Title

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Journal

JAWRA Journal of the American Water Resources Association, 62(3)

ISSN

1093-474X

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Publication Date

2026-06-01

DOI

10.1111/1752-1688.70123

Peer reviewed

JAWRA Journal of the American Water Resources Association

AMERICAN WATER RESOURCES ASSOCIATION

COMMENTARY OPEN ACCESS

Cultivating Collaborative Water Leaders: The Power of Experiential Learning

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Received: 26 December 2025 | **Revised:** 12 April 2026 | **Accepted:** 4 May 2026

ABSTRACT

Water systems in the American West are under mounting stress as climate change accelerates aridification and tensions grow over competing demands for scarce water resources. As socio-ecological pressures compound, siloed thinking and governance undermine the development of innovative water management approaches. A new generation of water practitioners is rising to meet this challenge. But working within this complexity requires systems understanding, transdisciplinary expertise, cultural competence, and collaborative leadership. As a multidisciplinary group of graduate students and field program leaders working on water in the West, we argue that experiential learning offers a powerful pathway to prepare future water practitioners with the skills they need to address wicked water problems. In this Commentary we present a set of best practices, grounded in our shared experiential learning experience, to guide the design of inclusive and transformative field opportunities for students engaging with water challenges across diverse geographic contexts: (1) dedicated time to orient as a team; (2) circular mentorship that generates radial impacts; (3) place-based site visits; and (4) secure funding. We offer a case study in the Colorado River Basin to demonstrate how the application of these design principles can support future experiential learning initiatives that cultivate water practitioners equipped to work across institutional, cultural, and hydrologic boundaries.

1 | Introduction

Water management in the American West is a wicked problem, characterized by socio-ecological uncertainty, competing priorities, entrenched legal frameworks, and siloed thinking and governance (Freeman 2000; Hargrove and Heyman 2020). These systemic challenges are constantly evolving, making it difficult to find solutions that satisfy diverse water users. Overuse and climate change are on a collision course in the West, a crisis that promises to worsen as aridification intensifies shortages (Dettinger et al. 2015; Overpeck and Udall 2020). Yet, historical precedent has led to path dependencies and infighting in Western water management, limiting our collective capacity to adapt and to re-envision dominant paradigms (Dilling et al. 2023). Addressing these water challenges requires moving beyond the status quo through reflexive,[1] pluralistic thinking about power and scale, supported by collaborative practice bridging multiple disciplines (Macpherson et al. 2024; Rusca et al. 2026). As water professionals attempt to negotiate outdated water laws,

address aging infrastructure, and align management with uncertain hydrologic realities, the ability to bridge conflicting human interests with ecological interdependencies is crucial.

One antidote to addressing the wicked nature of Western water management lies in ensuring that practitioners,[2] especially early in their careers, are equipped with systems understanding, cross-sector fluency, collaborative capacity, and cultural competence. Systems understanding enables practitioners to analyze interconnected challenges, while cross-sector fluency empowers them to engage more effectively in developing constructive solutions across domains. Equally important is cultural competence, which we characterize as the ability to engage across cultural differences in contextually appropriate ways that prioritize humility, respect, adaptability, and continuous learning (Quigley 2015). Embodying these skills can help reduce the risk of perpetuating injustice[3] or deepening conflict.

Students across fields must be prepared to navigate difficult tradeoffs as they shape our water future. They must not only be technically skilled (e.g., through classroom-based learning and internships) but also well-versed in the on-the-ground reality of how water is negotiated, used, moved, and tracked across socio-ecological settings and scales. We argue that experiential learning (hereafter, EL) offers one of the most powerful pathways to prepare the next generation of water leaders with the expertise they need to solve our entangled water challenges.

1.1 | Western Water Case Study: Learning in Place

This Commentary centers on the Climate Adaptation Science Academy Experiential Learning Expedition (CASA ELE), a program organized by Secure Water Future, a multi-institutional research collaborative focused on water resilience across the semi-arid West. CASA ELE combines site visits, river rafting, and mentorship to build student familiarity with the complexities of water management, climate adaptation, and transdisciplinary collaboration.

In 2025, the 10-day CASA ELE program explored the Upper Colorado River Basin (UCRB) as a salient case study of growing pressures on Western water systems. Across the Colorado River Basin (CRB), the compounding effects of prolonged drought, changing snowpack-runoff dynamics, groundwater depletion, and legacy legal frameworks threaten water and food security for key ecosystems and over 40 million people (Schmidt et al. 2023). To understand the practices and perspectives of agricultural, municipal, industrial, and recreational users in context, our cohort visited the UCRB, meeting with farmers, water managers, a Tribal water resources department, policy advocates, and researchers. We also spent four days on the Yampa River, the last major free-flowing tributary of the Colorado River (Figure 1), alongside five career water practitioners, four raft guides, and three program leaders.

