Volume III, Chapter 4
Eulachon

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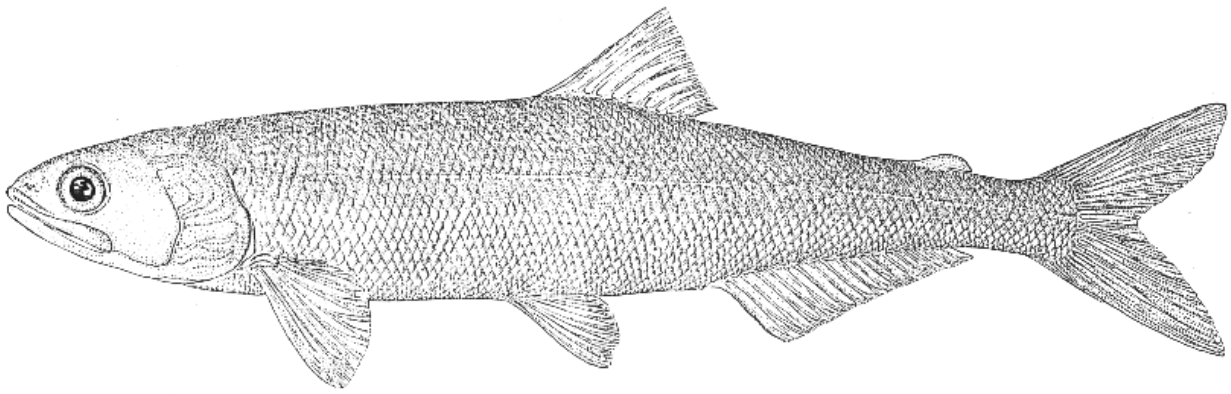

4.0 Eulachon (*Thaleichthys pacificus*)

Eulachon or smelt (*Thaleichthys pacificus*) are a small, anadromous forage fish inhabiting the Northeastern Pacific. Eulachon are a member of the family *Osmeridae*, which comprises several species including another anadromous smelt, the longfin smelt, *Spirinchus thaleichthys*. Eulachon differ from longfin smelt by having shorter pectoral fins (shorter than head length) and fewer gill rakers on the first arch (Wydoski and Whitney 1979). The name *Thaleichthys pacificus* is derived from the Greek words *thaleia* meaning rich, *ichthys* meaning fish, and *pacificus* meaning of the pacific (Hart 1973).

Eulachon fill a unique niche in the Northwest fishing community because of the timing of their runs and value as a food source. British Columbia tribal members even named the eulachon "salvation fish" because eulachon begin returning to rivers during bleak winter months providing sustenance until spring and summer. Eulachon were also called "candlefish" because of the high oil content of eulachon they could be dried and burned like candles (Scott and Crossman 1973).

Eulachon range geographically from Monterey Bay, California, to the Bering Sea and the Pribilof Islands. Eulachon spend most of their adult life in saltwater and little is known about this stage of life. The Columbia River is the site of the largest commercial eulachon fishery; other spawning locations are the Fraser and Nass Rivers in British Columbia. Approximately thirty rivers support eulachon runs in North America (Hay et al. 1997). Before the construction of Bonneville Dam in 1938, eulachon were reported as far upstream as Hood River, Oregon (Smith and Saalfeld 1955). Washington rivers outside of the Columbia River basin with known eulachon spawning runs include the Naselle, Nemah, Wynoochee, Bear, Quinault, Queets and Nooksack rivers (WDFW 2001).

In Washington and Oregon, eulachon support a commercial fishery in the lower Columbia River and tributary rivers: Grays, Cowlitz, Kalama, Lewis and Sandy. Commercial eulachon runs have been recorded in the Columbia River since 1894. Annual harvest in the Cowlitz River, a major tributary, has varied over time from no fish harvested to just over 3,000,000 pounds in 1976 (WDFW 2001).

