Reference SON: *Strategic initiative*

Lead PI: *Kyle McKay (ERDC)*

Project Development Team (PDT): *Bruce Pruitt, Katherine Chambers (ERDC), Tom Prebyl (U of Georgia)*

District Collaborators: *Brian Zettle (SAM), Mick Porter (SPA), Joshua Willis (SWG DA Intern)*

Other Partners: *Caitlin Conn, Amy Rosemond, Natalia Shim, Seth Wenger (U of Georgia); Brian Crawford, Mary Freeman (USGS); Rachel Katz (USFWS)*

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Wiki

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Ecosystem Restoration in Variable Environments[1]

Research Need

Adequately accounting for environmental variability is a critical concern in quantifying long-term success of ecosystem restoration projects. Ecosystems and ecological processes experience numerous sources or expressions of periodic stochastic and catastrophic environmental variation (e.g., seasonal temperature dynamics, rainfall fluctuations, and large floods), respectively[2]. These dynamic environmental conditions lead to variable and uncertain ecological benefit provided by these systems. For instance, an arid stream may be a significant source of aquatic habitat during wet years, and a nearly dry riverbed during drought. Moreover, many restoration projects have operational elements that respond to, and are often designed to change, ambient conditions (diversion structures, flood control features, etc.). Additionally, disturbance and land use change may alter future levels of environmental variability and potentially increase uncertainty as ecological responses change and adjust.

In order to better design, efficiently operate, and adaptively manage project features to optimize environmental benefits, project planners and operational specialists require tools for responding to variability and disturbance (e.g., drought).

Project Objectives & Plan

This project seeks to provide a suite of techniques for quantifying and incorporating environmental variability into project planning. Three primary and several secondary deliverables are proposed for this project:

- Review the state-of-the-science and synthesize techniques for quantifying environmental variability.
- Review the role of variability in setting and crossing ecological thresholds, maintaining ecosystem resilience, and designing restoration projects accordingly.
- Develop a case study to demonstrate accounting for variability of environmental benefits of restoration projects.
- Present findings to users in webinars, conference presentations, and on-site demonstrations with collaborating field personnel.

Payoff

Understanding and quantifying variability is particularly important in non-stationary environments, which are the new norm in aquatic ecosystems[2]. Developing techniques for evaluating variability will help practitioners to plan and design for fluctuating environments, increase the resilience of restoration projects, and avoid negative thresholds in restoration outcomes.

Products

Journal Articles (JAs)

McKay, S., Freeman, M. and Covich, A. (2016). Application of Effective Discharge Analysis to Environmental Flow Decision-Making. Environmental Management. 57. DOI: 10.1007/s00267-016-0684-4.

Shrestha S., Dwivedi P., McKay S.K., and Radcliffe D. (2019). Assessing the potential impact of rising production of industrial wood pellets on streamflow in the presence of projected changes in land use and climate: A case study from the Oconee River Basin in Georgia, United States. Water, 11(1), 142; https://doi.org/10.3390/w11010142.

Technical Reports (TRs)

McKay, S.K., Pruitt, B.A., Zettle, B.A., Hallberg, N., Hughes, C., Annaert, A., Ladart, M. and McDonald, J. (2018). Proctor Creek ecological model (PCEM): phase 1 site screening (ERDC/EL TR-18-11), Technical Report. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

McKay, S.K., Pruitt, B.A., Zettle, B.A., Hallberg, N., Moody, V., Annaert, A., Ladart, M., Hayden, M. and McDonald, J. (2018). Proctor Creek ecological model (PCEM): phase 2 benefits analysis (ERDC/EL TR-18-11), Technical Report. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Technical Notes (TNs)

Bhattacharjee, N.V., Willis, J.R., Tollner, E.W. and McKay, S.K. (2019). Habitat provision associated with environmental flows (ERDC/TN EMRRP-SR-85), Technical Report. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

McKay, S.K. (2022). Is mean discharge meaningless for environmental flow management? (ERDC/TN EMRRP-SR-91), Technical Note. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

Other

Bhattacharjee, N.V. (2017). Assessing Water Body Ecological Indicators using Time Series Analysis and Physics-based Modeling Approaches. Doctoral Dissertation, University of Georgia, Athens, Georgia.

Bumpers, P., Skaggs, J., and Wenger S. (2017). Response of shoal-dwelling fish to the cessation of hydropeaking on the Etowah River. Project Report, University of Georgia, Athens, Georgia.

Conference Presentations/Webinars/Workshops

Pruitt, B. A. and McKay, S. K. (2013). Integration of stream flow duration with hydraulic geometry in the southern Piedmont. Proceedings of the 2013 Georgia Water Resources Conference.

McKay, S.K. (2015). Quantifying hydrologic variability, Presentation. Ecological Society of America, Baltimore, Maryland.

McKay, S.K. and Conn, C. (2017). Using ecosystem functions to inform water management decisions, Webinar. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

McKay, S.K. (2017). Ecosystem restoration webinar series – SMART planning and ecological model development – a case study in Proctor Creek, Atlanta, GA, Webinar. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

McKay/Conn (2017). Making sense of noisy environmental systems: characterizing and quantifying variability, Webinar. U.S. Army Engineer Research and Development Center, Vicksburg, Mississippi.

(2017). The messy business of urban stream restoration – a case study in the southeastern United States. IGB Leibniz-Institute of Freshwater Ecology and Inland Fisheries, Berlin, Germany.

(2017). Capturing the socio-economic payoff from managing rivers for environmental objectives. PIANC Smart Rivers, Pittsburgh, Pennsylvania.

(2017). Trading-off socio-economic and ecological outcomes associated with municipal water supply. Society for Freshwater Science, Raleigh, North Carolina.

(2017). The messy business of urban stream restoration in Proctor Creek, Atlanta. Symposium on Urban Stream Ecology, Browns Summit, North Carolina.

[1]Project Alias – Work Unit Documentation Title: *Ecosystem restoration in variable environments*

[2]Milly P.C.D., Betancourt J., Falkenmark M., Hirsch R.M., Kundzewicz Z.W., Lettenmaier D.P., and Stouffer R.J. 2008. Stationarity is dead: Whither water management? Science, 319, 573-574