We write as the 2025 CASA ELE cohort, a team of eight graduate students and three program organizers from five public Western U.S. universities. With diverse personal histories, cultural heritages, and academic backgrounds spanning social science, earth science, engineering, and policy, we share a commitment to

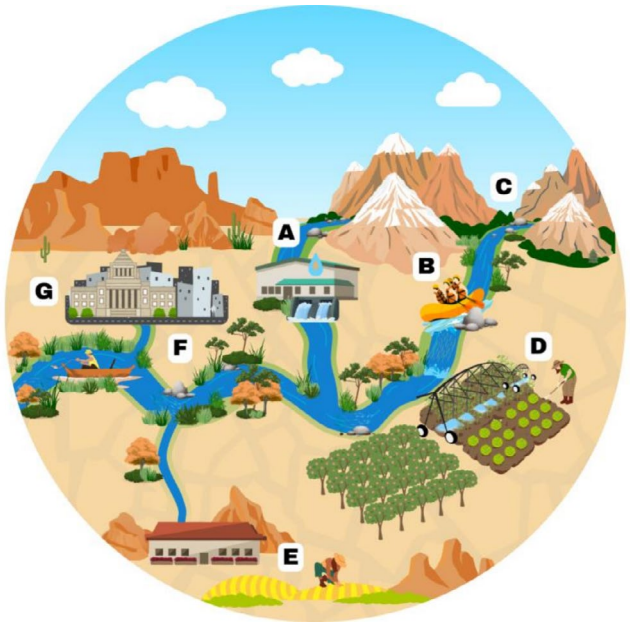

FIGURE 1 | Conceptual map of water sectors and institutional actors dependent on the Upper Colorado River Basin that participants investigated during CASA ELE 2025. (A) Hydropower: With over 1700 dams, the Colorado River Basin (CRB) has a hydropower capacity of 4,200 MW and contributes an affordable source of low-emission energy (U.S. Bureau of Reclamation 2021). (B) Recreation: The Colorado River and its tributaries support numerous recreational activities, including rafting, swimming, and fishing, generating important socioeconomic benefits for the region. (C) Unregulated Flows: Natural flow variability is vital for healthy river ecosystems, sustaining biodiversity, and supporting key processes such as channel formation and species' life cycles (Schook et al. 2016). (D) Agriculture: Spanning more than 5 million acres, irrigated agriculture accounts for roughly half of total CRB water use and supplies substantial produce, grains, and livestock feed for domestic and international markets (Richter et al. 2024). (E) Tribes: The CRB is home to 30 federally recognized Tribal Nations whose lives, livelihoods, and cultural relationships are sustained by the Colorado River and its tributaries (McKinney et al. 2023). (F) Municipalities: CRB water resources support over 40 million municipal water users, providing a critical portion of the water supply to major cities such as Phoenix (AZ), Las Vegas (NV), and Los Angeles (CA). (G) Basin Governance: CRB governance is distributed among hundreds of institutions, from municipal water agencies to irrigation districts, within and across basin and sub-basin boundaries.

building more just and resilient water futures. In composing this reflexive article, we held dual roles as participants and analysts, drawing on our own field notes and post-program reflections to contextualize our experiences. Though limited to our case and positionalities, we offer our reflections on one example of an EL program that others can further develop in their unique contexts. We believe the principles we detail hold relevance for a wide audience of students, faculty, and staff at academic institutions, along with potential funders, invested in water education.

Our cohort's CASA ELE demonstrated the significant value of field-based learning for equipping early career water practitioners with the skills they need to be effective future water leaders. While this commentary examines our shared experience in the UCRB, wicked water problems are ubiquitous, and we

believe this approach also has broad applicability across other geographic contexts. The transboundary basins of the Klamath River, Rio Grande/Bravo, and Great Lakes in North America, for instance, face similar tensions related to interstate governance, competing demands, ecological degradation, and hydroclimatic uncertainty (e.g., Doremus and Tarlock 2008; Richter et al. 2025; Annin 2019).

2 | Design Principles for Experiential Learning Expeditions

In this Commentary, we reflect on our cohort's field experience in the UCRB and identify four key design practices to guide the development of inclusive and transformative EL programs: (1) dedicated time to orient as a team; (2) circular mentorship models and dialogue that generate radial impacts; (3) place-based site visits that ground learning in diverse knowledge systems; and (4) funding structures that support equitable participation.