Commercial production (harvest) of eulachon decreased considerably in the mid-1990s prompting Washington, Oregon, and British Columbia fishery managing agencies to reassess

their eulachon management framework and increase research activity (WDFW2001). Commercial eulachon harvest in the main-stem Columbia River was recorded as only 235 pounds in 1994, the smallest harvest since 1935 (Figure 4-1) (WDFW 2001). The decline in eulachon abundance from British Columbia to California has generated more eulachon research than 100 years of commercial fishing (Moffitt et al.2002). Reasons for the decline in eulachon numbers remain unknown, but have been attributed to changes in climate, ocean productivity, and increased bycatch in shrimp trawl commercial fisheries. In 1999–2001, the commercial harvest of eulachon has increased. Eulachon are anadromous and like salmon are susceptible to similar impacts during their spawning cycle. Logging, land development, dredging, predation, water quality and fishing can affect eulachon production and survival rates (WDFW 2001).

Sport harvest of eulachon takes place in tributaries of the lower Columbia River. There is some sport fishing in the mainstem of the Columbia, but the majority of sport fishing takes place in the Cowlitz River. Effort and harvest data are not collected on sport harvest of eulachon. The amount of sport harvest is considered similar to that of the commercial tributary catch (WDFW 2001).

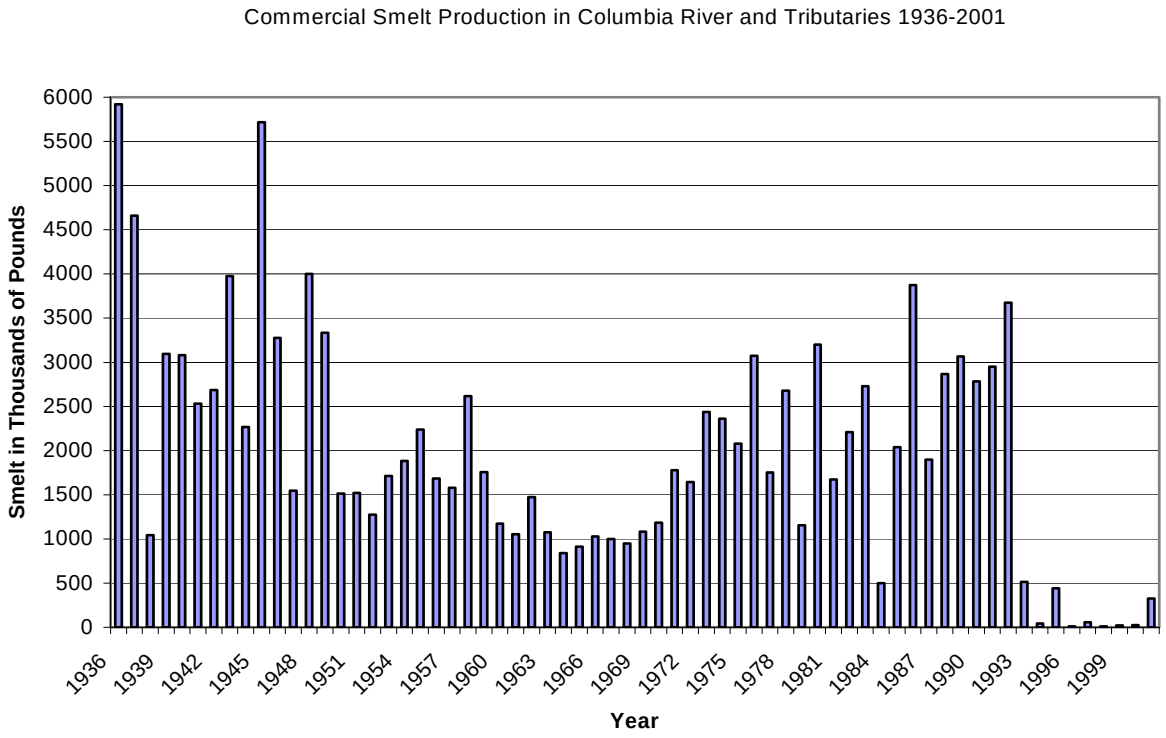

Figure 4-1. Eulachon commercial landings in the Columbia River and tributaries 1936–2001.

