THERMAL POLLUTION OF COLUMBIA RIVER MIGHT THREATEN SMELT

George R. Snyder

The smelt, or eulachon (Thaleichthys pacificus), fishery of the Columbia River and its tributaries is unique. The fish are caught commercially in the mainstem with gill nets, but commercial and sport fishermen are allowed to use dip nets in the tributaries.

Smelt are an accessible item for the winter dinner table. They are relatively easy to capture in the tributaries, and the commercial harvest provides a timely income. The 1968-69 harvest (1,120,000 pounds) was worth more than $280,000; the economic value of the sport fishery was estimated at $570,000. The 1969-70 winter season was estimated to have equalled or exceeded the 1968-69 catch.

Most smelt enter the Columbia River in late November or early December, when the river temperature averages 45° F. If the temperature varies above or below normal, schools act erratically: They are delayed, migrate farther upstream, or simply fail to enter their spawning tributaries.

The Columbia River smelt is anadromous. The adults spawn in fresh water but spend most of their life cycle in salt water. The major tributary spawning occurs in the Cowlitz River, but runs have been observed in the Lewis and Kalama Rivers (see figure 1). In past years, smelt were common in the Sandy River and migrated as far upstream as Cascade Locks in the Columbia River. The distribution of schools of smelt in the Columbia River is not well known; some are found between Puget Island and Vancouver. Schools enter tributary streams to spawn, but some remain in the mainstem. The 1969 season was a cold-water year, so the Cowlitz River run was delayed. The 1970 season was another atypical year in the Cowlitz. The run was delayed, but extensive runs ascended the Lewis River during April.

Apparently the males move into the tributaries first. Smelt spawn at 3 to 4 years, and most die soon after. Spawning occurs primarily at night.

Deposit Demersal Eggs

Female smelt deposit demersal eggs: eggs that sink slowly toward bottom. A female of average size produces about 25,000; the range possibly is 7,000 to 60,000 eggs.

The eggs are adhesive and surrounded by double membranes. As the egg settles and touches an object, the outer membrane ruptures and attaches to the substrate--usually to sand grains or debris. The inner membrane contains the embryo.

The eggs are not attended by the adults. Development takes about 3 weeks at 47° F.--from time of deposition to hatching of fry. The fry emerge from egg "shell" with yolk sac attached. They are about 4 millimeters long (6 fry placed end on end would measure one inch). The fry are weak swimmers and must leave fresh water and enter salt or brackish water soon after hatching. They are swept along with river current. Sensitive to light, they stay near bottom during downstream migration to the ocean.

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Article is updated version of one that appeared in 'Oregon Sportsman' in July 1969. With permission of magazine.

