MESM GROUP PROJECT PROPOSAL 2023-2024

Advanced technologies for hydrologic and biodiversity decision support for Groundwater Dependent Ecosystems of the Santa Clara River

Student authors: Hannah Vaughn-Hulbert | MESM 2024 | hvaughn-hulbert@bren.ucsb.edu
Vivian Phan | MESM 2024 | vivian_phan@bren.ucsb.edu

Faculty Advisor: Scott Jasechko (Co-advisors Ruth Oliver – Bren, Chris Jerde – MSI)

Client: Restoration Science LLC | Restoration Science Team
Tom Dudley, UCSB-MSI tdudley@msi.ucsb.edu, 805-698-8251

Project & Partners

The Restoration Science Team (RST) proposes a MESM group project to evaluate seasonal dynamics of shallow groundwater in three critical Groundwater Dependent Ecosystems (GDEs) in the floodplain of the Santa Clara River (SCR; Los Angeles/Ventura Counties), and subsequent relationships with associated biota. The RST is a regional working group including partners from UC Santa Barbara (UCSB), Stillwater Sciences, United Water Conservation District (UWCD), Santa Clara River Conservancy (SCRC), Ventura County Resource Conservation District and other resource specialists, represented here by Restoration Science LLC. Our program aims to enable resource managers to refine policies to meet mandated water resource and ecosystem management objectives in the Santa Clara River (SCR), the most hydrologically-intact river system in southern California (3,13). A recent grant from California DWR through the Ventura Co. Integrated Regional Water Management (IRWM) program will address these elements, and Bren students will be welcome and valuable participants in this on-going water policy research program.

Goals & Objectives

The Goal of this MESM project is to evaluate decision support tools for sustaining ecosystem services and biodiversity within the SCR watershed. This will involve data generated by RST using environmental assessment tools to characterize relationships of biota with hydrology within GDEs. By advancing current groundwater management models and applying biodiversity monitoring techniques, the project will provide information to be integrated into sustainable water management strategies for rural, urban, and agricultural water applications.

Specific Objectives

1. Evaluate hydrologic models for integrating shallow groundwater dynamics in GDEs into existing full-system models used by regional water authorities, specifically United Water Conservation District.
2. Evaluate the use of advanced tools and technologies for documenting GDE habitat conditions and biological diversity, including:
    1. Plant-water relations use and water use of key riparian plant species;
    2. Acoustic detection of riparian-associated vertebrates (birds, bats);
    3. Presence and status of native and non-native aquatic fauna, including protected species such as the southern steelhead trout;
    4. Mapping spatial extent of functional GDE assemblages using remote sensing and ground-based GIS methodologies.
3. Apply groundwater data to existing hydrologic models to understand seasonal dynamics of shallow-groundwaters, and to establish thresholds of water resource requirements for sustaining healthy GDEs.
4. Address impacts of groundwater extraction and inter-connected surface water usages of GDEs to make recommendations on best practices for groundwater management for regional Groundwater Sustainability Plans (GSPs).

Significance

- The SCR encompasses 6 hydrologically connected basins managed by 4 Groundwater Sustainability Agencies (GSAs). The Sustainable Groundwater Management Act (SGMA) requires GSAs to identify each basin's GDEs and the impacts groundwater management decisions have on GDEs as part of the GSAs Groundwater Sustainability Plans (GSPs).
- Characterizing interactions of shallow and deep groundwaters will advance understanding of hydraulic connectivity, within and between 'Basins', and the impacts of water extraction on GDEs. Such information is needed for UWCD's water management decisions that affect the full SCR floodplain and will directly contribute to local GSAs' sustainability plans (GSPs) (17).
- Riparian and aquatic biodiversity are under stress from human activities (urbanization, water extraction, floodplain development), yet resource agencies are mandated to sustain proper ecosystem functions and listed species, particularly GDEs (19).
- Water agencies apply hydrologic models for planning and managing water resources but lack data to integrate shallow groundwaters and surface water with existing flow models, which could enable improved management actions to sustain ecosystem services and sensitive biota.
- The SCR watershed supports over 110 federally listed or rare plant and animal species requiring careful management of natural resources to preserve and enhance biodiversity.