Figure 4-2. Eulachon distribution in lower Columbia River and tributaries.

4.1 Life History & Requirements

Eulachon are anadromous. They spawn and their eggs hatch in fresh water and grow to maturity in the sea where, as juveniles and adults, they feed mainly on euphasids, a small shrimp-like crustacean sometimes called krill.

As the spawning season approaches, eulachon gather in large schools off the mouths of their spawning streams and rivers. Males usually outnumber the females during the spawning migration. Researchers in a study of the Copper River Delta, Alaska, eulachon population found that between 1998–2002 males composed a mean of 68% of samples (Moffitt et al. 2002).

Eggs are broadcast over sandy gravel bottoms where they attach to sand particles. Newly hatched young are carried to the sea with the current. After three to four years at sea, they return as adults to spawn. After spawning, the majority of eulachon die.

Table 4-1. Annual timetable for eulachon presence in Columbia River and tributaries during individual life stages.

	Eulachon Presence in Columbia River System											
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Adult	X	X	X	X	X	X						X
Egg	X	X	X	X	X	X						
Larvae	X	X	X	X	X	X	X					

4.1.1 Spawning Conditions

Eulachon typically enter the Columbia River system from December to May with peak entry and spawning during February and March (WDFW 2001). Eulachon spawn in the main tributaries of the Columbia River and in the mainstem of the Columbia River. Water temperature plays an important role in upstream migration for spawning eulachon. Past studies have shown that the optimum water temperature for upstream migration is 40F (Smith and Saalfeld 1955). The colder the water, the longer the delay for spawning runs. Spawning eulachon enter Northern British Columbia Rivers in March through April or May (Garrison and Miller 1982).

4.1.2 Incubation

Eulachon spawn primarily at night. Eggs are shed, fertilized and abandoned. The average egg size is 1 mm. Each female deposits approximately 17,000 to 60,000 eggs, depending on size of female. (Morrow 1980) Fertilized eggs have an outer membrane, which separates from an inner cover and remains attached at a small area forming a short stalk or peduncle. This peduncle is adhesive and attaches to particles of coarse sand or other river substrate like pea-sized gravel or sticks (Smith and Saalfeld 1955). Eulachon eggs have been observed in water from 8 to 20 feet in depth. Water temperature influences the length of time to hatching. In temperatures of 6.5-9.0°C, eggs will hatch in about 22 days. At colder temperatures of 4.4-7.2°C, as found in the Cowlitz River, eulachon eggs will hatch in 30 to 40 days (Garrison and Miller 1982).

4.1.3 Larvae & Juveniles

Newly hatched larvae are transparent and 4-7 mm in length. They have poor swimming ability and migrate downstream at the mercy of river currents. Eulachon fry have been recorded to within 20 miles seaward of the Columbia River mouth. The result of several plankton hauls conducted in 1946 showed no fry had developed beyond yolk-sac stage; therefore, it is probable no feeding occurs in fresh water during outbound migration (Smith andSaalfeld 1955). After the yolksac is depleted eulachon will feed on pelagic plankton. Stomach samples of juvenile eulachon contained euphausiids (Barraclough 1964).

4.1.4 Adult

Eulachon spend the majority of life in salt water and little is known about this saltwater phase. Typically, eulachon return to spawn at 3-5 years of age. Recent studies indicate that age proportion of spawning eulachon can vary. In the Copper River Delta, Alaska, spawning eulachon ages varied as follows; in 1998, 89.4% were age 5; 9.5% age 4 and 0.3% age 3. In year 2000, 3.3% were age 5; 48.2% year 4; 48% age 3. In 2001, 1.3% were age 5; 42% age 4; 55% age 3 years. In 2002, 1.2% were age 5; 96.1% age 4; 1.4% age 3. Data for 1999 was not included due to insufficient sampling trials (Moffitt et al. 2002).

