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Using high-resolution distributed temperature sensing to estimate streambed water exchanges beneath the first-order stream in the alpine watershed in Taiwan

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The interaction between river and streambed is considered as a fundamental role in the functioning of riparian ecosystems. The endangered Formosan landlocked salmon have been successfully rehabilitated in Yusheng Creek, the first-order stream in the alpine watershed of Chichiwan Creek, Taiwan. However, the stream fragmentation, no surface streamflow, seriously reduced the salmon population, hampering the restoration work. The utility of combining high spatial and temporal resolution of distributed temperature sensing (DTS) technology and field installation of monitoring wells were demonstrated to comprehensive understand the exchange process and mitigate the effect of fragmentation on endangered salmon. The DTS measurements was conducted on the length of the 1,250 m reach covering the fragmented reach of creek from 7-13 November 2018. The monitoring wells provided the long-term water levels and streambed temperatures to analyze the dynamic behavior of hydraulic characteristics of streambed. The results showed that the DTS enabled to detect the locations of groundwater downwelling/upwelling and hyporheic exchange along the study reach. The temporal interactive processes between stream and groundwater from continuous to ceasing flow were also detected. Due to intensive rainfalls and stream fragmentation, the spatial and temporal changes of streambed in vertical hydraulic conductivities were significant. DTS measurements demonstrated significant impact of groundwater and hyporheic inflows on reducing the maximum stream water temperature by 1-2oC in November, 2018. These results implied that the downstream stream has the potential as the thermal refuge for the salmon and the fragmentation can be mitigated through the river restoration to significantly increase the salmon population.