Species of Interest: Pacific and Western Brook Lamprey and Freshwater Mussels Detailed Life History, Distribution, Abundance, and Other Information

Developed by: Confederated Tribes of the Umatilla Indian Reservation Spring 2004

Pacific and Western Brook Lamprey

It is well documented that Pacific (*Lampetra tridentata*) and western brook (*Lampetra richardsoni*) lampreys were both abundant in the Walla Walla River Subbasin historically (Lane and Lane 1979, Swindell 1940). Until recently, each species received little attention from fish managers. Abundance and range are currently unknown but populations of western brook lamprey appear to be maintaining, while Pacific lamprey are believed to be at or very near extinction.

<u>Pacific lamprey historic and current distribution and abundance</u>

Pacific lamprey are distributed in North America from the Aleutian Islands south along the Pacific coast to Baja California, Mexico, and inland to the upper reaches of most rivers draining into the Pacific Ocean (Ruiz-Campos and Gonzalez-Guzman 1996). Historical distribution of *L. tridentata* in the Columbia and Snake Rivers was coincident wherever salmon occurred (Simpson and Wallace 1978). Access rather than distance from the ocean was suggested to be the important factor influencing regional distribution (Kan 1975).

The current distribution of Pacific lamprey in the Columbia River extends to Chief Joseph Dam and to Hells Canyon Dam in the Snake River. Both of these Dams lack fishways and limit distribution of migrating fish. These describe the possible limits of distribution, but there has been no survey to examine the distribution throughout the Columbia River drainage. There are only sporadic reports of their presence because of the lack of survey data (Close et al. 1995). Both Lane and Lane (1979) and Swindell (1940) reported lamprey in the Walla Walla Basin. Tribal members used to harvest lamprey near the mouth of the Walla Walla River, near Skiphorton Creek in the South Fork Walla Walla River, and other various locations in the basin.

From the 1960’s and between 1985 and 1990, lamprey collected at screen trap boxes were either not enumerated or lumped with other non-salmonids and from 1992-1995, 246 lampreys were enumerated by ODFW staff at Walla Walla screen trap boxes but no attempts were made to differentiate between species (Jackson et al 1997). It was thought that four Pacific lamprey ammocoetes were identified in May 1997 at the Little Walla Walla River diversion where thousands of lamprey were removed during sediment cleanup, but recent studies have shown that they were likely western brook lamprey (A. Jackson, CTUIR, pers. comm. 2004). Assessment of the Walla Walla subbasin completed in 1998 showed that lampreys were present in eight of twelve subwatersheds inventoried (Mendel et al. 1999), lampreys were not keyed to species. A recent electrofishing survey completed in 1999 by CTUIR found no Pacific lamprey larvae in the Walla Walla River Subbasin (Bronson 2000), although resident western brook lampreys were sampled at 2 sites in the South Fork Walla Walla River (Rkm 1.8, density 0.04 ind./m2; and Rkm 11.2, density 0.31 ind./m2). More surveys are needed in the Walla Walla River Subbasin to completely understand the current abundance of lampreys. Pacific and western brook lampreys share many of the same life history characteristics and requirements, it is very likely that restoration efforts will need to take place for recovery of Pacific lamprey in the basin. More studies will need to take place to fully understand the distribution of Pacific lamprey in the Walla Walla River Subbasin.

<u>Pacific lamprey life history</u> (as described in Close et al. 2002)

The present state of knowledge suggests that the life history of Pacific lamprey is very similar to sea lamprey (*Petromyzon marinus*). They spend the early part of their life burrowed in fine silt or sand filtering detritus and other particulate matter. After an extended time (4 to 6 years), larvae go through metamorphosis which includes major morphological and physiological changes preparing them for life at sea. The juveniles then move to the ocean to feed (1 to 3 years) before returning as adults for reproduction.