Otoliths have been collected from 1987–2000 runs in the Lower Columbia River and its tributaries. Only those otoliths from 1992–1998 have been examined and preliminary readings

indicate that Columbia River eulachon returns (1992–1998) comprised 26-66% age 3 fish, 28-49% age 4 fish and age 5 fish made up 5-25% of the run (WDFW2001) (Table 4-2).

Table 4-2. Age composition of Columbia River eulachon, 1992-98 (WDFW 2001)

	Age Composition			Average Length (mm) by Age		
Year	**3**	**4**	**5**	**3**	**4**	**5**
1992	26%	49%	25%	169.4	189.3	190.8
1993	39%	39%	22%	164.4	159.4	149
1994	66%	28%	6%	178.7	177.4	164.8
1995	41%	46%	13%	171.3	181	197.5
1996	56%	39%	5%	168.5	179.4	170.2
1997	60%	33%	7%	165.4	170.5	162.8
1998	56%	37%	7%	173.5	181.5	175.9
Average	*49%*	*39%*	*12%*	*170.2*	*176.9*	*173.0*

Eulachon feed on plankton in salt water, but stop feeding when returning to fresh water. The homing instinct of eulachon (returning to birth streams) has not been established. Eulachon larvae are flushed out to sea shortly after hatching leaving little time for imprinting (Moffitt et al.2002). Returns to tributary rivers can vary from year to year, with some rivers having no return run of eulachon. Most, but not all, eulachon die after spawning. A few live spent adult eulachon have been observed downstream of spawning locations (Garrison and Miller1982). Whether this indicates long-term survival following spawning is unknown.

Adult eulachon are 15 to 20 cm long with a maximum recorded length of 30 cm. They are a brown to dark bluish color on the back, fading to silvery white on the belly. Males are slightly longer and heavier then females (Morrow 1980). The sex ratio of spawning adults is an average of 4.5 males to 1 female in the Columbia River and tributaries supporting eulachon. The male to female ratio has been recorded as high as 10.5 males to 1 female in the Cowlitz River (Smith and Saalfeld 1955).

Eulachon rear in near-shore marine areas from shallow to moderate depths. At sea juvenile eulachon may grow from 23 mm to lengths of 46-51 mm within eight months (Barraclough 1964). Eulachon will move into deeper water, up to depths of 625 m, as they grow (Allen and Smith 1988). Eulachon are an important link in the food chain between zooplankton and larger organisms. Small salmon, lingcod and other fish feed on small larvae near river mouths. As eulachon mature they are eaten by many predators including; halibut, cod, dogfish, sharks, seals, sea lions, porpoise, finback whales, killer whales, gulls, ducks and other sea birds (Garrison and Miller1982). Their value to the marine system is due to their high energy fat content and large biomass. Eulachon are high in oil (total lipid), ranging from 16.8% to 21.4% (Payne et al. 1999).

4.1.5 Movements in Fresh Water

Movements in freshwater are restricted to anadromous spawning cycles. Adult eulachon enter freshwater to spawn from December to March and the young migrate downstream shortly after hatching.

A study of larval distribution in the lower Columbia River found that eulachon larval density was greater in the lower portion of the water column (Howell et al. 2002). Larval densities in bottom samples were greater then densities in mid-water and surface samples. Mechanisms controlling eulachon larval distribution are not clearly understood. Plankton net

sampling was concentrated in the Columbia River downstream of the Cowlitz River with one sampling location above the confluence of the Cowlitz and Columbia Rivers. Larval density varied throughout the season, but larval numbers peaked between April 2 and April 18. (Howell et al. 2002). The purpose of the study was to evaluate potential effects of proposed channel-deepening operations in the Columbia River. (More on this study will be covered under 4.4 Factors Affecting Population Status)

An associated study by the same group (Romano et al.2002) found that in 2001 eulachon spawning habitat within the Columbia River was larger then previously assumed by earlier studies (Smith and Saalfeld 1955). Eulachon larvae were found between Price Island and the mouth of the Kalama River (Howell et al. 2002). Previous larval distribution studies did not find any eulachon larval above the Cowlitz River (Smith and Saalfeld 1955).

