

ABSTRACT

**UMATILLA RIVER TEMPERATURE TMDL ANALYSIS:
FLOODPLAIN CONDITION AND HYPORHEIC FLOW**

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The Umatilla River, Oregon, suffers from prolonged periods of sub-optimal and incipient-lethal river temperatures. Salmonids are highly adaptable and can utilize a wide variety of habitat; however, they require cool water temperatures. When exposed to temperatures greater than 18°C (64°F) rearing and migrating salmonids modify their behavior to alleviate stressful increases in their metabolic rates. In the Umatilla River salmonids seek out and move into cool water sources, such as tributaries, spring brooks or headwaters, but can become trapped by thermal barriers and low flows. This analysis considers land uses that contribute to stream heating: floodplain dissection, vegetation removal/disturbance, channel modifications (from bridges and roads railroads), and hydrologic disturbance (such as groundwater withdrawals). The influence of groundwater upon stream temperature dynamics is an important component to the habitat integrity of the Umatilla River. Hyporheic exchange between the river and the alluvial aquifer offers important heat moderation during periods of sub-optimal river temperatures (June through September). This analysis broadens the range of ‘traditional’ thermal sources to include the connection of the river to the alluvial aquifer via interrelated processes and landscape features in the floodplain, namely: land cover, morphology and hydrology (including subsurface water withdrawals). Remote sensing from aircraft is used to image topographic and land cover surfaces, and to detect the spectral patterns (electromagnetic signatures emitted from trees, ground surfaces, water, etc.) over the stream and floodplain. These data sets are extensively utilized in the analysis (for statistical analysis and as model inputs). Thermal infrared radiometry (TIR) was collected using a helicopter with a sensor (radiometer) that measures thermal radiation emitted from the ground, vegetation and the stream. Light intensity detection and ranging (LIDAR) was measured from an airplane with an instrument that emits laser pulses toward the ground that are then reflected back to a sensor, providing high resolution topography and land cover height data. Aerial photos provided visual information that can be used for mapping land cover and morphology features. Historical air photos (1949) were used to map stream position and land cover distributions. These spatial data sets are compiled over a basin-scale and used as inputs for computer models to simulate hydrology (river flow, hyporheic exchange) and thermodynamics (heat transfer). Three computer models were used: HEC-RAS (stream hydraulics), Wetlands Dynamic Water Budget Model (vertical hyporheic exchange), and Heat Source (heat transfer, mixing with tributaries, longitudinal hyporheic flows and stream temperature). Statistical analysis tested the developed theoretical basis for longitudinal and vertical hyporheic exchange. Simulated results indicate that hyporheic exchange is an important process for heat moderation and localized cooling in the Umatilla River.