Using Models to Assess and Revise 2010 Detroit Dam Operations to Meet Downstream Water-Temperature Goals

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Overview, Objectives, and 2010 Operations

Detroit and Big Cliff are two of the 13 multi-purpose projects operated by the Corps of Engineers in the Willamette Valley, Oregon. Located in Marion County in the rugged mountain forests below Mt. Jefferson, the two dams store the waters of the North Santiam River, Breitenbush River and Blowout Creek. The authorized purposes for Detroit project are flood risk management, irrigation, hydroelectric power, recreation, navigation, fish and wildlife and water quality. The authorized purposes for Big Cliff project include hydroelectric power and re-regulation.

Construction and operation of Detroit and Big Cliff Dams has altered the pre-dam seasonal thermal regimes in the North Santiam River. The altered temperature regime has negatively affected the productivity of ESA-listed spring Chinook salmon and winter steelhead in the lower North Santiam River, and has been identified as one of the most critical limiting factors for species recovery.

Reasonable and Prudent Alternative (RPA) 5.1.1 in the National Marine Fisheries Service's Biological Opinion (NMFS 2008) required an evaluation and implementation of modified operations at the Detroit and Big Cliff projects on the North Santiam River to improve downstream water temperature and TDG conditions for anadromous fish species listed under the Endangered Species Act (ESA). The objective of interim operations was to achieve water temperature benefits below the Detroit/Big Cliff complex without jeopardizing the authorized purposes of the dams.

In 2010, interim temperature control operations were conducted from June 1 through October 31, 2010. The Corps of Engineers monitored the effectiveness of interim temperature control operations by conducting water quality and biological assessments throughout the 2010 season. In general, interim temperatures operations met temperature targets throughout the season, but slightly exceeded these targets in late fall during incubation.

Although the benefits may not be quantifiable at the population level, interim temperature control has mitigated some of the potential thermal impacts to the ESA-listed species in the North Santiam River and provided overall benefits to the aquatic ecosystem below the dams.

Water Temperature Modeling

Water temperatures within a certain range are of vital importance in providing beneficial habitat for threatened Willamette basin salmonids such as upper Willamette River Chinook salmon (*Ocorhynchus tshawytscha*) and winter steelhead (*O. mykiss*). Following the National Marine Fisheries Service's Biological Opinion of 2008, the U.S. Army Corp of Engineers Willamette Basin dam operations have been evolving to improve water quality for fish species listed under the Endangered Species Act. One of the largest of these dams in the Willamette River basin, Detroit Dam impounds 455,100 acre-feet of water at full pool. From the time of its construction in 1953 until 2006, the operation of Detroit Dam resulted in an altered seasonal pattern of downstream water temperatures in the North Santiam River when compared to pre-dam conditions. Under an operational plan that emphasized power generation, the dam provided a net cooling effect to the North Santiam River in the early summer, but a net warming effect during the late summer and autumn. However, the structure of Detroit Dam allows releases at various depths, which allows water from multiple depths to be released and blended to meet a downstream temperature target. In particular, the release of cool water from deep in the lake in late summer and early autumn can help mitigate problems with the release of water that otherwise would be too warm for fish.

To explore the cooling potential that can be achieved by using multiple release structures at Detroit Dam during autumn of 2010, the USGS conducted simulations using a previously developed model of Detroit Lake that was based on the two-dimensional (laterally averaged) hydrodynamic model CE-QUAL-W2. Using a combination of measured and forecasted inputs (flow, water temperature, and meteorological conditions), numerous scenarios involving the use of the existing outlets (each at different depths) at Detroit Dam were explored. A “blending” algorithm within CE-QUAL-W2 previously developed by the USGS was used to predict the necessary flow from each outlet needed to meet a user-defined time-series of downstream temperature targets. Initial model runs using CE-QUAL-W2 in “blending” mode were used to quickly assess the extent to which temperature targets could be met using available dam outlets. This information then was combined with feasible dam operations to simulate downstream temperatures resulting from various operational scenarios.