During the 2001 study, adult eulachon migrated upstream to the Bonneville Dam and entered all major lower Columbia River tributaries (Grays, Elochoman, Kalama, Lewis and Sandy). Observations by researchers conclude that the strength of a eulachon spawning run varies throughout the course of a single season (Howell 2002).

4.1.6 Ocean Migration

Information about eulachon ocean migration is minimal. The current data about eulachon marine habits comes from information gathered from the Canadian shrimp trawl fisheries. Eulachon are commonly caught as bycatch in marine shrimp trawl fisheries. Harvest and mortality rates due to handling are unknown. In the British Columbia shrimp trawl fisheries, the eulachon bycatch has been estimated as high as 27% of the biomass caught (Hay et al.1999).

In a study measuring the Southern British Columbia offshore biomass, there was a strong positive correlation (r^2=0.34,P<0.01) between the offshore biomass and Columbia River eulachon catches. This study surmises that it seems probable most eulachon captured offshore of Vancouver Island spawn in the Columbia River (Hay et al.1999).

4.2 Population Identification & Distribution

Although eulachon are found throughout the northeast Pacific Ocean, genetic relationships among populations are unclear. Eulachon predecessors are believed to have survived through historical glacial changes in North America. Over the past two million years (Pleistocene Epoch) most of North America was covered with ice that advanced and retreated over the land through cycles of cooling and warming (McPhail and Lindsey 1970).

Freshwater fish were strongly affected by advancing glaciers. Species either became extinct or moved into ice-free glacial refugia. Anadromous fish, like eulachon, which require fresh water to spawn, would also have used the ice-free refuge areas as habitat in the cool climate (McPhail and Lindsey1970). The most recent cold period in North America was the Wisconsinian glacial period. Evidence from mtDNA suggests that populations of eulachon are derived from a single Wisconsinian glacial refuge, during the Pleistocene Epoch. While many private mtDNA haplophytes were found, over 97% of the total variation was found within populations. Mclean et al's analysis of eulachon mtDNA suggests that there is little genetic difference among eulachon from distinct freshwater locations and that eulachon might be considered as one meta-population.

Eulachon is the only member of the genus *Thaleichthys*. There are no other species or subspecies having a different life history.

4.3 Status & Abundance Trends

Eulachon are listed as a state candidate species on WDFW's SOC list. According to WDFW Policy M-6001, a species will be considered for designation as a state candidate if sufficient evidence suggests that its status may meet the listing criteria defined for state endangered, threatened, or sensitive.

In 1999, the NMFS received a petition to list the Columbia River populations of eulachon as an endangered or threatened species and to designate critical habitat under the ESA. The NMFS determined the petition did not present enough substantial evidence to warrant the listing of eulachon. (Fed Reg 64(226)).

4.3.1 Abundance

No quantitative stock assessment of eulachon is conducted. The best available long-term data on Columbia River eulachon returns are historical commercial landings in the Columbia River and its tributaries. Unfortunately, commercial landings are a poor index of eulachon run size because the economic market can dictate the harvest amount. Commercial fishing may cease or slow down once the market has been saturated and prices of eulachon decreased (WDFW 2001).

In 1994, WDFW initiated eulachon larval sampling in the Cowlitz River and other lower Columbia River tributaries. The long-term objective is to develop a relational index of eulachon production in the lower Columbia basin that can be used to assess annual variation in spawning and recruitment. Larval sampling conducted from 1994 through the present (2003) still needs further evaluation through a broad range of run sizes before being used as an assessment tool (WDFW 2001).

