UAA Professional Development Seminar Series

Assessing Fish Passage Success in Culvert Structures with a 2D Algorithm

Presented by Alexandra West Jeffries

Abstract: Fish passage through culvert structures requires suitable behavioral and physical conditions for fish. Current practice consists of "stream simulation" design where the stream is replicated throughout the crossing structure; however, space and/or budget constraints do not always allow this practice and require the designer to model hydraulics against fish swimming abilities to assess for barriers. Current models are one-dimensional and can be overly conservative.

This thesis analyzed stream properties within a culvert structure on Buddy Creek near Talkeetna, Alaska, and utilized this data to develop a two-dimensional algorithm with hydraulic output from River2D, to determine if the depth and velocity throughout the structure were conducive to passage of juvenile salmon. Modeled velocity and water depth from River2D were used and compared to published fish species' characteristics to determine if fish passage through the structure, in two-dimensions, would be successful. Additionally, the commonly used one-dimensional model, FishXing, was run to assess passage and to compare against the algorithm. Passage results from FishXing and the algorithm were compared against actual juvenile salmonid passage data at known flows provided by the Alaska Department of Fish and Game.

Both one-dimensional and two-dimensional models resulted in approximately 55% congruency for passage of juvenile coho and Chinook salmon that successfully passed from downstream to upstream according to Alaska Department of Fish and Game's tagging study. Both models passed 100% of the rainbow trout within the tagging study. Based on the similar results between the two-dimensional model and FishXing, FishXing appears to fairly accurately take into account occupied velocity of the juvenile fish when using proper velocity reduction factors. Although, FishXing and the two-dimensional algorithm are still fairly conservative and appear to be limited by the studied fish swimming abilities, especially for Chinook and coho salmon.

Biography: Alexandra West Jefferies, PE is a civil engineer/hydrologist at PND Engineers, Inc. and a graduate student at the University of Alaska Anchorage (UAA). She works primarily conducting hydrology and hydraulic design including: bridge and culvert design, scour, stream restoration, erosion control, storm drainage, and fish passage design. As an undergraduate student at UAA, she designed and UAA patented a hydro-powered fish carcass grinder to prevent unnecessary human and bear interactions along the Russian and Kenai rivers and to keep important marine-derived nutrients from the salmon in the ecosystem. She is currently completing her graduate thesis titled, "Assessing Fish Passage Success in Culvert Structure with the Development of a Two-dimensional Algorithm Considering Physical Capabilities of Juvenile Salmonids" and plans to graduate with her Master of Science in Civil Engineering this May.

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