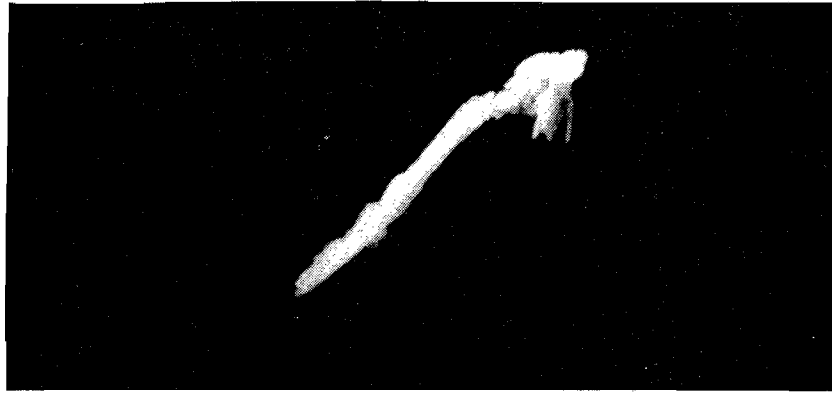
We have seen that the study of folk classification may reveal hidden complexity in a cultural adaptation. While Sahaptin fish classification accurately reflects natural discontinuities, it also highlights cultural values based in economic necessity but orchestrated in myth and ritual. People are thus seen to be linked to their environment by an intricate web of mutual effect, defined and maintained by careful observation, economic calculation, ritual monitoring, and mythical explanation.

Acknowledgements

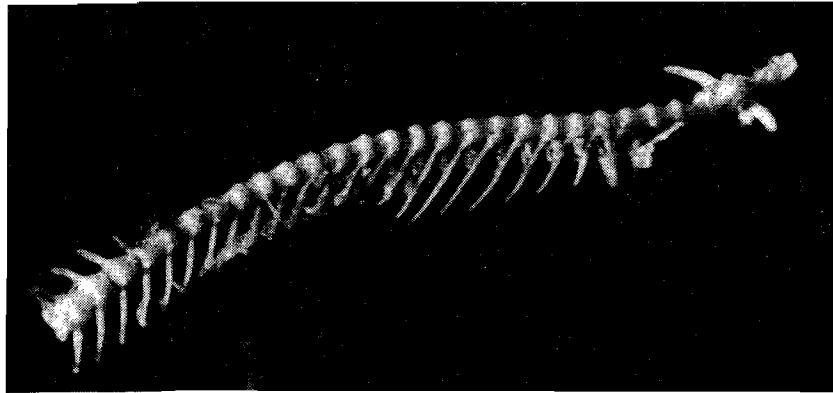
This report is based on research entitled "Sahaptin Ethnobiology" supported by Grant No. BNS7616914 from the National Science Foundation. Additional financial support was provided by a grant from the Melville and Elizabeth Jacobs Research Fund. Logistic support in the field from the Kamiakin Research Institute of the Yakima Indian Nation and the Consortium of Johnson O'Malley Committees, Region IV, is gratefully acknowledged. I do not have space sufficient to identify all the native Sahaptin speakers who provided expert testimony on which this analysis rests. However, the special contribution of James Selam and the late Donald Umtuch has been the key to the success of the research. Sara Quaempts, Elsie Pistolhead, Elsie Selam, and Otis Shiloh recorded myths, legends, and accounts cited above. An earlier version of this paper was presented to the symposium, Ethnobiology in the Pacific Northwest, at the Northwest Anthropological Conference, Pullman, Washington, 6-8 April 1978. I am also indebted to David French for a most careful, critical reading of this manuscript.

Notes

¹The data reported here are most complete for those Sahaptin speakers native to villages along the Columbia River between present-day Rock Creek, Klickitat County, and Patterson, Benton County, Washington, representing Rigsby's Rock Creek, John Day River, and Umatilla dialects of the Columbia River dialect cluster (Rigsby 1965:35-65). The data are fairly adequate for the Yakima dialect of the Northwest dialect cluster. Samples of the terminology of all current dialects are derived from the following sources: Rigsby n.d.a, Hymes 1975, Melville Jacobs's various publications on Sahaptin language and folklore, David and Kathrine French's notes on Warm Springs Reservation dialects, and my own field notes. The contrast between /núsx/ and /xúlxl/ emphasized in this paper should hold for Umatilla, John Day, and Rock Creek dialects of the Columbia River dialect cluster and perhaps for the Northeast dialect cluster, but the use of /tk^walá/ in place of /xúlxl/ in



a



b



c

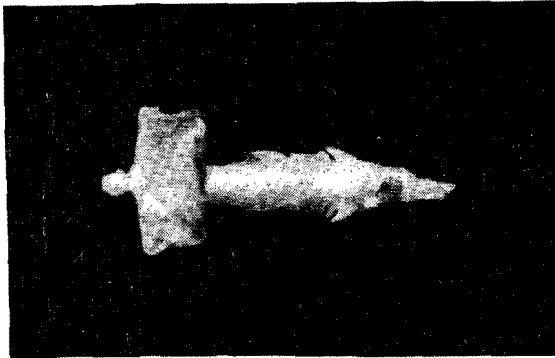
Fig. 4. Sucker's bones and their mythical identities. a, soft-basket woman monster; b, snake; c, raven's feet. Identification by Sara Quaempts and Elsie Selam; Umatilla dialect. Bones are of a bridge-lip sucker (*Castostomus calumbianus*) from Rock Creek, Washington.



a



b



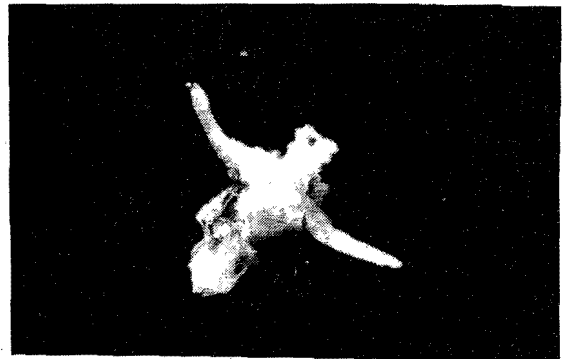
c



d



e



f

Fig. 5. Sucker's bones and their mythical identities. a, badger; b, Steller's jay; c, cricket packing her child; d, coyote's knives; e, grizzly's earring; f, bison's skull. Identifications provided by Sara Quaempts and Elsie Selam; Umatilla dialect. Bones are of a bridge-lip sucker (*Catostomus columbianus*) from Rock Creek, Washington.

the Northwest dialect area suggests that the salmon-sucker contrast was not central in the cultures of that portion of the Sahaptin range. For Tenino and Tygh dialect speakers of the Warm Springs Reservation /xúlʔul/ means simply "small trout" (David French:personal communication). In both regions trout may prove to be more important than suckers due to the proximity of the Cascade Mountain streams.

²One Yakima informant has suggested that /ayáy/ and /aytmín/ are distinct kinds of trout, the former a larger, widespread type, the latter a smaller "mountain trout." It is tempting to speculate that the so-called "mountain trout" is the uncommon and local cutthroat (*Salmo clarkii*) in contrast to the ubiquitous rainbow (*S. gairdneri*). Two trout species are also reported for the Umatilla dialect, /píkatyu/, "any sort of trout," and /híʃlam/, "a black trout," and the "Palus dialect, /wawálam/, "rainbow trout," and /híʃlam/, "a little bigger trout than /wawálam/" (Rigsby n.d.a). Tenino and Tygh speakers of the Warm Springs Reservation call all resident trout, including the introduced brook and brown trout, /xúlʔul/. Larger resident rainbows are set apart as /t'aʔát'aʔa/ (David French:personal communication).