<u>Pacific lamprey life cycle and ecological importance</u> (as described in Close et al. 2002)

*Larval stage

Pacific lamprey exhibits a protracted freshwater juvenile residence in the stream benthos. Larvae, often referred to as ammocoetes, leave the nest approximately two or three weeks after hatching, drift downstream (usually at night), and settle in slow depositional areas such as pools and eddies (Pletcher 1963). The larvae then burrow into the soft sediments in the shallow areas along the stream banks (Richards 1980). The larval stage has been estimated to range from 4-6 years (Pletcher 1963; Kan 1975; Richards 1980) although it may extend up to 7 years (Hammond 1979; Beamish and Northcote 1989).

Larval Pacific lamprey can represent a large portion of the biomass in streams where they are abundant, thus making them an important component along with aquatic insects in processing nutrients, nutrient storage, and nutrient cycling (Kan 1975). Larval lampreys process nutrients by filter feeding on detritus, diatoms, and algae suspended above and within the substrate (Hammond 1979; Moore and Mallatt 1980). Larvae also possess high entrapment efficiency for food coupled with low food assimilation rates. For example, based on studies of other lamprey species (*L. planeri*), larval Pacific lamprey may digest only 30-40% of the food taken in while passing large amounts of undigested food (Moore and Mallatt 1980).

*Downstream migrants

During metamorphosis, the larvae go through morphological and physiological changes to prepare for a parasitic lifestyle in salt water. Transformation of Pacific lamprey from the larval to young adult life stage generally occurs during July through November (Pletcher 1963; Hammond 1979; Richards and Beamish 1981).

Young adult lampreys begin their migration to the Pacific Ocean in the fall and continue through the spring. Time of entrance into salt water may differ among populations of Pacific lamprey due to environmental conditions (pers. comm., R.J. Beamish, Pacific Biological Station, Nanaimo, B.C., Canada). Kan (1975) suggested that coastal populations enter salt water in the late fall while inland populations enter in the spring. In the Nicola River of British Columbia, 99% of all metamorphosed lampreys migrated by April and May (Beamish and Levings 1991).

*Ocean life

The ocean life history stage of Pacific lamprey is not well understood, but the duration of ocean residency may vary. The parasitic-phase has been estimated to last for periods of up to 3.5 years for Pacific lamprey in the Strait of Georgia, British Columbia (Beamish 1980). Off the coast of Oregon, the duration of the ocean phase was estimated to range from 20 to 40 months (Kan 1975). Parasitic-phase Pacific lamprey have been collected at distances ranging from 10 to 100 km off the Pacific coast and at depths ranging from 100 to 800 m (Kan 1975; Beamish 1980).

The Pacific lamprey preys on a variety of fish species and marine mammals in the Pacific Ocean. Beamish (1980) reported five salmonid and nine other fish species that are known prey of Pacific lamprey (Table 1). Pacific lamprey has been reported to feed on finback (*Balaenoptera physalus*), humpback (*Megaptera nodosa*), sei (*Balaenoptera borealis*), and sperm (*Physeter catodon*) whales (Pike 1951). In addition, feeding occurs on a variety of midwater species such as Pacific hake (*Merluccius productus*) and walleye pollock (*Theragra chalcogramma*) in the open ocean (Beamish 1980).

Anadromous Pacific lamprey should not be viewed as a pest species like sea lamprey (*Petromyzon marinus*) of the Laurentian Great Lakes (e.g., Eschmeyer 1955; Moffett 1956; Coble et al. 1990). In the Great Lakes, an entire community of naive prey was exposed to an exotic predator. Most lampreys around the world live in equilibrium with their hosts (Renaud 1997). Pacific lamprey have co-adapted with their prey, which includes Pacific salmon. Beamish (1980) could find no evidence that increased lamprey production in the Skeena River would lead to predation problems on its sockeye salmon. The effect of intense commercial harvests of Pacific hake, walleye pollock, and ground fishes on the food chain dynamics of the north Pacific Ocean ecosystem and on Pacific lamprey is not well understood, but likely substantial.