Background

The Santa Clara River (SCR) watershed spans roughly 100 miles from the San Gabriel Mountains in Los Angeles County to the Pacific Ocean above the Oxnard Plain in Ventura County. While retaining a high degree of hydrological integrity, the SCR is also an essential water resource for local agriculture and both rural and urban communities (3,18). The river's floodplain retains significant Groundwater Dependent Ecosystems (GDEs), woodlands associated with perennially hydric zones in areas of rising groundwater that sustain high productivity, and biodiverse plant and animal communities (19, 2,15). GDEs provide numerous ecosystem services such as water purification, flood mitigation and erosion control, and serves as a critical habitat for over two dozen federally protected aquatic and riparian-dependent species (17,19). However, GDEs in the SCR Basin are at risk from groundwater pumping and off-channel diversions which can lower groundwater below levels needed by vegetation (6). GDEs are vulnerable in a warming, drying climate, and are also at risk from invasive species (e.g. *Arundo donax*) which transpire excessive groundwater (9,16). Current management and monitoring objectives include maintaining sufficient shallow groundwater to sustain riparian and aquatic habitats—elements mandated as part of on-going Habitat Conservation Plan development.

Hydrologic studies by UWCD and Stillwater Sciences have established the general structure of shallow groundwater zones where geological sills force groundwater to the surface to create perennially wetted areas historically supporting productive, high-biodiversity ecosystems (2,3,14). Currently the SCR supports several GDEs, of which three (two natural, one created by a diversion structure) are critical to water management strategies and are the subjects of this project. In one GDE, located within the Sespe Cienega site near Fillmore, diminished groundwater levels during the 2013 to 2016 drought caused widespread mortality in cottonwood-willow woodlands (7,20), a precursor to potential climate change impacts.

Equity

- The SCR holds waters significant to the Chumash people, who are concerned about the conservation of native species and biodiversity of the SCR. Current legal actions by Chumash groups target water management to reverse the extreme decline of the federally protected southern steelhead trout, as they are an important resource.
- Local groundwater agencies, including those of the SCR, are required to address stakeholder interests *and* local community needs in their groundwater sustainability plans (GSPs), specifically for disadvantaged communities.

- The project's model advancements will support more equitable and transparent sustainability strategies for these agencies.

Available Data

- Data produced by existing and newly installed monitoring wells maintained by UWCD, UCSB, SCRC and CDFW
- Existing California fish biodiversity database with current status of DNA primers, as well as eDNA survey data for fish, amphibians and mollusks of the SCR watershed
- UWCD's current groundwater model and 20+ years of model output
- Bird survey data from acoustic detectors currently being installed by UCSB, prior bird and bat monitoring data acquired by UCSB, Western Foundation for Vertebrate Zoology, The Nature Conservancy, and UWCD, and trailcam wildlife corridor data collected by UWCD and UCSB
- Vegetation and topographic data from recent LIDAR acquisition, and VIPER lab satellite (LandSat, MODIS) imagery
- Riparian vegetation and invasive Arundo abundance and distribution data with corresponding maps, collected by UCSB, Stillwater Sciences, and SCRC.
- Plant water-use data of co-dominant *Salix* spp. (willows) and *Arundo donax* (giant reed) measured by UCSB and UCLA.

Possible Approaches

- Hydrological modeling of seasonal shallow groundwater dynamics and surface water interactions, and integration with existing deep groundwater (200+ ft) hydrologic models to project groundwater influences on GDEs
- Monitoring indicators of ecosystem stress and evapotranspiration losses using plant-water ecophysiological measurement of trees and key invasive plants (Arundo).
- Biodiversity analysis through eDNA data from surface and subsurface habitats.
- GIS analysis to evaluate seasonal shallow groundwater extent and ecosystem responses by combining shallow groundwater data and plant performance measures visible using remote sensing, requiring spatial analysis of suitable distribution of groundwater monitoring wells to delineate the extent of vadose zone fluctuations.
- Data analysis of digital recorder data of birds and bats to establish relationships, with vegetation measures, as a guide for riparian restoration to enhance wildlife diversity and abundance, particularly of Special Status species. We currently have a restoration planning grant from the Wildlife Conservation Board targeted at one focal GDE and other grants supporting active restoration at our two other focal GDEs.