³The native fish species known to occur in the region but which are apparently not named in Sahaptin are the mountain sucker (*Catostomus platyrhynchus*), two species of dace (*Rhinichthys cataractae*, *R. falcatus*) the burbot (*Lota lota*), Columbia River trout-perch (*Percopsis transmontanus*), and the three-spined stickleback (*Gasterosteus aculeatus*).

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CULTURAL ECOLOGY IN THE CANADIAN PLATEAU: ESTIMATES OF SHUSWAP INDIAN SALMON RESOURCES IN PRE-CONTACT TIMES

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ABSTRACT

The purpose of this article is to use available publications dealing with Indian catches and salmon runs in the Fraser and Thompson rivers to estimate the quantities of Pacific salmon, particularly the sockeye salmon (*Oncorhynchus nerka*), available to the Shuswap Indians in pre-contact times.

Introduction

In an article dealing with the cultural ecology of the Shuswap Indians of the Canadian Interior Plateau, we attempted to estimate the influence of salmon resources on Shuswap cultural origins, demography, and cultural organization (Palmer 1974).

The development of intensive salmon fishing techniques in the Plateau about 2000 years ago would have permitted the prehistoric Interior Salish Indians living in the Fraser and Thompson drainages to double their population size. At about the same time these ancestors of the Shuswap were learning to exploit Pacific salmon, the Shuswap language differentiated from the Thompson language, a fact which indicates that the increase in population size may have permitted territorial expansion and resulted in the two languages drifting apart. The increasing reliance upon Pacific salmon crystallized the riverine settlement pattern which was already foreshadowed in the parallel distribution of the elk and deer along the river valleys and forest edge. Salmon were involved in trading patterns which in turn influenced the traditional Shuswap system of kinship and marriage. The limited nature of salmon resources is inferred from the fact that salmon fishing places were frequently the object of interband and intertribal warfare. The task group organization required by the various salmon fishing technologies, including spearing, netting, and the building of weirs would have had important, but presently unknown, effects on Shuswap sociology. All of these considerations imply that the more that is known of the distributions and quantities of salmon available to the Plateau Indians in pre-contact times, the better will we understand traditional Plateau cultures.

Sockeye Runs in the Shuswap Territory

The majority of the Shuswap population lived along the north branch of the Fraser River and along the Fraser's major tributary, the Thompson River, with its north and south branches. The Fraser River is potentially the best

sockeye river in the world. Its most productive branches are the Adams and Little rivers in the South Thompson system and the Chilco River which drains into the north branch of the Fraser (Rounsefell and Kelez 1938:754; IPSFC 1942:12-15, 1943:47). Several species of Pacific salmon were taken from these rivers by the Shuswap, but the primary species was the sockeye which spawns in gravelly stream and lake bottoms. Young sockeye spend their first two years maturing in inland lakes. In their second year they swim downstream into the sea and in their fourth year they return to their inland place of origin to spawn (Rounsefell and Kelez 1938:755).

For reasons which are not fully understood, the sockeye spawning runs of every fourth year tend to be much larger than the three years in between.

Prior to 1913 when railroad construction work blocked the Fraser Canyon and a large commercial salmon catch disturbed the cycle, the dominant year was based on four year intervals from 1901, but since that time the dominant year has been reckoned from 1902. The European disturbance of the Fraser system has also affected the seasonal pattern of the runs as the sockeye in the Adams River have shifted from early to late runs. This early disturbance of sockeye spawning by construction and commercial fishing makes it extremely difficult to estimate the size of the runs prior to Anglo-European contact. Ricker (1950) estimated an "off-year" average stock of 6,500,000 sockeyes. He then used what he regards as a conservative ratio of 1:25 to estimate a dominant year run of 160,000,000 sockeyes. However, he seems to regard 1:68 or 1:130 as more probable figures for the ratio of low years to big years.

Using the estimates of the size of sockeye runs derived from the conservative figure of 1:25 and an estimate of 4 lb per salmon, derived from the fact that a 48 lb commercial case of salmon contained 12 or 13 salmon on the average (Ricker 1950), the biomasses available to all the Indians on the Fraser would have been 26,000,000 lb in an off year and 640,000,000 lb in the one good year in four.

How much of this would have been available to the Shuswap? The inroads of the commercial fisheries and alteration of spawning runs by industrial construction make a reliable estimate impossible. My analysis of data provided by the International Pacific Fisheries Commission indicates that from 1941 to 1943 the river from Lytton upstream in both the Fraser and Thompson tributaries provided from 58% to 78% of the total Indian catch on all tributaries of the Fraser (IPSFC 1944:70-71). I see no reason why the figures would be lower in pre-contact times.

From 1941 to 1944 Indians never took more than 3.5% of the total run. Since the runs were severely depressed perhaps by a factor of ten (Rounsefell and Kelez 1938:767), Indians may have been taking an even lower percentage in pre-contact times, assuming that they were fishing just as heavily in the 1940s as they were before contact, but of course this is a very dubious assumption. Rounsefell believes that "a toll of between 400,000 and 500,000 sockeyes in the former big years is a conservative estimate of the Indian catch." The Indian catch for 1929 was 48,000 Sockeyes, 20,000 Kings, 25,000 Cohos, 4500 Pinks, and 6500 Chums (Dominion Report 1930, quoted in Rounsefell and Kelez 1938:760).

In 1941, the biggest year from 1941 to 1944, Indians took 52,920 sockeyes, or 1.2% of the total run (IPSFC 1944:66). In the years prior to 1946,

Indians took up to 76.6% of some of the small early runs (IPSFC 1944:25) indicating that they began as soon as they could perhaps because of tradition, or perhaps because their catch was limited by time and technology, rather than the maximum size of the run. They may also have taken full advantage of earlier runs if later runs were unpredictable, or they may simply have been in need of fish. The shift in salmon runs from early to late in the season probably worked to decrease the total catch.

The most productive tributaries from 1939 to 1942 were the Adams and Little river system and the Chilko River. Both of these averaged runs of more than 250,000 sockeyes (IPSFC 1943:47). In 1942 over two million sockeyes ascended the South Thompson River (including the Little River and the Adams River). This run comprised 93.9% of the total Fraser run that year (IPSFC 1942:12-15). The portion of the Indian catch which went to the general Thompson River system in the years 1941 to 1947 ranged from 35 sockeyes (0.0%) to over 10,000 sockeyes (about 20%) in the years 1942 and 1946.

Conclusions

Sockeye runs before the advent of the railroad and commercial fishing may have approximated 6,500,000 in the three low years of the cycle and 160,000,000 in the dominant year. The Shuswap living along the Fraser and Thompson rivers and their tributaries would have had access to at least 60% of this run, or about 3,900,000 sockeyes in a low year and 96,000,000 sockeyes in the dominant year. The known Indian catches in the Thompson River region ranged between zero salmon in 1941, when there was no fishing and 10,085 in 1946, a dominant year. The largest portions of the Thompson catches in the good years came from the South Thompson and its tributaries. The Indian catches in the Thompson system ranged from 0.1% of the total Indian catch in the Fraser in the off year of 1944 to 21.4% in the dominant year of 1942.