4.3.2 Productivity

Currently, there is no accurate measurement of eulachon productivity. Researchers believe eulachon abundance is influenced by ocean productivity within the first year at sea. Developing reliable eulachon forecasting techniques may included examining ocean productivity indices such as Southern Oscillation Index, sea surface temperature profiles and Oyster Condition Index. Another useful relationship to investigate for evidence of eulachon productivity is the survival of other anadromous species with a 3-year spawning cycle (WDFW 2001).

4.3.3 Supplementation

There are no supplemental hatchery programs for eulachon in the Columbia River or its tributaries. Experimental artificial propagation of eulachon has been conducted to observe the influences and water temperature and substrate on eggs and larval development (Howell et al 2002; Smith and Saalfeld 1955).

4.3.4 Harvest

The harvest of eulachon in the Columbia River mainstem is regulated by Washington and Oregon within the guidelines of the Columbia River Compact. The states must mutually approve the fishing regulations for eulachon. Sport and commercial fishing in the Columbia River tributaries is regulated by the individual states.

4.3.5 Commercial Fishery

Washington commercial anglers are required to have a Columbia River smelt license to fish commercially for eulachon (RCW 77.65.200 (1)(g)). Oregon does not require a separate

smelt license, but anglers must have a commercial fishing license and commercial fishing boat license (WDFW 2001).

Columbia River-caught eulachon are sold for bait in the sport sturgeon fisheries and also as a fresh food fish. Eulachon fishing in the Columbia River drops off after the fish have entered the Cowlitz River and other tributaries. Typical commercial fishing gear used are the 2-inch bobber gill nets and, not as commonly, diver gill nets and otter trawl. Trawl vessels greater than 32 feet are prohibited upstream from Tongue Point. Commercial eulachon fishing is limited to dip nets in the tributaries (WDFW 2001).

4.3.6 Sport Fishery

The majority of sport fishing for eulachon takes place in the tributaries using dip net gear, although the mainstem is also open for sport fishing. In general, both states manage the tributary fisheries consistent with the mainstem fisheries (WDFW 2001). Most sport harvest is in the Cowlitz River. Neither Washington nor Oregon requires an angling license for eulachon. There are restrictions on gear. In Washington the size of the dip net bag frame must not exceed 36 in (WAC 220-16-028). Oregon has no bag frame restriction. Washington's 2003 sport regulations allowed a maximum daily bag limit of 20 pounds from February 12–March 31, up from the standard 10-pound bag limit early in the year. Oregon's eulachon sport fishing regulations for 2003 allowed a 25-pound limit per day (WDFW 2001).

4.3.7 Tribal Fishery

Native Americans have fished for eulachon in the Columbia River tributaries for centuries. At present, members of the Yakama Nation fish for eulachon for subsistence purposes in the lower Cowlitz River using dip net gear. The annual catch of eulachon by Yakama tribal members is minimal (WDFW 2001).

4.4 Factors Affecting Population Status

4.4.1 Water Development

Hydropower development on the Columbia River has decreased the available spawning habitat for eulachon. Prior to the completion of Bonneville Dam, eulachon were reported as far upstream as Hood River, Oregon (Smith and Saalfeld 1955). Similar developments on tributary rivers, like the Cowlitz, also may have decreased spawning habitat.