COMMERCIAL FISHERIES REVIEW
Reprint No. 899

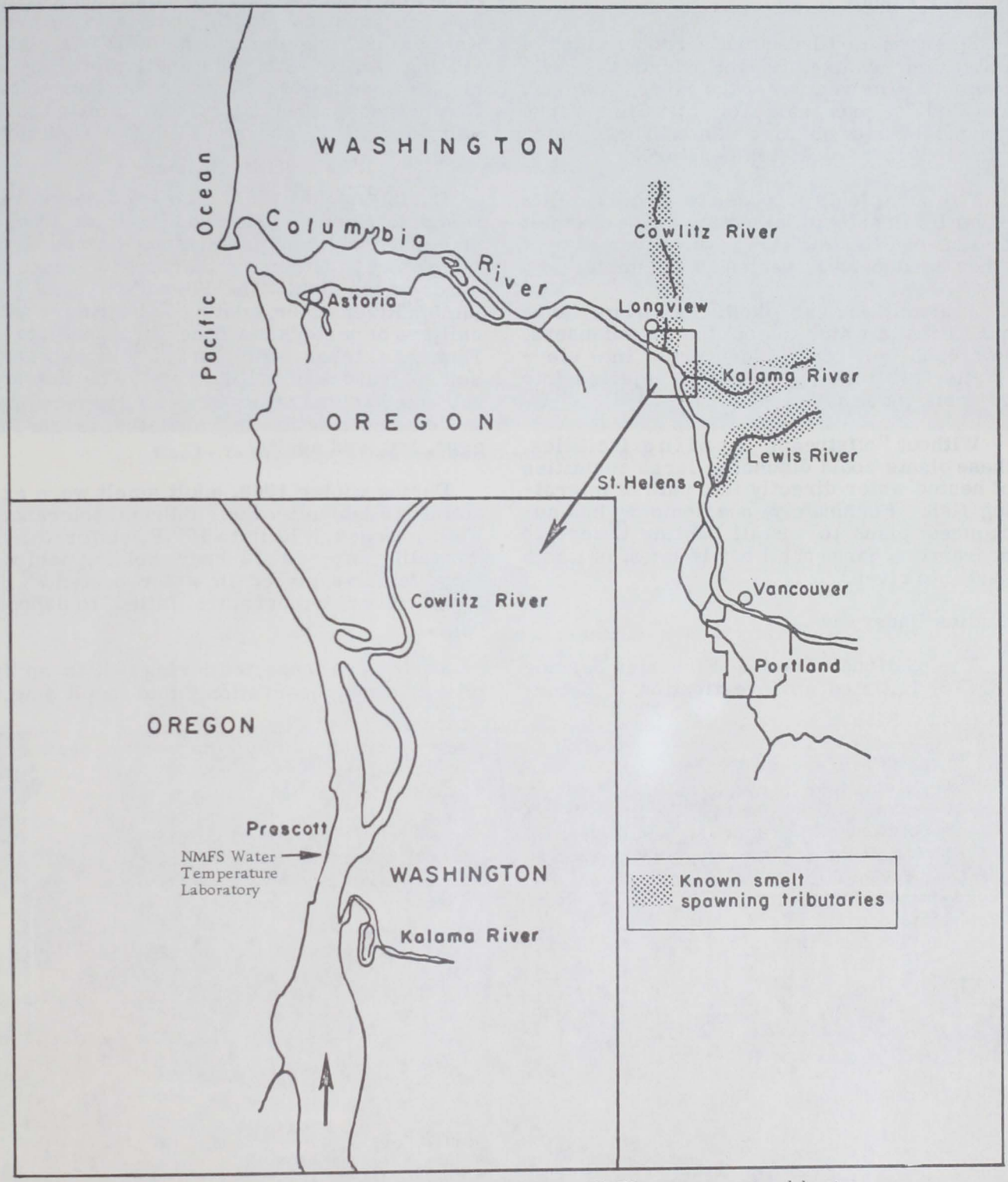

Fig. 1 - Location of smelt spawning areas in relation to NMFS water temperature laboratory.

Nuclear Plants

Smelt seem to require narrow ranges of water temperature. Recent industrial development in this section of the river, however, has led to proposals for installing large thermal nuclear electric plants. These plants can alter local river temperatures.

Two such plants proposed for above Cowlitz River lie directly in migration route of smelt that ascend Kalama and Lewis River and of other anadromous species in Columbia.

Thermal nuclear plants require large quantities of water to cool their condensers. For each unit of heat converted into electricity, two units of heat are ejected into adjacent waterways.

Without "offstream" cooling facilities, these plants could discharge large quantities of heated water directly into path of migrating fish. Fortunately, one company has announced plans to install cooling towers to prevent discharge of all but 15 c.f.s. of waste heat into river.

Studies Underway

The National Marine Fisheries Service (NMFS) initiated an investigation to determine what effect temperature increases would have on aquatic animals and plants between Kalama and Longview, Wash. NMFS is cooperating closely with State and Federal agencies to investigate effects of thermal pollution on anadromous fish such as salmon, trout, sturgeon, shad, and smelt in the Columbia River.