Returning adult Pacific lamprey are an important part of the food web for many species of freshwater fishes, birds, and mammals. Spawned out carcasses of lampreys are important dietary items for white sturgeon (*Ascipenser transmontanus*) in the Columbia and Fraser Rivers (Semakula and Larkin 1968; Galbreath 1979). Wolf and Jones (1989) reported the great blue heron (*Ardea herodias*) as a predator of spawning adult Pacific lamprey. Mink (*Mustela vison*) are also noted by Beamish (1980) as a predator of adult lampreys. In addition, fishermen have utilized adult Pacific lamprey as bait for sturgeon in the Columbia River Basin.

*Spawning migration

Beamish (1980) suggested that returning adult lampreys enter fresh water between April and June and complete migration into streams by September. Pacific lamprey overwinter in fresh water and spawn the following spring (Beamish 1980). Pacific lamprey does not feed during the spawning migration. They utilize stored carbohydrates, lipids, and proteins for energy (Read 1968). Beamish (1980) observed a 20% shrinkage in body size from the time of freshwater entry to spawning. Pacific lamprey along the coast of Oregon usually begins to spawn in May when water temperatures reach 10ºC to 15ºC and continue to spawn through July. In the Babine River system in British Columbia, Pacific lamprey was observed spawning from June through the end of July (Farlinger and Beamish 1984).

Pacific lamprey has very high fecundity compared to North American Pacific salmon species. Fecundity for Pacific lamprey in Oregon streams ranged from 98,000 to 238,400 eggs per female (Kan 1975), while fecundities for five North American Pacific salmon species ranged from 1,200 to 17,000 eggs per female (Burgner 1991; Heard 1991; Salo 1991; Healey 1991; Sandercock 1991). Relative fecundity in Pacific lamprey was significantly lower in an interior Columbia River tributary compared to Oregon coastal streams. Relative fecundity was 522.15 and 503.44 eggs/g body wt. in lamprey from the Umpqua and Molalla Rivers, and 417.94 eggs/g body wt. in the John Day River (Kan 1975). Kan (1975) suggested that the lower relative fecundity in the John Day lampreys was due to a higher cost of migration.

Pacific lamprey spawning success and production of larvae are not well understood. However, sea lamprey in the Great Lakes was estimated to only deposit 14% of their eggs in nests. The survival of sea lamprey eggs deposited in the nests was estimated to be up to 90% (Manion and Hanson 1980). During Pacific lamprey spawning, eggs were observed to overflow the nests and were actively eaten by rainbow trout (*O. mykiss*) and speckled dace (*Rhinichthys osculus*) in the Umatilla River, Oregon (pers. comm. J. Bronson, Confederated Tribes of the Umatilla Indian Reservation, Tribal Fisheries Program). After spawning, Pacific lamprey die within 3 to 36 days (Mattson 1949; Pletcher 1963; Kan 1975). Adult carcasses are likely a major contributor of nutrients in oligotrophic streams (Wilpfli et al. 1998; Fisher Wold and Hershey 1999).

*Prey and Predation

Larval Pacific lamprey constitutes a food source for other animals. There are two primary periods when larvae are subjected to predation: during emergence from nests and during scouring events that dislodge the larvae from their burrows. Pfeiffer and Pletcher (1964) found coho salmon (*Oncorhynchus kisutch*) fry ate emergent larval lampreys. In addition, larvae are commonly used for bait to catch the exotic smallmouth bass (*Micropterus dolomieui*) in the lower reaches of the John Day River, Oregon (pers. comm. J. Bronson, Confederated Tribes of the Umatilla Indian Reservation, Tribal Fisheries Program).

