Research Title: Do stream restorations scale up? An analysis of ecosystem response to restorations throughout river networks in the Great Lakes basin

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Overview and Objectives:

Throughout the Great Lakes basin, urban stream restorations are being implemented to improve the ecological, economic, and social integrity of freshwater resources. These restorations often enhance ecosystem services, such as re-establishing natural flow regimes or increasing nutrient processing rates. However, similar restorations (e.g., channel reconfiguration) may have different effects on stream processes depending on the location of the restoration within the river network (e.g., tributary vs. river main stem). Using process-based measurements of ecosystem function, sites within a river network can be targeted for restorations that maximize ecosystem services and minimize economic and social costs.

The objective of our study was to provide a quantitative assessment of urban stream restorations using integrative metrics of ecosystem function (e.g., whole-stream metabolism, nutrient cycling dynamics). We conducted our research in six watersheds in the Milwaukee metropolitan area. In each river, we selected adjacent restored and unrestored reaches (>200m in all cases), generally consisting of replacement of concrete channels with rock/sand/mud substrates flanked by riparian vegetation. These sites represented a gradient of discharge and watershed position within the broader Milwaukee River system, enabling us to address broad patterns as well as site-specific restoration outcomes.

To execute this field project, we partnered with local citizen groups (e.g., Milwaukee RiverKeeper), members of municipal (e.g., Milwaukee Metropolitan Sewerage District) and state agencies (e.g., Wisconsin DNR), and other academic institutions (e.g., UW-Milwaukee, Loyola University).

Accomplishments:

In FY2016, we completed additional fieldwork and data analysis beyond the original scope of the study overview and objectives. During the summer of 2015, we collected river sediments and recorded the physicochemical characteristics at 19 locations in the 3 major river systems and their tributaries in Milwaukee, WI, as well as the nearshore habitat in Lake Michigan. We conducted sediment denitrification assays to determine the amount of nitrate permanently removed from the lotic and lentic ecosystems using membrane-inlet mass spectrometry (MIMS). The additional research was conducted in collaboration with Dr. Tim Hoellein (Loyola University-Chicago) and Robert Mooney (UW-Madison). Furthermore, we continued our analysis of long-term water quality data in the river networks of Milwaukee, WI, in collaboration with Dr. Peter Lisi and Etienne Fluet-Chouinard (UW-Madison) and Dr. Matthew Diebel (Wisconsin DNR).

Publications:

CILER-related:

Levi, P.S. and P.B. McIntyre. 2015. Do Urban Stream Restorations Scale Up? An analysis of ecosystem response to restorations in the river networks of Milwaukee, WI. Report to the Milwaukee Metropolitan Sewerage District.

Levi, P.S. and P.B. McIntyre. *In preparation*. Does stream size affect ecosystem responses to channel restoration in urban watersheds? To be submitted to Ecological Applications in August, 2016.

Non-CILER-related: Levi, P.S., P. Starnawski, B. Poulsen, A. Baattrup-Pedersen, A. Schramm, and T. Riis. *In revision*. Microbial community diversity and composition varies with habitat characteristics and biofilm function in macrophyte-rich streams. Oikos.

Riis, T., P.S. Levi, K.G. Jespersen, S.R. Leth, and A. Baattrup-Pedersen. *In review*. Experimental drought changes ecosystem structure and function in a macrophyte-rich stream. Aquatic Sciences.

Presentations:

Levi, P.S., P.J. Lisi, E. Fluet-Chouinard, M. Diebel, and P.B. McIntyre. Long-term trends reveal varying controls on nitrogen, phosphorus, and chloride concentrations among urban river networks. Society for Freshwater Science. Sacramento, CA, 05/2016. Oral presentation.

Reisinger, A. J., E. Rosi-Marshall, P. Groffman, S. Lee, E. Bernhardt, J. Blaszczak, N. Grimm, S. Kaushal, J. Kelly, P.S. Levi, and E. Stanley. Biogeochemical symptoms of the urban stream syndrome: homogenization of water chemistry and implications for ecosystem functioning in urban streams. Society for Freshwater Science. Sacramento, CA, 05/2016. Oral presentation.

Riis, T., D. Graeber, P.S. Levi, A. Baattrup-Pedersen, J.J. Rasmussen, T.M. Jensen, S.L. Rosenhøj, and E.M. Neif. How does ecosystem structure and function respond to low-flow conditions in agricultural streams? Society for Freshwater Science. Sacramento, CA, 05/2016. Oral presentation.

Chaloner, D., B. Gerig, D.J. Janetski, P.S. Levi, A. Moerke, R. Rediske, J. Rüegg, J.L. Tank, S.D. Tiegs, and G.A. Lamberti. Influence of Pacific salmon spawners on stream ecosystems: why context matters. Society for Freshwater Science. Sacramento, CA, 05/2016. Oral presentation.

Levi, P.S. Do urban stream restorations scale up? An analysis of the ecosystem function of re-naturalized stream channels. Department of Geology and Atmospheric Sciences, Iowa State University, Ames, IA, 04/2016. Invited seminar.

Levi, P.S. Freshwater ecosystem management in the Midwest: Act locally, think globally. Raccoon River Watershed Association, Perry, IA, 04/2016. Invited seminar.

Levi, P.S. Is restoration a cure for unhealthy streams? Drake Undergraduate Science Collaborative Institute (DUSCI) Colloquium, Drake University, Des Moines, IA, 03/2016. Invited seminar.

Levi, P.S. Freshwater ecosystem management in the Midwest: Act locally, think globally. Iowa Department of Natural Resources, Des Moines, IA, 02/2016. Invited seminar.