During August 1967, a covered barge was towed to Carter's Marina, Prescott, Oreg., and converted to a modern aquatic research laboratory to determine thermal tolerance of anadromous fish. The laboratory uses Columbia River water, cooling or heating it with chillers or heaters in a once-through system. Fish are taken with purse seines, beach seines, trawl nets, and dip nets. The fish are subjected to increases in water temperature to determine lethal and sublethal levels for eggs, fry, and adults.

During winter 1968, adult smelt were examined to determine their thermal tolerance. Fish exposed 1 hour to 16° F. suffered 50% mortality after a 32-hour holding period. Most females placed in water heated 7° F. above river temperature failed to deposit eggs.

Tests were conducted during 1969 to verify preliminary observations that adult smelt

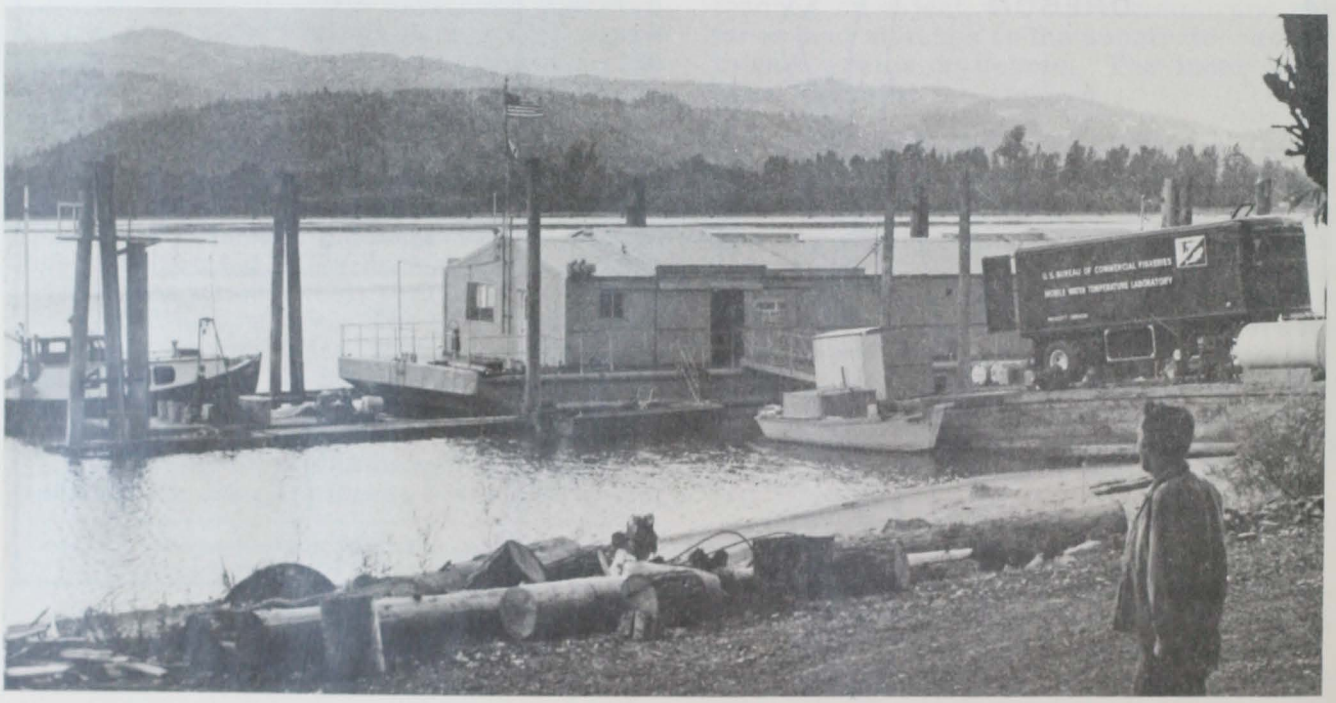

Fig. 2 - NMFS Water Temperature Laboratory on Columbia River--$\frac{1}{4}$ mile below proposed Trojan thermalnuclear electric plant site. (Photo: Robert K. Brigham)

Fig. 3 - Technicians collecting smelt from Cowlitz River with dip net for experimentation.