It is not known whether these percentages or the sizes of the catches bear any resemblance to percentages and catch sizes prior to contact. If Rounsefell's estimate of a total Indian sockeye catch of 400,000 to 500,000 in former big years is correct, then the figures for the 1940s would be lower than the aboriginal figures by a factor of ten (Table 1). In that case, it is possible that the Shuswap along the Thompson River were catching about 20,000 or less sockeye salmon in a low year and 100,000 or more in a dominant year. This would have provided them with 80,000 pounds of sockeye in the low year and 400,000 pounds of sockeye in a dominant year, which would yield an average of about 160,000 pounds of sockeye per year.

The use of other species of Pacific salmon probably doubled the catch, and thus the carrying capacity of the river system. It is also possible that the aboriginal runs and catches were four or five times as great as we have estimated.

TABLE 1

Comparison of Indian Sockeye Catch in Thompson River System with Total Catch in Fraser River System for the Years 1941 to 1947 (IPSFC 1944:70-71; 1946:27; 1947:20).

	Thompson Catch	Per Cent	Total Catch
1941	No fishing		52,920
1942	10,010	21.4	46,708
1943	1,875	6.9	27,042
1944	35	0.1	42,820
1945	No Data		
1946	10,085	20.12	50,127
1947	1,950	4.6	42,275

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INDIAN FISHERIES PRODUCTIVITY IN PRE-CONTACT TIMES
IN THE PACIFIC SALMON AREA¹GORDON W. HEWES
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ABSTRACT

The significance of the primitive subsistence fishing of the Pacific Salmon Area is analyzed in order to arrive at reasonable estimates of the aboriginal consumption of salmon. Salmon consumption has been selected as the best general measure of the use of fishery resources which can be applied both to the aboriginal and commercial periods. From this we shall proceed to the consideration of the evidence for a "resting" period, following the decline of the native fishing, and before the full establishment of commercial fishing, during which stocks of certain species actually may have become more abundant than they had been for many previous centuries. Further, we shall suggest that if such an increase occurred, part of the early high productivity of the commercial fisheries (in terms of expenditure of effort) might be attributable to the temporary existence of a fish surplus.

Significance of the Primitive Subsistence Fishery

Estimates of Aboriginal Salmon Consumption

For many centuries, perhaps for several millenia, parts of the Salmon Area were occupied by primitive peoples subsisting on aquatic foods where these were available. There is no reason to suppose that the aboriginal population of the area in 1770 or 1780 (whenever one chooses to end the prehistoric period) had been growing very rapidly in the several centuries preceding, so we may assume that the exploitation of the fisheries had been continuing at a fairly even rate at the time of the first white contact. We are, therefore, in a position to project certain known demand factors

against the known resources of the fisheries. Using the figures in the second column of Table 1, taken from Mooney (1928) and Kroeber (1939:136-38) for California, we can make estimates of aboriginal food consumption for the area, or for parts of it, and of its salmon consumption in particular.

We may start with a crude estimate of total food consumption, measured in calories, based on the normal calorie requirements of average populations. The figure of 2000 calories per day per capita for the Salmon Area as a whole does not seem excessive, if the high fuel consumption of the human body in cold winter climates is considered. The figure would be too low for some Eskimo and Athabaskan groups, and possibly too high for groups on the southern periphery of the area. Using the total estimated aboriginal population of 338,150 given in Table 1 times a daily calorie requirement of 2000 times 365 days, we obtain a crude annual caloric demand estimate of 245,740,000,000 calories. This unwieldy figure might better be comprehended in terms of weight, though caloric values of food are not directly expressible as weight units. Arbitrarily, we may take an average daily ration of two pounds with a caloric value of 2000 for the sake of example.² Such a ration would yield an annual demand, for the entire Salmon Area, of 122,804 short tons of food.

The satisfaction of this demand must have been largely up to the fisheries (including sea-mammal hunting), since other natural foods available in the area in quantity are notoriously low in fuel value.³ When available, the flesh of certain game animals, but not all of them, could provide adequate fuel values.

If, for the sake of argument, we assume that somewhat less than one-half of the caloric requirement of the average native consumer of the area was satisfied by eating salmon, this would yield an annual consumption of about 365 pounds of salmon per capita. This is based on the fact that the caloric value of salmon flesh is nearly 1000 per pound (903 to 915 Tressler 1923:270-271). Eulachon and some other fishes caught in the area may equal or exceed this value, but the commoner marine fishes have lower fuel value per pound, and the mollusks even less. The caloric value of the flesh and blubber of sea-mammals, however, is at least equivalent to fat beef, and is probably much higher (Tressler 1923:642).

Using the figure of 365 pounds of fresh salmon per person per year, the crude estimate of the pre-commercial salmon catch of the area would be approximately 123,424,750 pounds, or about 15 percent of the modern commercial salmon catch, 800,000,000 pounds. Instead of basing our estimate on calorie demands, we may take another minimal dietary requirement for protein. The daily protein intake of a normal individual cannot fall much below 60 grams without jeopardizing his health (Elvehjem 1942:289-98). Using 16 percent as the protein factor in salmon flesh (actually higher in the better portions), we find that 305 pounds per year would satisfy the native consumer if all or nearly all of his protein were obtained from salmon.⁴ At this rate, the natives of the area would have consumed about 103,135,750 pounds per year. It must be noted that this is based on minimal requirements, and that in the native environment there were no very good vegetable sources of energy. The intake of animal flesh had to cope with calorie

TABLE 1

ESTIMATES OF ABORIGINAL SALMON CONSUMPTION
(IN POUNDS OF FRESH FISH PER YEAR)

Native Groups	Estimated Population	Estimated Consumption	
		Per Capita	Total by Groups
<u>Western Alaska</u>			
Nuwuk, Kopak, Numatak	3,000	100	300,000
Malemiut	1,600	200	320,000
Kinugumiut, Kaviagmiut	2,800	300	560,000
Unaligmiut	1,600	200	320,000
Ikogmiut	500	800	320,000
Magamiut, Kaialigmiut	5,000	365	1,855,000
Nuniwagmiut	1,500	100	150,000
Kuskokwagmiut	7,200	1,000	7,200,000
Togiagmiut, Chingigmiut, Nushagak	1,300	500	650,000
Ogulmiut	<u>3,700</u>	<u>500</u>	<u>1,850,000</u>
Subtotal	28,000	Avg. 396	13,525,000
<u>South-Central Alaska and Aleutians</u>			
Aleut	16,000	280	4,480,000
Koniag	8,800	500	4,400,000
Tanaina	1,200	500	600,000
Chugachmiut	1,700	500	850,000
Eyak	<u>800</u>	<u>300</u>	<u>240,000</u>
Subtotal	28,500	Avg. 416	10,570,000
<u>Northern Interior</u>			
Alaska Kutchin	1,600	475	760,000
Yukon Territory Kutchin	2,200	200	440,000
Ahtena	500	600	300,000
Khotana, Kalchana (except Tanaina)	3,200	690	2,208,000
Tahltan, Taku-tine	<u>2,500</u>	<u>260</u>	<u>650,000</u>
Subtotal	10,500	Avg. 445	4,358,000