Deliverables

In addition to the Bren School deliverables, this project will produce ***one or more*** of the following:

- Output from enhanced UWCD hydrology model to UWCD for updating water conveyance actions to ensure sustainability of Groundwater Dependent Ecosystems (GDEs).
- Report to local GSAs, such as the Fillmore & Piru Basins Groundwater Sustainability Agency, regarding best practices for shallow groundwater sustainability.
- Technical report of comparative evapotranspiration and drought-stress ecophysiology of dominant native and non-native riparian plant species, as well as aquatic biodiversity based eDNA analysis.

Internships

Restoration Science LLC will be able to provide $5,000 or more for internships for Bren student(s) in the Group Project during summer 2023, and partnering organizations including United Water Conservation District are interested in supporting student interns to participate in hydrological model enhancement and application. UWCD is also interested in providing partial support to initiate the biodiversity assessments to serve HCP needs and mitigation actions for water conveyance facilities. We anticipate internship support for three or more MSEM researchers for Summer 2023.

Citations

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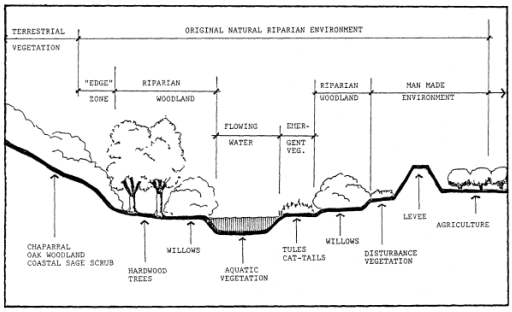
Budget

Other than the internships, it is not anticipated that the proposed project will require additional funding beyond the $1,000 contributed by the Bren School.

Client Letter of Support

Restoration Science LLC
4831 Rim Rd., Santa Barbara, CA 93105
California Lic. No. 201420310158



25 January 2023

Dear Bren MESM Evaluation Committee;

As the manager of Restoration Science LLC and Principal Investigator for the just-approved Integrated Water Resource Management grant (to be administered by UCSB-MSI) that is a focus of the proposed MESM study, I commit to making available data from the IRWM and other current and previous studies, facilitate access to resource managers in the Santa Clara River watershed, meet regularly with the Bren team to review research directions and progress, and provide logistical and financial support for carrying out a valuable project, including provision of $5,000 to support summer internships for participating students.

As coordinator of the Restoration Science Team, consisting of the following partners (not complete);

UCSB Marine Science Institute – Chris Jerde, Randy Long, Tom Dudley, Josefina Jaramillo, Conor McMahon, Chris Kibler,
Stillwater Sciences – Bruce Orr, Christian Braudrick, Karley Rodriguez, Danielle Yaconelli
Santa Clara River Conservancy – Shawn Kelly (a Bren School graduate)
Ventura Co. Resource Conservation District – Jamie Whiteford, Desirae Braga
Western Foundation for Vertebrate Zoology – Linnea Hall
US Geological Survey – Jim Hatten

I report that all have agreed to provide assistance, data and practical research experience to the Bren students who will participate, and we anticipate both technical reports and publications to results from the research program and Bren students would be considered equal partners in our program.

We have communicated with Scott Jasechko who has agreed to be the Bren faculty advisor and will bring extraordinary expertise to this ecohydrological study, and we anticipate collaborating with other Bren faculty and affiliates on key aspects of the project. We look forward to another successful Bren MESM project with high potential for benefiting natural resource policy and riparian biodiversity conservation.

Tom Dudley, Researcher
UCSB Marine Science Institute | Riparian Invasion Research Lab/RIVRLab