Fig. 4 - Adult smelt being captured with short-handled dip net when major run is in river.

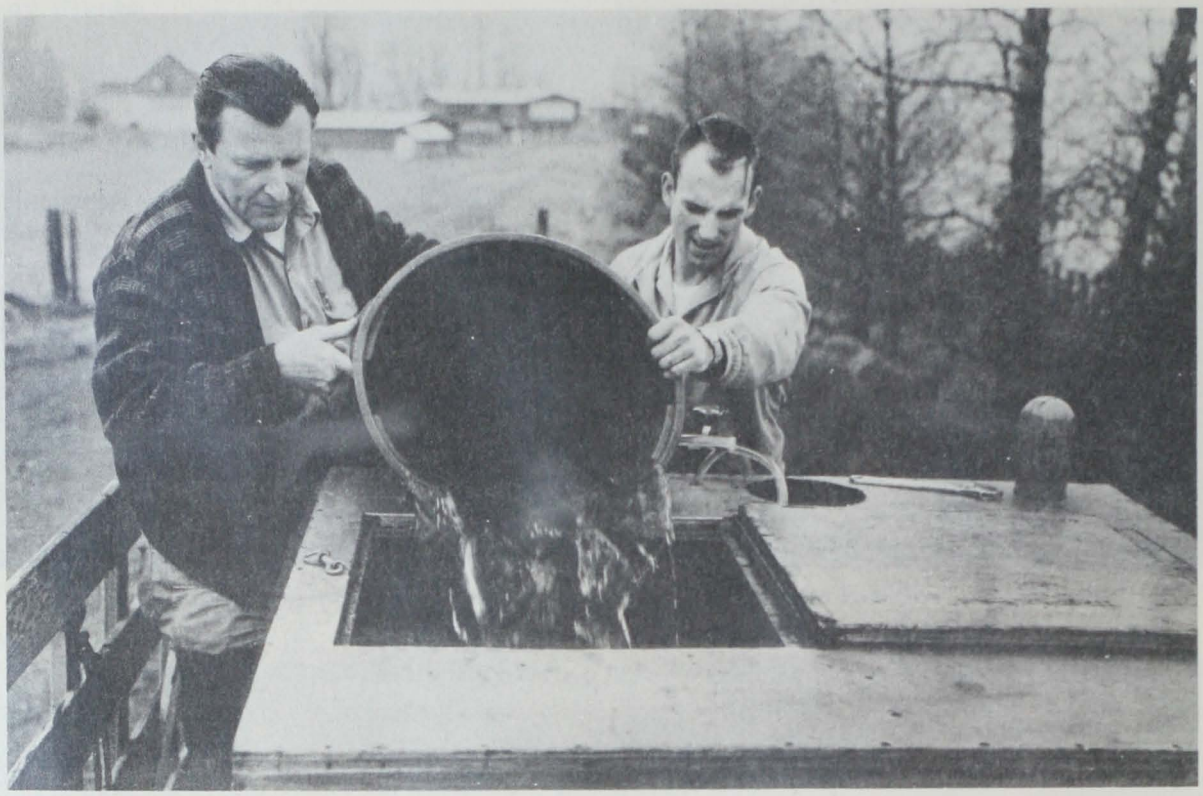

Fig. 5 - Transferring smelt from Cowlitz River to transportation tank; oxygen is provided to insure maximum survival.