TABLE 1--Continued

Native Groups	Population	Estimated Consumption	
		Per Capita	Total by Groups
<u>Northwest Coast</u>			
Northern Tlingit	2,000	500	1,250,000
Southern Tlingit	7,500	500	3,750,000
Haida	9,800	400	3,920,000
Tsimshian Proper	3,500	400	1,400,000
Niska, Gitksan	3,500	500	1,750,000
Haisla	1,300	500	650,000
Heiltsuk	1,400	500	700,000
Bella Coola	1,400	500	700,000
Kwakiutl	4,500	365	1,645,000
Nutka	6,000	300	1,800,000
Makah, Quilleute, Quinault	4,000	365	1,460,000
S.E. Vancouver Island	9,200	500	4,600,000
North of Fraser River	7,400 a	600	4,440,000
Fraser Delta	3,900	1,000	3,900,000
Nutsak, Lummi	800	600	480,000
Clallam, Chimakum	2,400	365	876,000
Skokomish, Nisqualli, Twana, Puyallup, Snoqualmi, Snohomish, Skagit	6,000 b	350	2,100,000
Subtotal	75,100	Avg. 485	34,779,000
<u>Columbia-Fraser Plateau</u>			
Tlatskanai	1,600	365	584,000
Lower and Upper Chehalis, Owilapsh, Cowlitz	1,200	365	438,000
Klikitat, Yakima, Wanapum, Palus	11,200	400	4,480,000
Nez Perce	4,000	300	1,200,000
Tenino, Umatilla, Wallawalla	2,900	500	1,450,000
Wailatpu (Cayuse)	500	365	182,500
Wenatchi, Sinkiuse, Spokane (part)	3,500	500	1,750,000
Wenatchi-Spokane (part)	2,400	500	1,200,000
Kalispel, Coeur d'Alene, Pend d'Oreille, Flathead	2,800	100	280,000
Okanagan, Lakes	2,200	500	1,100,000
Kutenai	1,200	300	360,000
Chilcotin	2,500	600	1,500,000
Lillooet	4,000	600	2,400,000
Thompson, Nicola	5,150	900	4,635,000

TABLE 1--Continued

Native Groups	Population	Estimated Consumption	
		Per Capita	Total by Groups
<u>Columbia-Fraser Plateau (Continued)</u>			
Shuswap	5,300	500	2,650,000
Carrier, Babine	8,500	600	5,000,000
Bannock, N. Paiute, N. Shoshone	<u>3,000</u>	<u>50</u>	<u>150,000</u>
Subtotal	61,950	Avg. 438	29,459,500
<u>Oregon Coast to N.W. California</u>			
Chinook	22,000	400	8,800,000
Tillamook	1,500	320	450,000
Yaquina, Alsea, Siuslaw	6,000	320	1,920,000
Kus	2,000	300	600,000
S.W. Oregon Athabaskans	8,800	300	2,640,000
Tolowa	1,000	365	365,000
Kupa, Chilula	1,500	365	547,000
Yurok	2,500	365	912,000
Karok	1,500	450	675,000
Wiyet	1,000	300	300,000
Nongatl, Mattole, Lassik, Wailaki, Kinkyone	<u>4,000</u>	<u>200</u>	<u>800,000</u>
Subtotal	51,800	Avg. 335	18,039,000
<u>Willamette Valley-Klamath Lakes</u>			
Kalapuya	3,000	100	300,000
Takelma	500	300	150,000
Shasta, Chimariko	3,000	300	900,000
Klamath, Modoc	1,200	20	24,000
Achomawi, Atsugewi	3,000	100	300,000
Mountain Maidu	<u>1,000</u>	<u>77</u>	<u>77,000</u>
Subtotal	11,700	Avg. 149	1,751,000
<u>California</u>			
Kato	500	247	123,500
Yuki, Coast Yuki	3,000	100	300,000
Wintu (Sac'to drainage)	2,000	300	600,000

TABLE 1--Continued

Native Groups	Population	Estimated Consumption	
		Per Capita	Total by Groups
<u>California (Continued)</u>			
Wintu (Trinity	1,500	300	450,000
Wintun	2,500	365	938,000
Yana	1,500	300	450,000
F'thill Maidu, Ninenan	4,000	200	800,000
Plains, F'thill Miwek	9,000	200	1,800,000
Costanoan, Esselen	7,500	10	75,000
Valley Yokuts	11,000	50	550,000
F'thill Yokuts	7,000	50	350,000
Western Mono	2,000	5	10,000
Pome (except Lake)	6,000	100	600,000
Wappe, Coast Miwok	3,000	75	225,000
Patwin	6,000	300	1,800,000
Valley Maidu	<u>4,000</u>	<u>300</u>	<u>1,200,000</u>
Subtotal	70,500	Avg. 182	10,271,500
Grand Total	338,150	Avg. 356	127,755,800

^aGulf of Georgia^bPuget Sound

demands that in our own diets are met in part by sugar, starch, eggs, and dairy products. At least, these two crude estimates are an indication of the order of magnitude of the total salmon and/or fish consumption of the area.

There are data indicating that the actual consumption of salmon by natives in some parts of the area were much higher per capita than we have assumed above, while in other, less favorable districts, the annual per capita intake of salmon may have been as little as 10 to 25 pounds, representing the meals which might be prepared from half a dozen fish in the course of a year.

The most complete series of estimates of aboriginal fish consumption are from Alaska. The earliest figures seem to be those of Dall (1870:485, 537), who stated that "The number of salmon annually consumed by the natives

of Alaska cannot be less than 12,000,000, at the lowest estimate." Converting this figure into terms of weight using the factor of five pounds for the average salmon of all species, we obtain 60,000,000 pounds, which, apportioned among the 26,843 natives then enumerated in the territory, yields a per capita annual consumption of 2220 pounds. Using the figures given in another of Dall's references, for Kodiak Island and Cook Inlet, the more moderate estimate of 930 pounds per person per year is obtained. In his report on the population and resources of Alaska for the 1880 census, Ivan Petroff devoted several pages to the native fish catch, which he considered in nine separate areas (Petroff 1881:69-70). For Southeastern Alaska with a predominantly Indian population in 1881 of 7000, Petroff states that each individual consumed "the equivalent of 3,000-4,000 pounds of fresh fish per year," with halibut and salmon as the basis of supply. At Prince William Sound, he estimated a consumption of 300,000 pounds of fish, mostly salmon, or 500 pounds per year per capita. At Belkofsky, near the southwestern tip of the Alaska Peninsula, the Aleuts consumed about 290-300 pounds of salmon "fresh and dried" per capita per year. Petroff's estimate comes to 312 pounds for salmon on Cook Inlet, and on Kodiak the mixed white population annually packed 200,000 pounds of salt salmon, equivalent to 624 pounds per person of fresh fish. The Kodiak figure was in addition to the consumption of fresh (unsalted) salmon; if the dried salmon pack at Kodiak, averaging 312 pounds per person, were added to the salted pack and to the amounts consumed fresh, the per capita total would rise above 1000 pounds. Petroff's estimate for Unalaska is not allocated by species. For Bristol Bay, Petroff's estimate of 500 pounds of salmon per person is a rough estimate, for the population there is given in round numbers. Including the consumption of salmon by sled-dogs, the natives of the Kuskokwim are stated to have consumed the astonishing total of 6000 pounds of fish per capita annually. Three tons appears excessive, even if dogs outnumbered humans five to one. In this instance, not all the consumption was of salmon; whitefish, trout, and blackfish were included. An equally high figure, species unstated, is given for the natives of the Yukon Valley (Petroff 1881:33).