4.4.2 In-Channel Habitat Conditions

Eulachon freshwater spawning habitat can be affected by in-channel conditions. Eulachon are broadcast spawners with highly adhesive eggs that attach to coarse sandy substrates. Dredging has the potential to impact adult and juvenile eulachon (Larson and Moehl 1990). In a 2001 study, researchers found that the sand wave movements in near-shore areas of dredging operations in the lower Columbia River made the substrate too unstable for the incubation of eulachon eggs. Recommendations presented suggested that channel-deepening operations be scheduled to avoid eulachon spawning areas during peak spawning times (Romano et al. 2002). The same recommendations have been echoed in the Washington and Oregon Eulachon Management Plan concerning dredging activities in tributaries to the Columbia River. The plan also recommended further investigation into the theory that the development by the Corps of the Sediment Retention Structure on the Toutle River may have caused poor eulachon returns in the Cowlitz River during 1994–99 (WDFW 2001).

4.4.3 Water Quality

Information concerning the effects of contaminants on eulachon remains minimal. Eulachon have been shown to be sensitive to pollutants in fresh water (Smith and Saalfeld 1955). There also is some evidence that, because of their high lipid content, eulachon may be susceptible to accumulating contaminants during spawning runs. But, this last idea has been refuted based on the fact that eulachon do not spend much time in fresh water either as adults or juveniles (WDFW 2001).

4.4.4 Species Interactions

Predators and scavengers accompany large runs of eulachon as they enter the rivers to spawn. The sight of many birds fishing for eulachon is not uncommon on tributary rivers. Avian predators include bald eagles, mergansers, cormorants and eight species of gulls (WDFW 2001). Eulachon have a high energy density from being extremely high in lipids. Eulachon oil is also comparatively high in vitamin A and iron. The effort exerted by predators to capture eulachon is relatively low because eulachon are weak swimmers and concentrate in low-velocity waters. This combination of attributes makes eulachon an energy efficient meal for predators and scavengers (Marston et al. 2002).

The California sea lion, Northern sea lion, Harbor seal, Harbor porpoise, and Dall's porpoise also prey on Lower Columbia River eulachon. In a study of gastrointestinal contents of stranded marine mammals in the Columbia River estuary, eulachon made up 43.8% (by occurrence) in California sea lions and 40% (by occurrence) in the stomach contents of Harbor seals. By comparison, Pacific herring (*Clupea pallasi*) composed 12.5% and 14% stomach contents by occurrence, respectively (Jeffries 1984).

A white sturgeon (*Acipenser transmontanus*) feeding study in the lower Columbia River resulted in the following information regarding predation on eulachon eggs. Two size classes of white sturgeon from two separate river locations were examined for the feeding study. Size class I measured 5.6-13.7 in (144-350 mm) FL (fork length) and size class II measured 13.7-28.5 in (351-724 mm) FL. Stomach content samples were taken from sturgeon at RM 95 (RKm 153) (Woodland) and RM 131 (RKm 211) (Skamania). Summary numbers represent percentage of total Index of Relative Importance (%IRI) during May–June 1988.

Table 4-3. Percent of total index of relative importance for eulachon eggs observed in white sturgeon stomach samples (McCabe et al. 1993).

Location	Size I (144-350mm)	Size II (351-724mm)
Woodland	2%	12%
Skamania	25%	51%

4.4.5 Ocean & Estuary Condition

Juvenile and adult eulachon spend most of their life at sea; it is unknown for what portion of their lives or how long juveniles stay in estuaries before migrating further seaward. Information about the impacts ocean and estuary conditions have on eulachon remains limited. Larval sampling has mainly taken place in fresh water. It is believed that young larvae in estuaries and near-shore ocean areas are sensitive to marine pollution and runoff from agriculture and urbanization. If conditions in a river are not right, eulachon may choose a different stream for spawning or return another year (PSMFC 1996).

4.5 Inventory & Assessment of Existing Management Plans

4.5.1 Washington & Oregon

Washington and Oregon jointly regulate commercial and sport eulachon fishing in the mainstem of the Columbia River. Recreational and commercial fishing in the Columbia River tributaries are managed by the individual states. To meet management needs, each state regulates the tributary fisheries consistent with the mainstem fisheries (WDFW 2001).