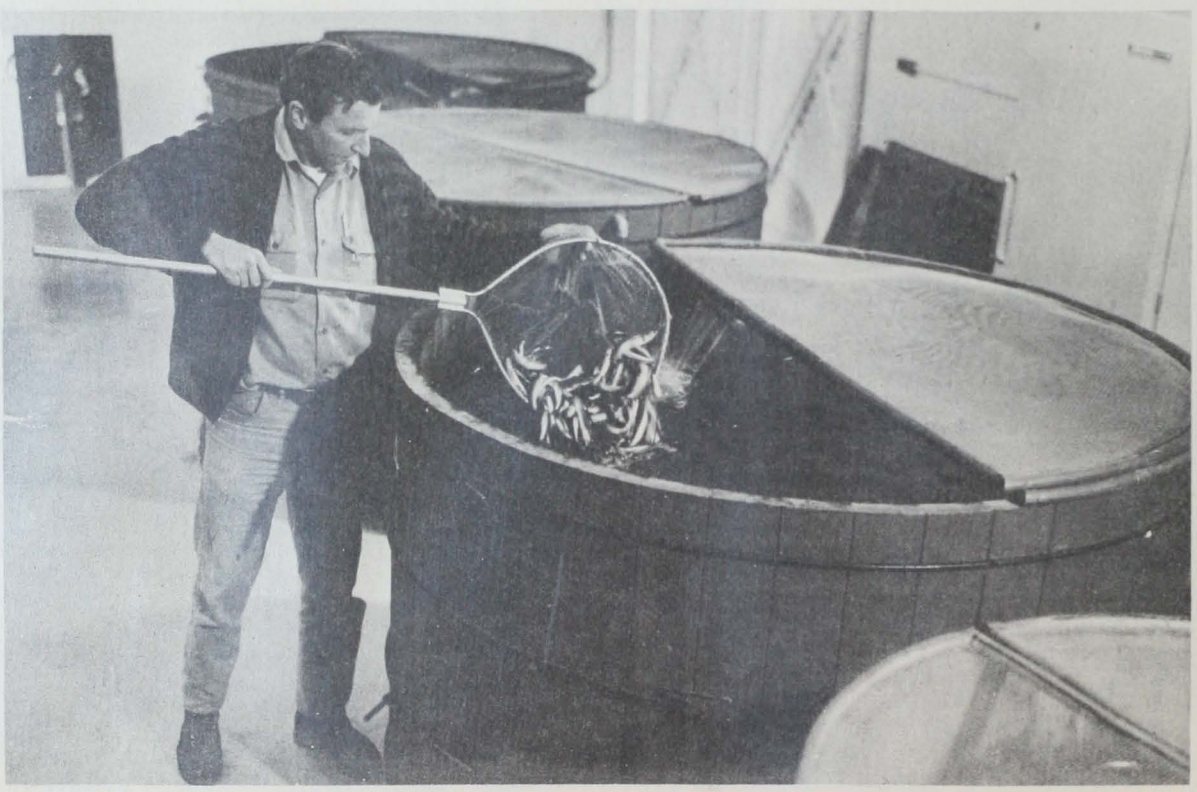

Fig. 6 - Placing smelt in holding tanks on floating lab for several days before testing.