Sources quoted by Bean (1887:93-94), apparently independent of Dall's and Petroff's estimates, give us additional data for fish consumption by the natives of Alaska. For Kodiak and Afognak, the dried salmon or "ukali" put up by each family for winter use averaged between 930 and 958 pounds per person, in equivalent fresh weight of fish. This was, of course, in addition to fish eaten fresh, and to salmon preserved by salting, which was not an aboriginal process. Bean (1887:87) quotes another source for the parish of St. Paul on Kodiak, which yields a figure of 1875 pounds per person. For Cook Inlet, Bean's figures amount to 925-940 pounds per capita.

At a much later date, when the white population of the Yukon basin "in some measure" dependent on local fisheries was greater than the Eskimo and Indian population, Cobb (1930) presents some figures for salmon consumption. Using standard conversion factors based on Gilbert and O'Malley's later Yukon study, per capita utilization of salmon in 1918 was 910 pounds per person per year. To each human consumer, however, must be added the fish eaten by 0.6 of a husky dog. The Yukon statistics included 11,000 people

and 6,183 dogs. In 1920, according to Gilbert and O'Malley, salmon consumption in the same area was 3100 pounds per capita, counting the dogs owned. There was a decline in the population of Alaska between 1918 and 1920, partly caused by the ravages of the pandemic influenza, the recession of the gold fever, and above all by the attraction of war industries in the United States. In all, this decrease amounted to 9320, but the greater part of the discrepancy between Cobb's and Gilbert and O'Malley's estimates may be due to a different ratio for converting weight of dried salmon to its fresh equivalent. We learn from Gilbert and O'Malley that the average Alaskan work-dog consumes an amount equal to 1080 pounds of fresh salmon each year.

Sullivan (1942:29) provides additional information to gauge the reliability of the foregoing estimates. Dealing with a group of Ten'a (Koyukon) in the villages of Kaltag, Nulato, and Keyukuk, he notes that practically every family has a team of at least seven sled dogs, many having nine or eleven. When the animals work on the trail in winter, their ration consists of "at least one good-sized, dried salmon a day." In summer, and when not working, they are fed only half a salmon each day. Assuming that 100 days a year are working days for these animals, they would consume 232-1/2 fish. If the salmon were of the species commonly fed to dogs, *O. keta*, which average 8 pounds apiece, each dog should consume 1860 pounds a year. Multiplying this by the minimal seven-dog team, the quantity needed to supply the dogs of each family would be 13,020 pounds, or 3255 pounds for each person of the average family, over and above what is required for human food consumption. In pre-white times, however, the Athabaskans of the interior of Alaska did not use dog sleds (Osgood 1940:357). Without the dog teams which now must be reckoned in the fish consumption of the Yukon Valley, the use of salmon there in the past must have been considerably lower.

The writer discussed these high figures for salmon consumption with Dr. Cornelius Osgood, whose ethnographic work in the Yukon Valley and at Cook Inlet would make him a good judge of their reliability. Osgood did not feel that amounts over 1000 pounds per capita were excessive, stating that during his own residence in the interior of Alaska he consumed several pounds of fish each day, mostly dried salmon.

From farther south, in British Columbia, we have a general estimate for the per capita Indian consumption in 1879 of 583 (Carrothers 1941:5).⁵ For the Indians around the headwaters of Skeena River and at Babine Lake, an observer in 1904 reported that each native family used about 1000 salmon each year. Taking 4 pounds as the lowest average weight of salmon in that district, this amounts to an annual per capita consumption of 1000 pounds (Carrothers 1941).⁶ Still farther south, we have the rough estimate of 365 pounds per year for the natives of the Columbia Basin, used by Craig and Hacker (1940) and a figure of 307 pounds per capita derived from statistics of the modern Indian catch at Celilo Falls, which is shared by a population of 13,000 natives enjoying treaty rights in its salmon dip-net fishery (Pacific Fisherman).

The various estimates of annual per capita consumption of salmon by native groups within the area are combined in Table 2, below.

TABLE 2

ESTIMATES OF NATIVE CONSUMPTION OF SALMON
(UNIT: FRESH SALMON IN POUNDS PER CAPITA PER YEAR)

Estimate	Area or Group	Remarks and Source
290-300	Belkofsky Aleut	Salmon less important than cod. (Petroff 1881)
307	Celilo Falls	Modern catch by Indians with treaty rights. ("Pacific Fisherman")
312	Cook Inlet natives	(Petroff 1881)
365	Columbia Basin in aboriginal times	(Craig and Hacker 1940)
500	Prince William Sound natives	Includes some fish besides salmon. (Petroff 1881)
500	Bristol Bay Eskimo	(Petroff 1881)
583	Indians of entire Province of British Columbia in 1879	(Carrothers 1941)
910	Natives and whites of Yukon Valley	Includes fish eaten by dogs. (Cobb 1930)
930	Kodiak and Cook Inlet natives	(Dall 1870)
925-940	Kodiak, Afognak, Cook Inlet, and adjacent areas	Dried salmon only. (Bean 1887)
1000	Indians around Babine Lake and upper Skeena	(Carrothers 1941)
1000 or more	Kodiak natives and whites	Includes fresh, dried, and salt salmon. (Petroff 1881)
1875	St. Paul Parish, Kodiak Island	Dried salmon only. (Bean 1887)
2220	Natives of entire Territory of Alaska	(Dall 1870)

TABLE 2--Continued

Estimate	Area or Group	Remarks and Source
3000-4000	Southeastern Alaska Indians	Includes halibut, etc. (Petroff 1881)
3100	Natives and whites of Yukon Valley	Species of fish net stated. (Petroff 1881)
3255	Koyukon	Salmon eaten by sled dogs, apportioned among members of dog-owning families. (Sullivan 1942)
6000	Yukon and Kuskokwim natives	Includes species other than salmon. (Petroff 1881)

This table indicates that we must weight the salmon consumption of some aboriginal groups or areas much more heavily than others. While we have very few quantitative hints for the regions south of Alaska, it is reasonable to suppose that per capita consumption among intensive fishing peoples in parts of the Plateau and on the Northwest Coast reached amounts equivalent to at least the lower estimates given above. It seems hardly necessary to add that the per capita consumption of salmon or any other natural product was subject to the variability of supply from year to year due to climatic and other factors. Even the best estimates can only be generalizations, rarely coinciding with actual experience in any particular year. In the case of salmon, the annual fluctuation in their availability was very marked in some areas, as with the sockeye of the Fraser Basin, with its four-year cycle of abundance.

