ENV Report 26 – *Computer Model for Transport of Larvae Between Barge Tows in Rivers* by E. R. Holley

ABSTRACT

For two separate tows, each composed of one or more barges and a self-propelled vessel, or towboat, traveling in the same direction in a river, some percentage of the water and fish larvae that go through the propellers of the second towboat may have also gone through the propellers of the first or leading towboat. A computer program has been developed for calculating this percentage. For this calculation, the river is schematized as a rectangular channel with constant depth and constant velocity. Being located at a certain percentage of the total width of a rectangular channel is essentially equivalent to being at the same percentage of total flow rate in a natural channel.

The flows from the propellers of a towboat are analyzed as jets. The distances between tows are assumed to be large enough that the flow from the propellers of the leading towboat will become fully mixed over the river depth before the second towboat encounters this water. Thus, all of the analyses are done in terms of two-dimensional, depth-averaged conditions. The propeller jets are generated by a moving source, while the analysis was done in a stationary coordinate system. Thus, it was necessary to transform the momentum or through from the propeller jets in a moving coordinate system into an equivalent momentum in a stationary coordinate system.

For tows traveling upstream, the jets are treated as being in a co-flow, i.e., a flow which is going in the same direction as the jet. Since the jets can persist for large distances (on the order of a kilometer), an approximate analysis was done to account of the effects of boundary friction on the jets. The end of the jet region is determined based on a tolerance for the magnitude of the jet velocity relative to the river flow velocity. After the jet velocities decrease to being within this tolerance, ambient river diffusion is used to determine the mixing of the water form the propellers of the first towboat. Based on the jet velocities, the river flow velocity, the speed of the tows, and the distance between the tows, the program determines whether the second towboat encounters the water from the first set of propellers in the jet region or in the ambient diffusion region and then calculates the makeup of the intake water for the second set of propellers. For these calculations, the river is divided into a number of vertical strips. The calculations are done for the center of the first tow, at the center of each of the vertical strips. For each location of the first tow, the second one can also be at the center of each of the vertical strips. The jet calculations for tows traveling upstream were verified by comparison with laboratory measurements of velocities downstream form a stationary towboat.

The calculations for tows traveling downstream are similar except that the propeller jets are now directed against the river flow sot he analysis is based on jets in counter flows. Since the jet and river flows are opposed to each other, the region of jet flow is small enough that the effects of boundary friction are not included in these calculations. The end of the jet region is taken to be when the water from the propellers returns to the cross section where the jet was generated.