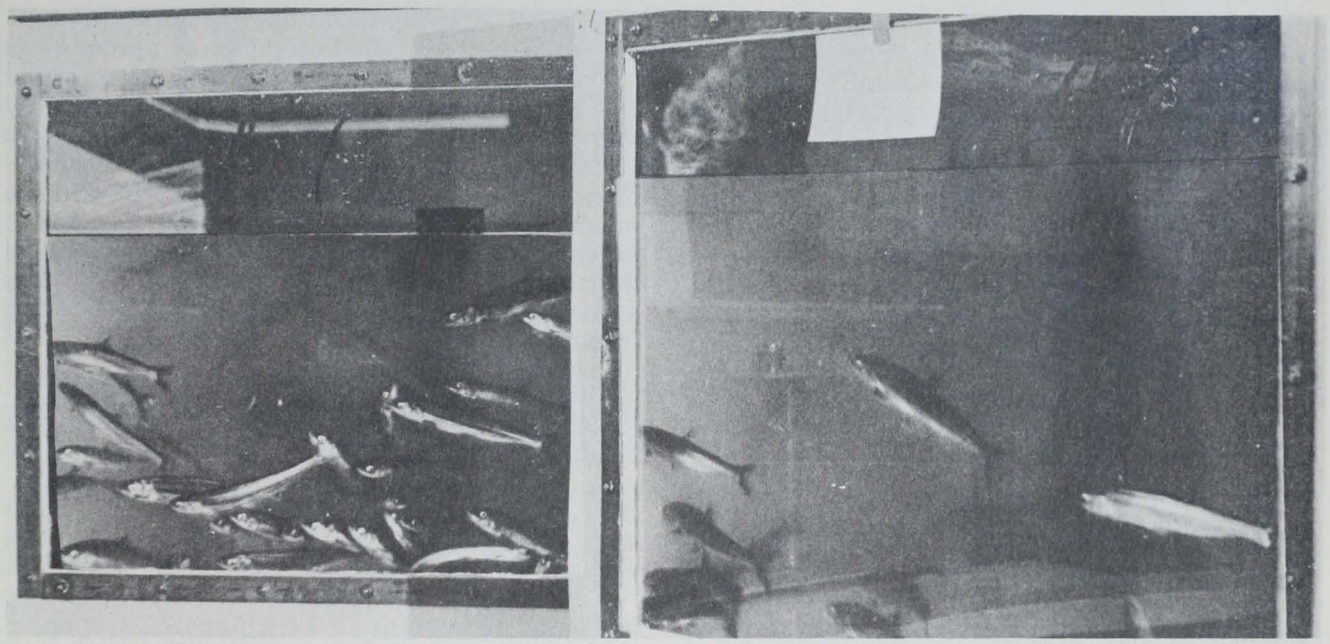

Fig. 7 - Adult smelt subjected to increases in water temperature in 50-gallon test tanks. Each tank contains similar number of fish; the water in tank on right was 1° C. warmer than in tank on left.

Fig. 8 - Biological technician checks tanks periodically to assess effects of increasing temperatures on smelt.

are intolerant to temperature increases. The first fish were taken from mainstem of Columbia River by commercial fishermen cooperating with Washington Department of Fisheries.

More fish were obtained from Cowlitz River by laboratory staff. Fish were dip netted from a boat and on the beach. They were transported by tank trucks to Prescott and placed in tanks aboard floating lab. (They were first transferred to holding tanks to determine handling mortalities and placed in test tanks with heated water.)

Temperature-Tolerance Studies

The general results of temperature tolerance studies verified earlier results: adult smelt are sensitive to temperature increases. Increases of 10° F. killed all test fish in 8 days. Temperature increases of 5° F. killed 50% in same time period. Higher temperatures killed fish in shorter period. Studies of smelt eggs showed these more resistant to temperature increases than the adults. Again in 1969, adult fish were reluctant to deposit eggs after subjection to increased temperatures.

Smelt populations could face serious problems if thermal nuclear plants are allowed to discharge heated water into river. The problems could be compounded if water-temperature regulations and standards for Columbia are based on tolerance limits of steelhead trout and salmon, the most valuable anadromous fish. The most favorable temperatures for salmon and trout range from 42 to about 60° F. The thermal electric power industry states that more heat could be allowed into Columbia during winter; also, that this increase, theoretically, could benefit salmon production during near-freezing temperatures. However, our present knowledge of thermal tolerance levels for smelt indicates some temperature increases could be detrimental.

Water-temperature standards for the Columbia River--recommended by Washington State--allows addition of more heat into the river at lower temperatures than during summer. Oregon standards for Columbia allow only increases of 2° F. at any time, not to exceed 68° F. Water-temperature standards for interstate waters should be consistent and designed to protect all commercial and sport fish.

Industrialization & Smelt's Fate

Many experts predicted that severe winter temperatures during December and January, 1968-1969, would keep smelt from entering Cowlitz River to spawn. The smelt did enter the river--but they were 5 weeks late. If colder water produces erratic and nonpredictable smelt runs, would warmer water produce similar situation? The fate of smelt runs in lower Columbia River may be determined by increasing industrialization.