Young adult lampreys migrating downstream may have buffered salmonid juveniles from predation by fishes and birds. Pacific lamprey are found in the diets of northern pikeminnow (*Ptychocheilus oregonensis*) and channel catfish (*Ictalurus punctatus*) in the mainstem Snake River (Poe et al. 1991). Further, Merrell (1959) found that lampreys comprised 71% by volume of the diets in California gulls (*Larus californicus*), ringbill gulls (*Larus delawarensis*), western gulls (*Larus occidentalis*), and Fosters tern (*Sterna forsteri*) in the mainstem Columbia River during early May. This is interesting, in light of the controversy concerning waterbird predation on salmon smolts in the Columbia River estuary (Collis et al. 2001).

Adult lampreys may have been an important buffer for upstream migrating adult salmon from predation by marine mammals. From the perspective of a predatory sea mammal, lampreys have at least three virtues: (1) they are easier to capture than adult salmon; (2) they have higher caloric value per unit weight than salmonids; and (3) their migration in schools means fertile feeding patches. Pacific lamprey is extraordinarily rich in fats, much richer than salmon. Caloric values for lamprey range from 5.92 to 6.34 kcal/g wet weight (Whyte et al. 1993); whereas salmon average 1.26 to 2.87 kcal/g wet weight (Stewart et al. 1983). In fact, the work of Roffe and Mate (1984) revealed that the most abundant dietary item in seals and sea lions was Pacific lamprey. As a result, marine mammal predation on salmonids may now be much more severe because lamprey populations have declined.

<u>Pacific lamprey cultural significance to tribes</u> (as described in Close et al 1995)

The cultural significance of the Pacific lamprey in the Columbia and Snake River Basins is directly related to the Northwest tribes. Tribal peoples of the Pacific Coast and interior Columbia Basin have harvested these fish for subsistence, ceremonial, and medicinal purposes since time immemorial. The tribes use the common name “eel” when in reference to Pacific lamprey in the Basins. The fish are often harvested at locations were the geology favors capture such as falls or barriers. Two well known places where tribal members historically harvested Pacific lamprey (eels), were at Kasuth near the mouth of the Snake River and at Wallula near the mouth of the Walla Walla River. Eeling is usually done at night when the fish are most active. Active capture methods are used such as a hook on a pole or dip nets. The fish are then prepared traditionally by drying or roasting. Lamprey are part of the Columbia River tribal culture and are important in ceremonies and celebrations the same as many other foods. Eels are also used medicinally for their oils, and is often used as hair grease. There are many legends that are associated with the eels, such as the eel and the sucker:

> *I have heard it said that long ago before the people, the animals were preparing themselves for us. The animals could talk to each other during this time. The eel and the sucker liked to gamble so they began to gamble. The wager was their bones. The eel began to lose but he new he could win. The eel kept betting until he lost everything. That is why the eel has no bones and the sucker has many bones.*

<u>Western brook lamprey life history</u> (Scott and Crossman 1973; Wydoski and Whitney 2003)

Western brook lamprey spawning occurs April-July, depending on stream temperature. 12 lampreys have been observed on a single nest, and other spawning groups are known to superimpose on nests. Eggs likely hatch in 10 days in 10oC-15oC water in Oregon, and ammocoetes typically have left nests within 30 days post hatch and burrow into depositional areas to rear. Ammocoetes are filter feeders that feed upon desmids, diatoms, algae and detritus.

Pletcher (1963) suggested that western brook lampreys live up to 6 years in British Columbia. Larger ammocoetes metamorphose from August to November and adult size varies (130-200mm). Mature adults do not feed, their only function is to reproduce. Many life history characteristics and requirement are shared by both the western brook and Pacific lampreys.

<u>Western brook lamprey historic and current distribution and abundance</u>

Western brook lampreys are distributed in coastal streams of western North America from California to British Columbia. In Washington, this lamprey is found in coastal and Puget Sound streams and as far inland as the upper reaches of the Yakima River (Wydoski and Whitney 2003).

