SUPERSATURATION

Columbia River water supersaturated by nitrogen was recognized as a problem to anadromous fish in 1965 when levels as high as 125% of saturation were recorded. A comprehensive study (Ebel 1969) of dissolved gas levels done in 1966-1967 throughout the Columbia River from Grand Coulee Dam to the estuary at Astoria, Oregon, substantiated that high levels of dissolved gases occurred throughout the study area. The study also showed that water plunging over spillways is the main cause of supersaturation and that little equilibration of supersaturated gases occurs in the reservoirs associated with the dams.

There is ample evidence, both in laboratory and field studies, that adult and juvenile salmon and steelhead are jeopardized by gas bubble disease in the Columbia River Basin (Ebel et al. 1975). The severity of the disease and its consequences depend on the level of supersaturation, duration of exposure to supersaturation, water temperature, general physical condition of fish, and the swimming depth maintained by the fish (Exhibit 8).

During spill, levels of dissolved gases measured at and between major dams (135 to 140%) were well above critical levels. Unfortunately, even with maximum utilization of turbine capacities, the dissolved gas levels during the average- and high-flow years continued high enough to cause problems for upstream and downstream migrants. Because all reaches of the Columbia and Snake Rivers through which adult and juvenile salmon and steelhead must migrate were significantly supersaturated, the total time of exposure was serious, and any undue delays that fish encountered resulted in substantial mortalities from gas bubble disease.

Information currently available on depth distribution of juveniles (Mains and Smith 1964; Smith et al. 1968; Monan et al. 1969; Smith 1974) all indicate that the largest percentage of downstream migrants are found in the top 5 feet of water. This means that the average hydrostatic compensation achieved is about 7.5% of saturation--insufficient to compensate for levels as high as 135 to 140% when levels as low as 115% can cause substantial mortality.

Even if migrants were able to gain relief by traveling deep in the river, adults are forced to utilize restricted depths when entering and negotiating fishways at dams. During the time the fish are in the fishways, they are restricted to a maximum depth of about 7 feet. Observations at various dams (Monan and Liscom 1973) indicate the fish are frequently near the surface in the fishways. Even though there was some reduction in the dissolved gas levels in the ladder, the restricted depth places an additional stress on fish previously equilibrated to high levels of gas supersaturation.