The Joint State Eulachon Management Plan, developed in 2001, is intended to guide eulachon fishing regulations in the Columbia River basin. The function of the management plan is to provide for three levels of fishing based on:

- parental run strength as indexed by commercial and sport fisheries data,
- juvenile production as indexed by larval sampling data, and
- estimates of ocean productivity as indexed by environmental measures and the abundance of other fish species.

These fishing regulations would be in effect through the January to March timeline. Any adopted fishing level may be modified in-season based on data collected from sport or commercial fisheries (WDFW 2001).

Level one fisheries are the most conservative level with a presumed harvest rate of 10% or less based on indications of a poor run or uncertainty of run strength. Under the level one fisheries commercial and sport fishing would be limited to one 12–24 hour fishing period per week for the Columbia and Cowlitz Rivers. The purpose of the level one fisheries is to develop a fishery database and collect information of the variability of eulachon runs while minimizing the risk of overexploiting the run.

Level two fisheries are recommended when fishery data indicates a promising abundance in spawning return, yet it is unknown whether the run is moderate or strong. Commercial and sport fishing would be open two to three days per week in the Columbia and Cowlitz Rivers. Depending on the level of abundance in these rivers, consideration would be given to opening commercial and sport fishing in other tributaries of the Lower Columbia River. Fishery monitoring data would be used to decide if an increase to level three or a decrease to level one is warranted (WDFW 2001).

Level three fisheries are recommended when there are very positive indicators of strong abundance and productivity and a very low risk of overexploitation. Commercial fishing would be open up to four days a week in the Columbia River and all tributaries. Sport fishing would be open in all tributaries four to seven days a week. Daily bag limits could be increased from 10 pounds per person to 15 to 25 pounds per person under the level three fisheries plan (WDFW 2001). In the current fishing year (2003) eulachon fishing in the Columbia River and tributaries

was set at the level three fisheries. The daily limit was increased to 20 pounds per person and fishing was open 7 days a week through March 31, 2003 (WDFW News Release).

The conservation policy guidelines for the Washington and Oregon Eulachon Management Plan incorporates the following; use of a precautionary approach to resource management, maintain healthy populations of eulachon while assuring the integrity of the ecosystem and habitat, and to consider best scientific information while striving to improve the information base of eulachon (WDFW 2001).

4.5.2 Yakama Nation

Management plans for a tribal subsistence fishery for eulachon on the Cowlitz River and other Washington tributaries is being coordinated annually between members of the Yakama Nation and WDFW. The annual plan specifies that smelt taken by Yakama Nation members will be used for subsistence purposes only and may not be sold commercially. The parties will consult to determine the appropriate levels of subsistence fishing based on abundance and conservation needs (WDFW 2001).

4.5.3 British Columbia Eulachon Fishery

The Department of Fisheries and Oceans of Canada (DFO) has the Pacific Region Eulachon Integrated Fisheries Management Plan (IFMP) as a tool for regulating eulachon fisheries in British Columbia. Information to be considered in the management of Columbia River eulachon is that the IFMP includes an annual offshore index of eulachon biomass on the West Coast of Vancouver Island. These juvenile eulachon are believed to be both Fraser and Columbia River stock (DFO 2002).

4.6 Inventory & Assessment of Existing Restoration & Conservation Plans

The Washington and Oregon Eulachon Management Plan makes these recommendations for further conservation and research into Columbia River eulachon runs.

- Initiation of an observer program to determine eulachon bycatch in Washington and Oregon marine trawl shrimp fisheries.
- Consistent implementation of fishery monitoring and larval sampling activities to assess eulachon abundance and productivity.
- Evaluate and utilize abundance forecasting techniques. Abundance of other anadromous species and forage fish may provide insight into eulachon abundance.
- Define and characterize the critical habitats of eulachon, specifically understanding spawning areas and physical factors that affect freshwater survival.
- Establish one or more spawning sanctuaries on the Cowlitz River, which is the largest spawning tributary in the Lower Columbia River.

4.7 References

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