Table 1 represents an attempt to refine the crude estimate of aboriginal salmon consumption for the whole Salmon Area by adding separate estimates for each group, instead of simply multiplying the entire population by the arbitrary factor of 365 pounds per year. While the method still rests on guesswork more than on factual evidence, every effort has been made in the table to arrive at reasonable figures, based on the available ethnographic data presented in Hewes (1947). Tribes which are known to have spent little time in fishing, or which depended more on the hunting of land mammals or the collection of wild plant foods, have been rated as low consumers of salmon. Where marine aquatic foods other than salmon were present in abundance, as on the Northwest Coast, or among the sea-mammal-hunting peoples of the Bering Sea region, estimates of salmon intake have been reduced. Thus, the Karok are considered to have eaten more salmon per capita than the Yurok, and the Lower Chinook less than the Tenino. The grand total estimated salmon consumption obtained by this

addition of local figures is 127,755,800 pounds, as against our earlier crude estimate of 123,424,750 pounds, or 103,135,750 pounds based on minimal protein requirements. Considering the degree of reliability of the original population estimates upon which the whole assumption rests, and our ignorance of many factors which may have affected the aboriginal use of salmon in the area, 100,000,000 to 130,000,000 pounds per year probably comes as close to the truth as we shall ever be able to reach.

We can use this quantitative value as an indication of the order of magnitude of the fraction of the salmon resource of Northwestern North America which was removed each year, possibly for many centuries, with no serious danger to the future productivity of the fishery. Observations based on the catch of the commercial period alone are of too short duration, and complicated by such external factors as erosion, blockage, and pollution, to be entirely conclusive.

Consumption of Other Aquatic Foods

No attempt has been made here to reckon the consumption of food fishes other than Pacific salmon, even though in some localities they may have been of greater subsistence importance. (Carrothers [1941:85] gives estimates for the aboriginal consumption of halibut in British Columbia.) This is because the main scientific interest in the fisheries of the area so far has been on problems related to the salmon species, both because of their economic value and their migration and spawning in fresh water, which has made it easier to study the conditions which determine their abundance or threaten them with depletion. The life histories of many of the important food fishes which spend their entire life cycle in deep sea waters are little known by contrast, because of obstacles to observation. For salmon we have not only a good body of statistical data, covering nearly all the large streams of the area, but reliable studies of their biology and distribution. Finally, the nutritive values of the various species of salmon can be equated on a calories-per-pound basis. Were we to deal with several unrelated food species, the reduction of their nutritive values to a common factor would be far more difficult.

Patterns of Growth and Decline of Commercial Fisheries

In Hewes (1947:196-205) is a sketch of the rise of the commercial fishing industry of the Salmon Area, from the early endeavors to establish dependable food supplies for fur trading posts and for sale to the occasional merchant vessels visiting the coast, to the development of the canning of salmon and the more recent growth of the halibut, pilchard, and albacore fisheries. Confining our attention to the salmon fishery, let us first examine the pattern of initial rapid growth and eventual decline which has characterized the industry on the rivers of the Pacific Coast, beginning with the Sacramento in 1864.

After a peak production reached in 1882, the first marked decrease set in on the Sacramento in the ensuing decades.⁷ This was the first decline on any salmon fishery stream on the coast, except for the Smith

River, where the commercial fishing was never of real importance. In 1883 the salmon yields on the Eel River reached a peak. The only California salmon stream to maintain a rising curve of production was the Klamath, where a decline did not become apparent until after 1912.

To the north, the fisheries on the eleven rivers of the Oregon coast culminated in 1911, when the district yielded 250,000 cases. Since then production has fallen to about 15,000 cases a year.

On the Columbia River, depletion was foreseen as early as 1888 (Bancroft 1888:758). The pack there reached its maximum in 1895, but the signs of decline were masked by the substitution of chinook salmon for the sockeye, which formerly constituted the bulk of the Columbia River pack, and by greatly increased output of fishing effort. The magnitude of the pack in any year is determined to a great extent by the market outlook, but when greater and greater expenditure of the labor of fishermen fails to increase the yields under the pressure of market demands, then the depletion is real. In 1930 the salmon pack of the Columbia was down to less than half of the 1895 total (Freeman and Martin 1942:209-10). (A 48-pound case is equal to 68-70 pounds of fresh salmon [Bancroft 1888, Cobb 1930].)

The declines on the streams of western Washington entering Willapa Bay and Grays Harbor set in after 1902 and 1911, respectively. The Quinault, Queets, Hoh, and Soleduck fisheries culminated in 1915. The catch in Puget Sound is based largely on the huge runs of salmon into the Fraser River. The heyday of Puget Sound salmon fishing was from 1899 to 1919, when the catch averaged nearly one million cases a year, with a peak pack in 1913. In 1939 the pack had dropped to 400,000 cases, and in 1940, to 121,000 cases (Freeman and Martin 1942). On the Fraser River, the pack reached its peak in 1901. The fisheries on the Skeena, Rivers Inlet, Smiths Inlet, and Nass, and outlying streams of British Columbia culminate much later, in 1918-1920, with the increased fishing effort to satisfy the booming market following the end of the First World War.

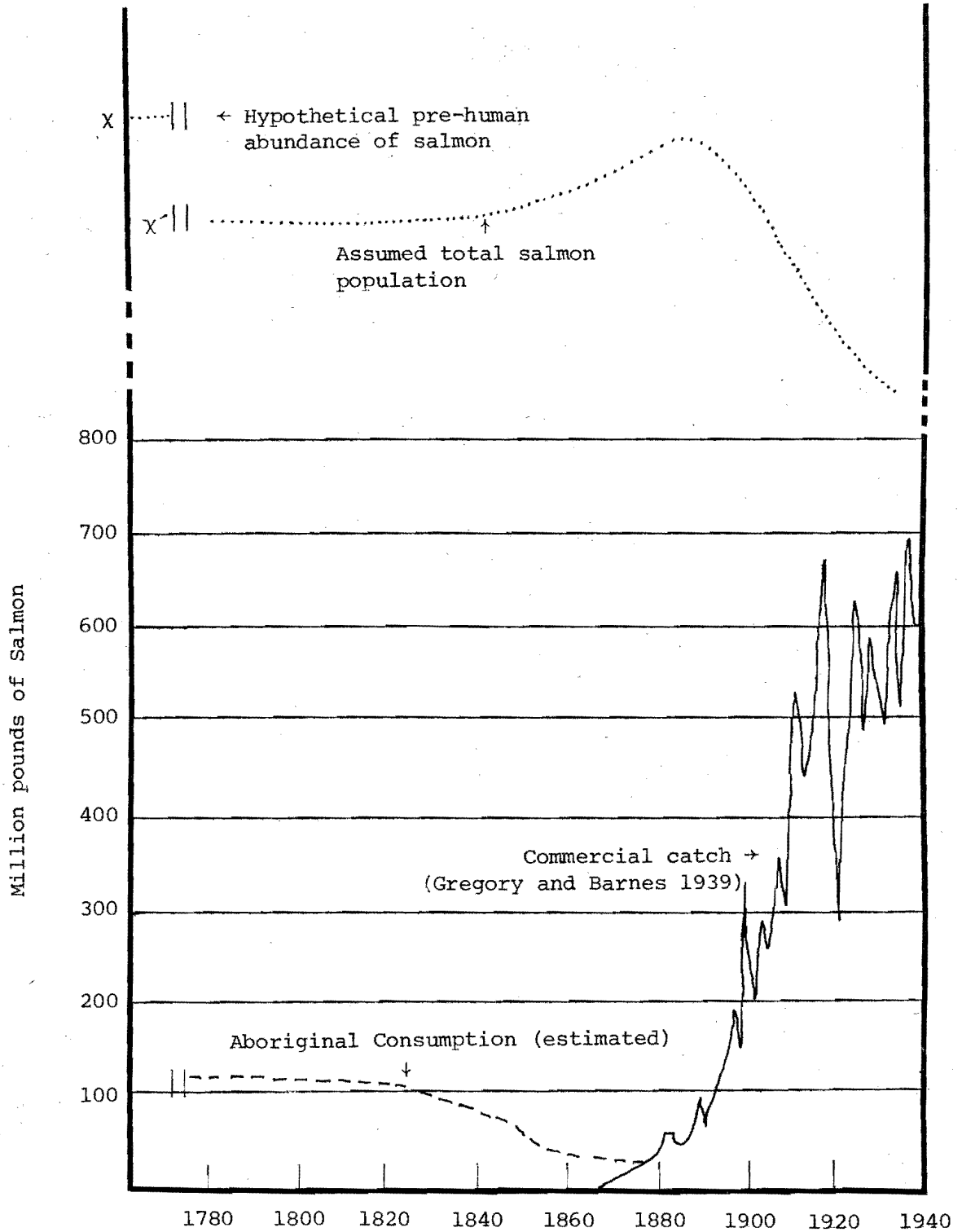
The Alaskan salmon pack surpassed that of the Columbia as early as 1888. It has had two maxima, one coinciding with the First World War market in 1919 and the other in World War II. Since 1924 the Federal Government has regulated the Alaskan catch by requiring an escapement of 50 percent of the salmon to their upstream spawning beds (Freeman and Martin 1942, Bower 1944:25-27).