The Walla Walla River Subbasin historically has had and currently still has a population of the non-anadromous western brook lamprey. Both Lane and Lane (1979) and Swindell (1940) reported lamprey in the Walla Walla Basin, which may have included western brook. Tribal members used to harvest lamprey near the mouth of the Walla Walla River, near Skiphorton Creek in the South Fork Walla Walla River, and other various locations in the basin.

From the 1960's and between 1985 and 1990, lamprey collected at screen trap boxes throughout the basin were either not enumerated or numerically included with other non-salmonids. From 1992-1995, 246 lampreys were enumerated by ODFW staff at Walla Walla screen trap boxes but no attempts were made to differentiate between species (Jackson et al 1997). Assessment of the Walla Walla subbasin completed in 1998 showed that lampreys were present in eight of twelve subwatersheds inventoried (Mendel et al. 1999), although lampreys were not keyed to species. A recent electrofishing survey completed in 1999 by CTUIR found resident western brook lampreys were sampled at 2 sites in the South Fork Walla Walla River (Rkm 1.8, density 0.04 ind./m2; and Rkm 11.2, density 0.31 ind./m2). It is important to recognize that Pacific and western brook lampreys share many of the same life history characteristics and requirements, it is very likely that restoration efforts for Pacific lamprey will benefit western brook lampreys as well. Further studies are needed in the Walla Walla River Subbasin to completely understand the current abundance of lampreys.

Western brook lamprey ecological importance

Little is currently known on the ecological importance of western brook lampreys. It has been observed that various sculpin and salmonids prey upon eggs at the time of spawning, and it can be assumed that many of the same reasons the Pacific lamprey is ecologically important, applies for the western brook lamprey due to the fact that the two species share many of the same life history characteristics.

Western brook lamprey cultural importance

Oral history interviews suggest that the western brook lamprey was an important part of tribal culture. CTUIR tribal members referred to the western brook lamprey as the short eel, and it was said that Jasper Shippentower used to collect this species in Meacham Creek of the Umatilla River Subbasin, Oregon (Jackson et al 1997). As mentioned above, tribal members used to harvest lampreys near the mouth of the Walla Walla River and near the confluence of Skiphorton Creek in the South Fork Walla Walla River drainage (Lane and Lane 1979, Swindell 1940). Lamprey are an integral part of Columbia and Snake River tribal cultures and other tribes along the Pacific coast (Anglin et al. 1979; Mattson 1949; Pletcher 1963).

Freshwater Mussels

NOTE – This section was not reviewed nor approved by the lead entities, Subbasin Planning Team, or the public.

Freshwater mussels (Mollusca: Unionoida) are vital components of intact salmonid ecosystems and are culturally important to Native Americans. However, in part because freshwater mussels are sensitive to a myriad of pollutants and ecosystem alterations, these animals are now one of the most endangered faunal groups in North America.

Although the greatest diversity of freshwater mollusks occurs in the southeastern United States, the western states contain at least six endemic mussel species, and many endemic snail species. Historically, at least seven mussel species occurred in Oregon and Washington: the western pearlshell, *Margaritifera falcata* (Gould, 1850); western ridged mussel, *Gonidea angulata* (I. Lea, 1838); Yukon floater, *Anodonta beringiana* Middendorff, 1851; California floater, *Anodonta californiensis* I. Lea, 1852; western floater, *Anodonta kennerlyi* I. Lea, 1860; winged floater, *Anodonta nuttalliana* I. Lea, 1838; and Oregon floater, *Anodonta oregonensis* I. Lea, 1838 (USFS Mollusk Database 2004, Williams et al. 1993, Frest and Johannes 1995).

In the Walla Walla River Subbasin, little is known about the historical or current occurrence and abundance of freshwater mussels. Anecdotal information, however, suggests that *Anodonta* and *Margaritifera* are extant in the basin. However, we know of no historical or recent systematic surveys for freshwater mussels in the Walla Walla Subbasin.

