# A Spatial Model to Assess the Effects of Hydropower Operations on Columbia River Fall Chinook Salmon Spawning Habitat

**James R. Hatten and Kenneth F. Tiffan**

US Geological Survey, Western Fisheries Research Center, Columbia River Research Laboratory, 5501A Cook-Underwood Road, Cook, Washington 98605, USA

**Donald R. Anglin, Steven L. Haesker, Joseph J. Skalicky, and Howard Schaller**

U.S. Fish and Wildlife Service, Columbia River Fisheries Office, Vancouver, Washington, 98683, USA

Corresponding author: [jhatten@usgs.gov](mailto:jhatten@usgs.gov)

Abstract.—Priest Rapids Dam on the Columbia River produces large daily and hourly streamflow fluctuations throughout the Hanford Reach during the period when fall Chinook salmon Onchorhynchus tshawytscha are selecting spawning habitat, constructing redds, and actively engaged in spawning. Concern over the detrimental effects of these fluctuations prompted us to quantify the effects of variable flows on the amount and persistence of fall Chinook salmon spawning habitat in the Hanford Reach. Specifically, our goal was to develop a management tool capable of quantifying the effects of current and alternative hydrographs on predicted spawning habitat in a spatially explicit manner. Towards this goal we modeled the water velocities and depths that fall Chinook salmon experienced during the 2004 spawning season, plus what they would have experienced under several alternative (i.e. synthetic) hydrographs, using both one and two dimensional hydrodynamic models. To estimate spawning habitat under existing or alternative hydrographs, we used cell-based modeling and logistical regression to construct and compare numerous spatial habitat models. We found that fall Chinook salmon were more likely to spawn at locations where velocities were persistently greater than 1 m/s and in areas where fluctuating water velocities were reduced. Simulations of alternative dam operations indicate that the quantity of spawning habitat is expected to increase as streamflow fluctuations are reduced during the spawning season. The spatial habitat models that we developed provide management agencies with a quantitative tool for predicting, in a spatially explicit manner, the effects of different flow regimes on fall Chinook salmon spawning habitat in the Hanford Reach. In addition to characterizing temporally varying conditions, our research describes an analytical approach that could be applied in other highly variable aquatic systems.

One model component produced a table of modeled river fluctuations and redd locations and elevations, which was used to model the location and duration of entrapments throughout the 110 mile long Hanford Reach. This model component was updated to use the actual hydrograph for the year 2011, and the resulting table of modeled data is the table presented here.