In Table 3 we have plotted the combined production curve for all the salmon districts, from 1864 to the present, against which may be compared our estimate of the aboriginal catch and the assumed total salmon population in the Salmon Area. The commercial catch statistics have been converted to their fresh equivalent weight.

Some species were far more sensitive to commercial exploitation than salmon, and depletion has been more serious. Of these, the sturgeon, native oyster, shrimp, and halibut (Babcock 1930) may be mentioned. In many instances, depletion has been postponed by expansion of the fishery to more and more distant banks, or by the greatly increased expenditure of labor in relation to yield. In almost every case of a commercial fishery

TABLE 3

Assumed Relationship of Curves of Total Salmon Population,
Aboriginal Consumption, and Commercial Catch for the Period 1780-1940



resource intensively exploited, however, the pattern of growth and decline has resembled that of the salmon industry, with the same interplay of economic and biological factors.

Indirect Destructive Effects of White Settlement on the Fisheries

In addition to the direct causes of depletion of fishery resources discussed above, which we may consider "over-fishing," there are many conditions, apparently unconnected with the exploitation of aquatic resources, which have contributed to the declines in abundance of fresh-water species, and to a limited extent of species dwelling entirely in marine environments. These conditions may be classified either as pollution or as blockage. Activities like mining, agriculture, the felling and milling of timber, and many other industries produce both types.

Mining was the first major cause of fisheries depletion, not related to over-fishing, in the Salmon Area. The early methods of placer mining and the later dredging operations on the streams of California have accounted for the obliteration of perhaps 50 percent of the available salmon spawning beds. Van Cleve (1945:101) estimates that mining, plus more recent installations of irrigation, water supply, and power dams, has been responsible for a decrease of 73 percent of the salmon spawning beds. The Indians of California were apparently the first to voice complaints about the deleterious effects of mining on the fish supplies (Cook 1943:33-34). California was not the only region to suffer from pollution and blockage of streams by mining. On a smaller scale, equally drastic biotic changes were wrought by the gold seekers in the Cariboo district of British Columbia, in Idaho, and in parts of Alaska (Marsh 1885:606-07, Goode 1887:[4]44).

The chief effect of placer mining is to increase the amount of silt in suspension in the water flowing from the diggings, which reduces the penetration of light to aquatic photosynthetic micro-organisms, thus lessening the total amount of food available in a given body of water (Needham 1938). Heavy silting on salmon spawning beds may simply smother the spawn under a deep layer from which the young cannot emerge. A slight turbidity in the lower courses of rivers, on the other hand, may be of value to the survival of the salmon fry. Light placer mining might cloud the water of a stream sufficiently to hide the fry from the predatory birds which normally subsist on them.

The lumber industry, a characteristic activity of much of the area, has had a well-known destructive effect on the fishing resources of streams and lakes. Removal of the forest cover bordering small streams exposes the shallow water to direct sunlight, raising the temperature above the toleration of cold-water fauna. The toleration is based on the amount of dissolved oxygen in the water, which is greater at lower temperatures. On a larger scale, lumbering promotes erosion and flash floods, which, with the debris left from trimming, etc., physically obstruct the migrations of fish to their spawning grounds. The effects of agricultural and pastoral occupance of the land adjacent to streams are similar to those of the lumber industry. Increased run-off follows plowing or grazing, leading to the cycle of floods,

silting, and choking of streams with impassable blocks of debris. Direct blockage of fish migration is more often due to the construction of dams, diversion ditches, railway embankments, and highway embankments with culverts which fish cannot enter from below. Grand Coulee Dam, 350 feet high, has eliminated at one stroke some 1100 miles of salmon streams in the upper Columbia Basin.

For a detailed study of fishery pollutants, see the paper by Ellis (1937). The list below, by no means complete, summarizes the indirect causes for the declining yields of fresh-water and tide-water species in the Salmon Area.

1. Agriculture: erosion silt and blockage of streams by irrigation and drainage canals.
2. Livestock raising: erosion silt from over-grazing, organic wastes from dairies, and wool washings.
3. Mining: erosion silt from open pits and quarries, blockage or diversion of streams by dams and flumes, tailings and dredge-wastes, chemical pollutants from smelting.
4. Lumber industry: erosion silt from cleared areas, logging debris, flush-dams and mill-dams, sawdust and paper-mill wastes.
5. Transportation: stream blockage by culverts in highway and railway embankments, silt from erosion of cuts and fills, silt from harbor and channel dredging, fuel oil and bilge wastes.
6. Miscellaneous: organic, mineral, and chemical wastes from various manufacturing plants; municipal sewage; stream blockage by water supply and power dams; hot water discharged from chain-reaction piles (as at Hanford on the Columbia River).

In contrast to these destructive processes, there have been stream-improvement projects and the operations of fish hatcheries, to say nothing of laws and regulations to protect fishery resources by limiting the kinds or times of use of various types of gear. An incidental benefit to the salmon and trout populations of the area may also have come about with the virtual extinction over enormous areas of their range of beavers, during the early decades of the 19th century. The hunting of beavers soon resulted in the natural removal (through lack of constant repair) of hundreds of thousands of beaver dams, which have been recognized as disadvantageous to migrating salmon as well as to resident trout (Cook 1940).

