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**Coastal Zone and Estuarine Studies Div.**  
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National Marine Fisheries Service  
Northwest Fisheries Science Center  
Coastal Zone and Estuarine Studies Division  
2725 Montlake Blvd. E.  
Seattle WA 98112

**U.S. DEPARTMENT OF COMMERCE**  
Ronald H. Brown, Secretary

**National Oceanic and Atmospheric Administration**  
John A. Knauss, Administrator

**National Marine Fisheries Service**  
William Fox, Jr., Assistant Administrator for Fisheries

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### Effects of Fluoride on Fish Passage

The upstream migration of adult spring chinook salmon in the Columbia River has been subject to unusually long delays at John Day Dam. During the spring migration period, average passage times for radio-tagged salmonids at John Day Dam were 158 and 156 hours in 1979 and 1980, respectively. In contrast, average passage time at Bonneville Dam was less than 48 hours and at The Dalles Dam it was less than 24 hours. In addition, passage times for salmonids in the fall of 1982 were twice as long at John Day Dam as they were at The Dalles and McNary Dams. The delay of nearly 1 week at John Day Dam appeared to contribute to increased mortality and may have affected the spawning success of migrating adult salmonids.

Migratory delays at John Day Dam were not decreased appreciably by changes in fishway entrance locations, water discharge volumes or configurations, or turbine operating conditions. The lack of response by migrating salmonids to flow alterations below the dam focused attention on the possibility that something in the water might be causing fish to avoid the fishways and delay their passage.

In 1982, preliminary studies conducted by CZES Division personnel assessed the distributions of many pollutants near John Day Dam. The results of this investigation suggested that the fish-passage delays might be related to contaminants discharged at an aluminum smelter outfall located on the Washington shore 1.6 km upstream from John Day Dam. In particular, high concentrations of fluoride in the vicinity of John Day Dam (0.3-0.5 mg/L in 1982) prompted investigators to focus sampling and research efforts on this contaminant.

In 1983 and 1984, behavior tests were conducted in which over 600 returning salmonids (chinook, coho, and chum, *O. keta*, salmon) were captured and tested with different concentrations of fluoride in a two-choice flume located in the spawning channel of Big Beef Creek, Washington. The conclusion from these experiments was that the behavior of upstream-migrating adult salmon would be adversely affected by fluoride concentrations of about 0.5 mg/L and that concentrations of 0.2 mg F/L were at or below the threshold for fluoride sensitivity of chinook and coho salmon.

Beginning in 1983 and continuing through 1986, fluoride discharges from the aluminum plant were greatly reduced. This was initially due to modifications in the plant's pollution-discharge system. However, it was also during this period that the Washington Department of Ecology (WDOE) took an active interest in the results of the CZES Division's water quality and behavior tests. The WDOE lowered significantly the discharge limitations for a number of contaminants, including fluoride, in the aluminum

plant's wastewater discharge permit. With the reduction in fluoride discharged from the aluminum plant, there was a corresponding drop in fluoride concentrations in the river near the outfall and John Day Dam. Concurrently, fish passage delays and interdam losses of adult salmon decreased to acceptable levels.

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