Freshwater Mussel Life History

Freshwater mussels are unique among bivalves in that they require a host fish to complete their life cycle. Unlike male and female marine bivalves, which release sperm and eggs into the water column where fertilization takes place, fertilization of freshwater mussels takes place within the brood chambers of the female mussel. The female mussel carries the fertilized eggs in the gills until they develop into a parasitic stage called glochidia. Female mussels then release the glochidia into the water column where they must come into contact with a suitable host fish species. Once the glochidia are released they will survive for only a few days if they do not successfully attach to a host fish (O'Brien and Brim Box 1999, O'Brien and Williams 2002). Glochidia may attach to a non-host fish, but the glochidium will fail to encyst and will eventually be sloughed off. After successfully attaching to the host fish, glochidia metamorphose and drop to the substrate to become free-living juveniles (Jones 1950, Howard 1951). The time required for glochidial metamorphosis varies with water temperature and among mussel species.

The mussel/fish relationship is usually species-specific (Lefevre and Curtis 1912); only certain species of fish can serve as suitable hosts for a particular mussel species. The number of host fish utilized by a mussel species varies. Some mussel species have a very restricted number of host fish species (Watters 1994, Michaelson and Neves 1995) while other mussels parasitize a wide range of fish species (Watters 1994, Haag and Warren 1997). To increase their chances of coming into contact with a suitable host fish, some mussel species lure potential host fish by extending brightly colored portions of their mantles that mimic minnows, insects, or other prey (Coker et al. 1921, Kraemer 1970). In addition, some mussels release glochidia into the water column when light sensitive spots are stimulated by the shadow of a passing fish (Kraemer 1970, Jansen 1990). Other mussel species have evolved elaborate lures resembling fish food as mechanisms to attract specific host fishes (Haag et al. 1995, Hartfield and Butler 1997, O'Brien and Brim Box 1999). Knowledge of the reproductive biology of many mussels is incomplete (Jansen 1990), and the host fishes are known for only about a quarter of the mussel species in North America (Watters 1994).

The duration of the parasitic stage varies from about a week to several months (Fuller 1974, Oesch 1984, Williams et al. 1992), depending on mussel species and as a function of water temperature (higher temperatures causing shorter durations) (O'Brien and Brim Box 1999). After metamorphosis, juvenile mussels drop off from their host fish, and must fall to substrate suitable for their adult life requirements or they will not survive. Suitable substrates include those that are firm but yielding and stable (Fuller 1974). In general, shifting sands and suspended fine mud, clays and silt are considered harmful to both juvenile and mature mussels (Fuller 1974, Williams et al. 1992, Brim Box and Mossa 1999, Brim Box et al. 2002).

Mussels orient themselves on the bottom of a stream with their anterior ends buried in the substrate, usually with the two valves slightly open, which allows the intake of water through an incurrent siphon (and food and oxygen) while allowing waste materials to leave the body through an excurrent siphon (Oesch 1984). Food items include organic detritus, algae and diatoms (Coker et al. 1921, Matteson 1955, Fuller 1974). Increases in fine sediment, whether deposited or suspended, may impact mussels by interfering with feeding and/or respiration (Fuller 1974, Brim Box and Mossa 1999).

Although considered fairly sedentary, adult mussels may move in response to abnormal or transient ecological events. For example, water level fluctuations may cause some mussel species to seek deeper water (Coker et al. 1921, Oesch 1984). Often in late summer, mussel trails are visible as the water recedes. However, mussels colonize upstream areas mainly through the use of the parasitic glochidial life stage. Without this stage, freshwater mussel populations would, over generations, slowly shift downstream.

