ORIENTATION OF FUTURE RESEARCH

by

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The massive dimensions of the Kaplan turbines, the predictability of flow patterns, and the discrete locations of suspected lethal areas suggest that zones of relative safety may exist within turbines, or conversely, that zones lethal to fish may be discrete. The importance of this concept is strengthened by the knowledge that fingerling salmonids are stratified vertically within turbine intakes and not randomly distributed. The zones within a Kaplan turbine through which fish pass may depend upon the depth of travel of the fish in the intake.

Equipment already developed will be used to determine the rate of fish mortality in relation to zone of travel, size of fish, river condition, turbine load, and other factors that appear important to the development of protective methods (fig. 1). Definition of agents within turbines lethal to fish, but which may be eliminated by operation or modification, will receive particular attention. The experiments will be designed to examine the probable routes of travel by the fish in relation to the location of lethal agents, the type of injury each agent may produce, and the effect of turbine design at different dams on mortalities.

Methods for protecting young migrant salmonids are possible and will be examined. Fish near the ceiling of a turbine intake may be bypassed around the turbine by guiding the fish upward into the gatewell and subsequently into an ice and trash sluiceway (fig. 1) or other suitable bypass system for transport to the tailrace. Fish also may be diverted out of dangerous and into safe zones by influencing vertical distribution in turbine intakes. The economical and practical feasibility of guiding fish into bypasses or diverting them into safe areas may depend upon the location and discreteness of the hazardous zones.

Within turbine units, safe passage for fish may be obtained by eliminating or nullifying agents lethal to fish. For example, if cavitation in turbines proves to be lethal, the entrainment of small amounts of air in appropriate water masses may nullify its lethal qualities. Rasmussen (1956) points out that, "the maximum pressure in a collapsing bubble greatly depends upon the compressibility of the surrounding liquid . . . water-air mixture, if it is regarded as a continuous medium, is much more compressible than air-free water . . . (also) a content of non-condensable gas in the collapsing bubble will act as a buffer reducing the hammer effect." In laboratory experiments, Rasmussen demonstrated that 1 percent of air by volume at regular pressure was sufficient to eliminate almost entirely the erosion of metal by cavitation. More recently studies in a cavitating model turbine by Prempridi (1964) indicate that fish mortalities may be reduced by the entrainment of air in the water.

Research will be conducted in prototype turbines to eliminate any limitation of scale reduction inherent in most laboratory experiments. Laboratory facilities may be utilized, however, to aid in interpreting and analyzing data gathered in the field. For example, interpretation of the cause of injuries sustained by fish in turbines is now largely subjective. Basic studies can be conducted in the laboratory to classify the injuries produced by the specific agents now under suspicion. Future research will carefully consider the advantages of laboratory studies in light of the results of work in the prototype.

LITERATURE CITED

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