Hydrologic Thresholds for Biodiversity in Semiarid Riparian Ecosystems: Importance of Climate Change and Variability

Thomas Meixner, Kate Baird, Mark A. Dixon, James F. Hogan, S. Joy Lite, and Julie Stromberg,
University of Arizona, Tucson, AZ

Riparian ecosystems of the arid and semiarid Southwest are linear corridors of high productivity and diversity. These ecosystems are sensitive to even small changes in the riparian water balance, with sharp changes in vegetation as streams become intermittent and as groundwater declines below survivorship thresholds. As a result, riparian vegetation has declined on many rivers due to water abstraction or has been altered due to the hydrologic impacts of climate variability. Despite much disciplinary work on individual rivers, a regionally comprehensive and integrated understanding of how aquatic-terrestrial ecotones respond to hydrologic change, including those imposed by climate change, awaits development.

The investigators will determine region-wide sensitivity of riparian vegetation to climate change. Project hypotheses include: (1) decadal scale climate change and variability alter riparian aquifer recharge through mechanisms that depend on the magnitude, frequency, and seasonality of flooding, and exert the greatest change in reaches that receive minimal groundwater inflow from the regional aquifer; (2) riparian vegetation structure responds non-linearly as riparian aquifers are dewatered and as key hydrologic thresholds for survivorship of plant species are exceeded; and (3) decadal scale climate variability and change alters riparian ecosystem water budgets that in turn changes vegetation structure and function and the ecosystem services provided to society.

For **hypothesis 1**, the investigators will: isotopically quantify riparian aquifer recharge along a regional precipitation gradient. On one river, the San Pedro, a model that links storm flow and aquifer recharge, calibrated with isotopic data, to estimate steam base flows and seasonal aquifer conditions will be developed. For **hypothesis 2**, the investigators will: further evaluate established connections between vegetation condition and hydrologic conditions of flood flows, groundwater depth, and stream flow permanence. For **hypothesis 3**, the investigators will: develop five alternative scenarios of climate change and use a scenario driven model to estimate the climate impacts on vegetation along the San Pedro River. For the other rivers, climate scenarios and hydrologic and vegetation data will be used to develop a climate change sensitivity matrix. Biodiversity and water quality ecosystem services of riparian systems will be quantified for each scenario.

This research project will produce three useful products for resource managers in the Southwest. First, the research will improve understanding of the linkages between climate (precipitation timing and amount), hydrologic variability (stream flow and aquifer conditions), vegetation structure, and ecosystem services in riparian ecosystems, and of the regional variability in these relationships. Second, a transferable coupled model of hydrologic-vegetation processes in riparian ecosystems that will allow for modeling of non-linear responses to hydrologic change resulting from climate change or other causes will be produced. Third, the climate sensitivity matrix that is developed will be useful for projecting regional impacts of climate change and anthropogenic impacts on riparian water budgets and ecosystem change.

EPA Grant Number: R833025