Attempted Projection of a Curve of Abundance for Salmon Resources, 1780-1940

Table 3 referred to above is an attempt to project an estimated curve (shown by dotted line) of abundance of the various Pacific salmon species, as a whole, during the three economic periods: native subsistence, transition, and commercial; with this curve are curves representing the estimated

aboriginal catch or consumption (dashed line) as it declined from 1780 to 1880, and the commercial catch (solid line) as it rose from 1864 to 1940. The portion of the dotted line near the top of the table, at χ , represents the hypothetical pre-human abundance of salmon, possibly several thousand years ago. When the dotted line is resumed after the break at χ' , it represents the lowered stock of fish which is assumed to have existed because of the native consumption. As the aboriginal population decrease accelerated, especially after about 1830, the total salmon stock rose gradually as shown by the rising dotted line. We assume that the highest point after its recovery was around 1890, as the net result of several decades of lowered fishing intensity on most if not all streams of the Pacific Slope. The rapid expansion of the commercial salmon fishery, combined with the cumulative destructive effects of the occupation of the adjacent lands by mining, lumbering, and agricultural enterprises may be assumed to have produced the drastic decline in the total salmon stock which is shown on the upper right-hand side of the table. This line has been drawn so as to approach the rising solid line of the commercial catch, which now takes all but 1/5 or 1/6 of the annual natural production of the various salmon species. The vertical scale (in millions of pounds) has been broken purposely above the 800 mark, however, to indicate that the actual size of the total salmon population is unknown. Only where systematic weir counts of migrating salmon have been made have there been reliable indications of the size of the stock available in a given river system.

The theory on which the curves in Table 3 rest has been carefully developed by Craig and Hacker (1940:150) to explain changes in the salmon productivity of the Columbia River system. We quote their paper:

Therefore [since the salmon used by whites between 1820 and 1865 by no means equalled the falling off of the Indian catch occasioned by the great decline in the native population] it is not improbable that there was less fishing strain on the salmon populations of the Columbia during the period from about 1835 to 1865 than at any other time in their history. If this were the case, the salmon of the Columbia may have been more abundant during the few years immediately before the advent of the canning industry in 1866 than at any other time within our knowledge.

Further on, they state:

However, discontinuance of the primitive Indian catch because of the great decrease in the number of Indians may be one of the factors which helps to explain the ability of the Columbia River salmon to produce as large a catch as they have, even under increasingly unfavorable conditions.

The high initial productivity experienced on nearly every salmon stream in the commercial era may therefore be explained in part by the "resting period" which set in with the sharp drop in the rate of the native subsistence fishing. The subsequent declines in the commercial salmon fisheries may represent a partial return to fish-population levels which had prevailed during the many centuries of aboriginal fishing, whatever additional decrease

there might have been from the effects of over-fishing and the indirect destruction of resources from mining, farming, and the lumber industry.

There is no question as the importance of a "resting period" or hiatus in the exploitation of a fishery in restoring a stock to a condition which may approach its former abundance. This was clearly demonstrated in the case of the fisheries of the North Sea which were afforded a four-year respite from trawling between 1914 and 1918. The productivity of these banks had long been declining as the careful statistics of several nations showed. Yet, when the fishing fleets returned to the banks in 1919 and 1920, with no greater output of labor than in pre-war years, hauls of phenomenal size were recorded. The surplus was short-lived, to be sure, and by the 1930's the danger of depletion on the North Sea banks again became a matter of international concern (Heincke and Buckmann 1926, Thursby-Pelham 1926).

Within the Salmon Area, a less dramatic instance of fishery recuperation is reported from Bristol Bay, where fishing was greatly restricted in the 1935 season to prevent depletion in the 1940 run of sockeye, which there happen to exhibit a five-year cycle of abundance. The 1940 run was of noticeably increased size because of the larger percentage of spawning fish which had been allowed to escape the gill nets and to proceed upstream in 1935.

We are simply suggesting that a similar, though nondeliberate, conservational effect occurred in the northwestern North American area during the period of pioneer white settlement and the shattering of native cultures in the middle of the last century.

Conclusions

In addition to the main conclusion just presented, some minor conclusions can be drawn. We have stressed the relatively high efficiency of primitive fishing methods in the Salmon Area, and of primitive fishing in general. In this connection we have discussed the technological dilemma confronting those who would exploit a fishery, but at the same time seek to preserve its future productivity. It has been noted that the improvements which have been made in fishing technology belong mostly to the category of accessory processes—such as transport to and from fishing places; or of fishery products, or means of preserving fish—rather than to the category of basic catching techniques. So far as river and other inland fishing is concerned, the technological differences between native cultures of North America and our own civilization are almost immaterial.

In considering the fishery resources of any region, if it is or has been inhabited by man, even in cases where the aquatic fauna has not been utilized for food, one should deal with them as features of the cultural landscape, unless it can be shown that human occupancy has had no effect whatsoever on such resources. Thus, in an extreme instance, where the native cultures have express prohibitions against fish as food, there are local cultural modifications of aquatic environments, as from irrigation. Much more drastic effects on the aquatic fauna of streams in parts of the American

Southwest (an area with fish tabus) have followed the introduction of sheep, with intensified erosion which the close grazing of these animals initiates.

Finally, we see that for a fisheries biologist to disregard the aboriginal fishing in an area, and to assume that the aquatic resources of that area were in a condition identical to the "natural environment" prior to the establishment of commercial or recreational fishing is to commit a serious error. The literature of ecology in America still contains statements implying that the habitat of wildlife species on this continent before the arrival of white men was a pre-cultural, primordial wilderness. The point of view is exemplified in a pamphlet of the Ecological Society of America (1921) dealing with a plan for wilderness parks to preserve something of the conditions "that existed before the coming of man."

It has been one of the purposes of this study of the relation between the aboriginal and the commercial uses of the fishery resources of Northwestern North America to show that before the epoch of European discovery, the aquatic life of the rivers, streams, lakes, bays, and coastal waters formed a genuine component of the cultural landscapes. We have also tried to show how these same faunal resources have persisted as integral features in the present cultural mosaic of fields, pastures, orchards, roads, wood lots, and towns and how their present and future productiveness is linked with past usage.

Notes

¹This work formed Parts 3 and 4 of my 1947 doctoral dissertation in Anthropology at the University of California, Berkeley, "Aboriginal Use of Fishery Resources in Northwestern North America." Since the estimates of aboriginal fisheries productivity in various parts of the Plateau, Northwest Coast, and western Alaska have been utilized in several later studies bearing on Indian utilization of resources, it has seemed worthwhile to reissue this material. No significant changes have been made in the text. However, a bibliography has been added to provide some guidance to the literature on fisheries production in the area, between 1946 and 1972.

²The average North Chinese male peasant consumes 2.2 pounds per day, on a diet consisting chiefly of grains, which have higher fuel values per pound than most of the foods eaten aboriginally in northwestern North America (Buck 1937:427).

³This applies to nearly all the vegetable items in the native dietary aside from the acorn and the pine nut, both consumed in significant quantities only in the southern and southeastern portions of the Salmon Area. One pound of acorn meal contains 2180 calories. The farinaceous bulbs and tubers such as wapato, bitterroot, camas, clover root, etc., are low in calories, while berries and miscellaneous greens, so necessary for vitamins and trace elements, are negligible sources of fuel.

⁴Some proteins are indispensable; others may be omitted.

⁵Carrothers (1941) quotes a source which states that in 1879 the natives of British Columbia consumed about 17,500,000 pounds of salmon, said to have been the average over a period of several years. Using Mooney's (1928) population data, the Indians in that Province in 1879 numbered about 30,000, which by division gives a per capita figure of 583 pounds.

⁶The average weights of fresh salmon and equivalent values of dried salmon are given in a letter of Ward T. Bower, U.S. Fish and Wildlife Service, dated 25 March 1946. The lightest salmon at the time of spawning are humpback (*O. gorbuscha*), which weigh four pounds.

⁷The statistics on which this and the following statements are based are to be found in Cobb 1930.

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