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PUBLIC SERVICE COMPANY OF NEW HAMPSHIRE

Final Project Report - February 1992

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SUMMARY

During the spring of 1989 and 1990 a radio telemetry study of downstream migration of Atlantic salmon smolts past five Public Service of New Hampshire (PSNH) hydroelectric facilities was conducted. The hydroelectric facility sites are located within a 91 km segment of the mainstem of the Merrimack and Pemigewasset Rivers in New Hampshire (the Pemigewasset is the headwater tributary to the Merrimack). The primary objective of the study was to evaluate smolts' selection of downstream passage routes over a representative range of environmental conditions. A secondary objective was to assess smolts' use of bypass facilities constructed at each dam by PSNH.

The radio telemetry system used in this study was designed to provide automated collection of fish passage data. The system was capable of identifying up to 45 individual miniature radio transmitters (radio tags) simultaneously. In addition to radio tag identification, the telemetry system determined the location (e.g. spillway, bypass, turbines) at which a tag was detected, the times of detection and subsequent loss of signal, and covariate data (e.g. water temperature, generation, waste gate position) for the times of signal detection and loss.

Radio-tagged smolts were released at several sites between mid-April and late May or early June of each year. In the course of the study 205 smolts with operating radio tags were released. One hundred forty five (71%) of the smolts released are known to have moved past at least one dam. Transmitter regurgitation, incomplete receiver coverage of areas through which fish may have passed, transmitter malfunction, lapses in coverage due to power failure or human error, and failure of the migratory instinct comprise the likely explanations for fish not being detected at the various sites. Of the 145 smolts that passed at least one dam, 53 (37%) were recorded only at the first dam encountered. Seventy three (50%) of the smolts reached, and presumably passed, the downstream-most facility (Amoskeag Dam). The passage route could be determined with confidence for 282 of 399 known instances where a smolt passed a site. Considering only passages for which the route could be determined, most smolts (63%) passed PSNH hydroelectric facilities at spillways or waste gates. Turbines accounted for 32% of the known passages. Bypasses constructed specifically for smolt passage accounted for only 5% of the passages. Between-years differences in the percentage of smolts passing through turbines was noted at all sites except Ayers Island (a facility with relatively deep turbine intakes, which are located > 14 m below the surface). These differences were attributed to inter-annual differences in the percentage of river flow entrained through the turbines at the time when smolts were passing the sites.

Passage route selection at two sites, Eastman Falls and Amoskeag, could be explained by a "passive drift" model in which smolts are randomly distributed in the water column and simply maintain position within a discrete volume of water. At the Garvins Falls site, entry into the station's headrace canal was consistent with the passive drift model;

although once in the canal, smolts appeared to avoid turbine passage. Forty three percent of the smolts that entered the canal exited via the bypass or waste gate which accounted for only 1%-7% of the turbine flow. At Ayers Island, smolts were apparently reluctant to sound to the depth of the turbine intakes. Only 3 of 67 known passages occurred via the turbines at Ayers Island. Smolts encountering the Ayers Island site when river flows were less than approximately 120% of the hydraulic capacity of the turbines tended to be delayed until substantial spill occurred at that site. Passage route selection at the Hooksett site could not be evaluated due to insufficient data.

Migration success (a statistic expressing the percentage of smolts that passed a site which were later detected at a site downstream) was used to compare relative survival rates between smolts that passed through turbines and smolts that used bypasses (including spillways and waste gates). Contingency table analysis indicated that there were no detectable differeces in migration success rates between turbines and bypasses. Sample sizes were, however, insufficient to detect the anticipated subtle differences (on the order of 5%-10%) in migration success rates between the turbine and bypass routes. The study was not designed to estimate, nor are the data collected adequate to assess, rates of turbine or bypass survival.

The Ayers Island facility appears to play a key role in determining the potential success of wild smolt (i.e. smolts produced as a result of fry stocking) emigration from the Merrimack River Basin due to the potential for substantial delay of migration during low flow years. Priority for development of fish passage measures should be placed at this site. Estimated long-term average bypass rates for other sites indicate possible priorities for further development of downstream bypass measures. Using this approach, the order of development priority (after Ayers Island) would be Amoskeag, Eastman Falls, Garvins Falls, and Hooksett.