Dynamic In-Stream and Floodplain Water Level Modeling in the Lower Roanoke River Corridor, North Carolina, 1997-2007

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Modeling tools developed from extensive and credible site-specific data are being constructed by the U.S. Geological Survey in order to assess effects of possible changes in Kerr operations on downstream flows, floodplain habitat, and water quality. The lower Roanoke River corridor supports a large and diverse population of nesting birds, waterfowl, freshwater and anadromous fish, and other wildlife, including threatened and endangered species. In addition to providing critical habitat for wildlife, the Roanoke River is utilized for a variety of other purposes, including water supply, hydropower production, wastewater assimilation, and recreation. The timing, duration, and extent of floodplain inundation can have either positive or negative effects on vegetation, wildlife, and fisheries in the lower Roanoke River corridor depending on the inundation characteristics. The relationship between river flow and floodplain water level is important but poorly understood for the Roanoke River. Flooding and floodplain inundation is primarily governed by upstream reservoir releases. A numerical hydrodynamic model for continuous simulation of in-stream flows and floodplain inundation for a 118 mile reach of the lower Roanoke River corridor (Roanoke Rapids, NC to Jamesville, NC) was constructed for the period 1997-2007 using the one-dimensional hydraulic model Hydrologic Engineering Center–River Analysis System (HEC-RAS). The model was tested to ensure mass conservation, particularly for out-of-bank flows, and calibrated to 1998 water-level measurements at nine gages. Flows during the spring of 1998 were at sustained high levels of about 40,000 cubic feet per second, and resulted in extensive floodplain inundation. The mean in-stream water level errors for the 11-year continuous simulation were less than 0.07 feet at five gages, and +0.25, -0.66, -0.88 and -1.21 feet at the remaining four gages. Standard deviations of these errors ranged from 0.13 to 1.20 feet. Further testing included the comparison of modeled versus measured floodplain water levels. Because the inundation process is inherently two-dimensional, achieving adequate model performance during periods of extensive and prolonged inundation using a one-dimensional model was challenging. Data from water-level gages located in each of the Big Swash, Broadneck and Devil's Gut floodplains were compared to simulated floodplain depths for three unique periods of sustained high in-stream flows in 1998. The average water level errors for each of the floodplains were -0.16, -0.35 and -1.39 feet with respective standard deviations of 1.82, 1.55 and 2.58 feet. This model is a tool that will enable managers of the Kerr project to simulate changes in Kerr operations in order to more effectively manage the system.