DELTA SCIENCE FELLOW 2013

Delta Stewardship Council
Delta Science Program

Sea Grant California

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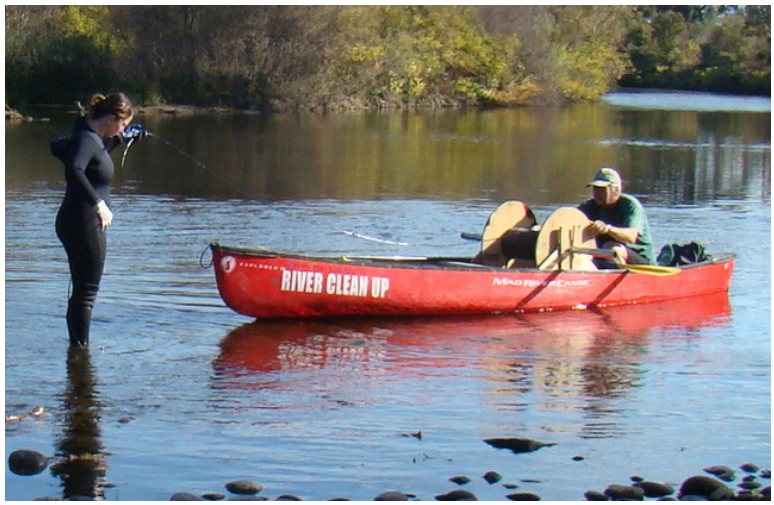
WHY THIS RESEARCH MATTERS

Gravel bars provide important streamed habitat for early life stages of gravel spawning fish, including Chinook salmon (*O. tshawytscha*). Zones of loose gravel and inflow of surface water to and from the shallow subsurface (hyporheic exchange) sustain hydraulic and thermal conditions and deliver oxygen to incubating eggs.

Water supply managers have modified their operations in order to restore streambed habitat, but little is known about how and in what ways restoration actions can support the sediment and subsurface flow processes that maintain important habitat features.

Studying gravel bars in rivers to identify what features facilitate groundwater exchanges that create good Chinook salmon spawning habitat



Erin Bray installs fiber-optic distributed temperature sensing cable (DTS) with the assistance of Chuck Kroeger (RiverTree Volunteers) along the length of a gravel bed reach of the San Joaquin River downstream of Friant Dam. *Richard Sloan, RiverTree Volunteers*

PROJECT

The Fellow conducted a field and modeling investigation to examine sediment characteristics and hyporheic exchange, which were used to inform two-dimensional subsurface flow modeling along gravelly riffle-pool reaches. The subsurface flow model used terrain data previously collected by the U.S. Bureau of Reclamation, and was developed using the Fellow's own in situ measurements of streamed hydraulic conductivity.

RESULTS

The Fellow presented new theory and field data to illustrate the conditions required for infiltration and exfiltration of flow between a stream and its bed, and a groundwater model to investigate the factors that affect paths and residence times of flow through the hyporheic zone. Geometry of bed features, including their asymmetry, was shown to play an important role in determining what extent of the streambed promotes inflow and thus hyporheic exchange. Streambed hydraulic conductivity varied by orders of magnitude along gravel bars due to fine sediment accumulation and downstream coarsening related to the processes that shape and maintain the bar features. The lowest hydraulic conductivity along the reach

RESULTS (continued from front)

occurred along the pool tails and upsloping faces of bars. This zone is also where infiltration would otherwise be greatest into the intragravel hyporheic zone, indicating the importance of managing sand supply to maintain the ventilation and flow through salmon spawning riffles.

MANAGEMENT APPLICATIONS

The results will allow managers to use a new, simple equation to identify where along the length of a river hyporheic exchange with occur. The results also allow managers to understand the effects that asymmetry of bed features (such as gravel bars) has on the extent over which hyporheic exchange can occur. This will allow managers to easily identify places to prioritize for restoration targeted at early life stages. They will help develop a Delta-wide predictive capacity for hyporheic flow processes, identify the physical constraints that limit surface water inflow to the intragravel zone when embryos are present, and improve modeling performance and mapping of critical zones for *O. tshawytscha*.

Results are currently in press or revision for publication in scientific journals. The new theory and model results will be useful to managing and restoring spawning habitat in any gravel bedded river. The results are particularly useful to the San Joaquin River Restoration Program and the Department of Water Resources in efforts to restore spawning and incubation habitat and increase salmon fry survival in the San Joaquin River.

Erin Bray takes field measurements of streambed hydraulic conductivity using a backpack permeameter in the upper San Joaquin River, CA with geomorphologist Mitchell Swanson. *Jennifer Natali, PhD Candidate at UC Berkeley*

SELECT PRESENTATIONS

Bray, EN and Kondolf, GM. 2016. Effects of observed variations in barform morphology on infiltration and hyporheic exchange in gravel bed rivers. American Geophysical Union Fall Meeting, San Francisco, CA, USA. [Oral Presentation] 2016-12

Invited Speaker, San Joaquin River Restoration Program Science Meeting, U.S. Bureau of Reclamation & California Department of Water Resources, Fresno, CA, August, 2016. Public/profession presentation, 100 attendees

RESEARCH MENTOR

Thomas Dunne, Bren School of Environmental Science and Management, University of Santa Barbara, California

COMMUNITY MENTOR

Erin Rice, U.S. Bureau of Reclamation

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