Freshwater Mussel Ecological Importance

The richest mollusk fauna in the world is found in North America north of Mexico, and is represented by about 600 species of gastropods and 340 species of bivalves. Freshwater mussels are also considered the most endangered faunal group in North America, with over 70% of species either imperiled or extinct (Neves et al. 1997). Extinction rates for freshwater mussels are an order of magnitude higher than expected background levels (Nott et al. 1995), and mussels are imperiled disproportionately relative to terrestrial species (e.g., birds and mammals) (Williams et al. 1993). Given that freshwater mussels are an endangered global resource, they are assigned tremendous ecological importance by many freshwater biologists (Corn 1994). Freshwater mussels are ecologically important because they are primary consumers, detritivores and act as nutrient sinks (McMahon and Bogan 2001). In addition, freshwater mussels filter and clarify large amounts of waters and therefore contribute to maintaining water clarity (McMahon and Bogan 2001). Freshwater mussels can also be important food items for fish, mink, otters and raccoon (Dillon, Jr. 2000).

Freshwater Mussel Historic Distribution and Abundance

Over 300 records of historical mussel occurrences in Oregon and Washington, dating back to 1838, were obtained from the US Forest Service Freshwater Mollusk Database. Accounts from the Columbia River drainage comprise over half of these records. These records from the Columbia Basin include seven of the eight species known to currently occur in the western United States: *Anodonta beringiana*, *Anodonta californiensis, Anodonta kennerlyi, Anodonta nuttalliana*, *Anodonta oregonensis, Gonidea angulata* and *Margaritifera falcata.* Two historical records for *Margaritifera falcata* were found from the Walla Walla River Subbasin.

A total of 81 historical records of freshwater mussels from the western United States (i.e., shell material reposited in museum collections) were found at the United States National Museum (Smithsonian Institution) and California Academy of Sciences. Over half of these records of freshwater mussels were from the Columbia River drainage. However, none was from the Walla Walla River Subbasin.

Although no museum records and only a few historical records for freshwater mussels were found from the Walla Walla River Subbasin, tribal elders who were interviewed remembered gathering mollusks at the mouth of the Walla Walla River.

Freshwater Mussel Current Distribution and Abundance

Little is know about the current distribution and abundance of freshwater mussels in the Walla Walla River Subbasin, mainly because systematic surveys for mussels have not been conducted in the basin. However, live *Margaritifera falacata* were recently found in the Little Walla Walla River just north of the Oregon/Washington state line, and *Anodonta* were found at the confluence of the Walla Walla River (D. Crabtree, pers. comm., 2003, USDA/Forest Service). There are no historical or current records of *Gonidea* from the subbasin. A systematic survey of the entire subbasin for freshwater mussels is needed in order to determine the current distribution of all three genera of western freshwater mussels in the Walla Walla River Subbasin.

Freshwater Mussel Cultural Significance to Tribes

Historically freshwater mussels were an important food for tribal peoples of the Columbia River Basin. Native Americans in the interior Columbia River Basin harvested freshwater mussels for at least 10,000 years (Lyman 1984). Ethnographic surveys of Columbia Basin tribes reported that Native Americans collected mussels in late summer and in late winter through early spring during salmon fishing (Spinden 1908, Ray 1933, Post 1938). A few tribal elders from the Columbia and Snake River basins recalled that mussels were collected whenever conditions of the rivers were favorable (Hunn 1990, Chatters 1995). Tribal harvesters collected mussels by hand. When wading was not possible they used forked sticks (Post 1938). They prepared mussels for consumption by baking, broiling, steaming, and drying (Spinden 1908, Post 1938). The Umatilla Tribe preferred to boil freshwater mussels for consumption (Ray 1942).

Native American use of freshwater mussels decreased during the last 200 years, probably due to declines in native populations and assimilation following Euro-American settlement (Chatters 1987). A Umatilla tribal elder, however, remembered his parents trading fish for dried mussels as late as the 1930s (Eli Quaempts, per. com., 1996, CTUIR tribal member). In addition, shell middens found at village sites near the mouth of the Umatilla River, as well as the presence of mussels at burial sites in the same area, suggest that historically freshwater mussels were important to the indigenous peoples of the mid-Columbia River Plateau for multiple reasons.