These observed best practices mirror other positive analyses of EL—that is, learners are curious and engaged participants; knowledge is situated in place and time; learners are exposed to new, challenging experiences; learning centers real-world problems; and reflection transforms experience into meaningful knowledge (Kolb 2015; Morris 2020). CASA ELE offers an example of these principles in action, while contributing a novel approach through our circular mentorship and radial impacts framework discussed below.

2.1 | Orienting as a Team

Successful collaboration and group integration depend on guidance and facilitation, especially among students and researchers shaped by distinct analytical traditions. The team orientation process lays the groundwork for honest dialogue and creative problem-solving across disciplinary languages and backgrounds. This process requires time and facilitation to build trust, respect, and collaborative capacity (Bennett and Gadlin 2012; Steger et al. 2021). EL offers a potent opportunity to fast-track this process through collaborative, hands-on experience.

Leadership and participants play key roles in ensuring successful team cohesion. CASA ELE leadership laid the groundwork by (i) setting clear goals, (ii) designing an intentionally heterogeneous cohort, and (iii) fostering engagement. Students then *opted in* and created a dynamic co-learning environment that transformed team orientation into team building.

i. Setting goals: CASA ELE 2025 aimed to introduce graduate students to the interconnected hydroclimatic and sociopolitical challenges we face in Western water management, while building skills in climate adaptation science, science communication, and transdisciplinary problem-solving in a field setting. In the months preceding the trip, program leaders established connections with water practitioners from diverse sectors who were willing to meet with our cohort, forming the basis of our itinerary (see Figure 1). Two months out, program leaders began facilitating weekly Zoom discussions on readings covering water justice, CRB governance, team science, and EL. Students were prompted to flag resonant quotes and come prepared to discuss connections to our research and personal experiences.

These regular meetings fostered interpersonal and domain-specific familiarity. For example, one conversation centered on a temporary release of Colorado River water to the delta along the U.S.–Mexico border for ecological restoration. This case led to an animated exchange about the value of water management actions with transient ecological and economic effects, but potentially pivotal sociopolitical impacts. Through these interactions, we developed a shared language, grounded in openness and curiosity, essential to an effective team dynamic.

During these meetings, we also reviewed the trip itinerary, set expectations for participant engagement, and established a list of trip goals and questions for site visit hosts, ensuring that everyone was prepared to make the most of the field experience.

ii. Cohort heterogeneity: Trip leaders intentionally assembled a group of graduate students from various disciplines, backgrounds, and institutions who could learn from one another and contribute to CASA ELE's learning objectives. Participants contributed insights from their lived experiences and prior work in both domestic and international contexts, broadening everyone's understanding of water challenges and solutions.

For example, drawing students with expertise in soil science in Peru and Utah into conversation with others focused on California groundwater policy surfaced cross-cultural commonalities that might not emerge within a disciplinary silo or in conversations where practitioners mostly share sociocultural worldviews and professional trajectories. As a cohort, we committed to building an inclusive and democratic learning community, allowing us to expand our conceptual repertoires and co-produce new forms of knowledge (Rusca et al. 2026).

iii. Fostering engagement: In the field, program leaders devised schedules that balanced formal meetings, reflection periods, writing activities, and unstructured social time to cultivate curiosity and support dialogic learning. For instance, while resting along a riverbank in Grand Junction on day one, we each answered the question, "What do you bring with you to the field?" Responses included "a notebook," "river waders," and "a voice recorder," offering windows into participants' values and training. This simple exercise quickly led us to recognize the complementary strengths of our respective methodological approaches, allowing us to "find common water."

These activities encouraged active listening and reflexivity, core components of adaptive management vital for achieving sustainability goals with diverse actors (e.g., McLoughlin et al. 2020; Moleka 2026). By gaining familiarity with each other's positionalities and problem-solving approaches, our team was better prepared to engage in honest dialogue about complicated topics like water rights and environmental justice. Rather than aiming to alleviate all frictions, these practices help transdisciplinary teams adeptly navigate the shared and divergent priorities that underlie water resource conflicts.

2.2 | Circular Mentorship

In EL settings, mentorship helps participants to navigate uncertainty and translate field-based insights into a more nuanced perspective. Mentorship is a critical component of knowledge transfer and is especially important within water systems, where information and governance are dispersed across generations and domains.

Conventional forms of mentorship are often top-down (see *vertical mentorship*, Figure 2), where a more experienced authority shares knowledge and skills with someone less senior (Keinänen and Gardner 2004). But in complex systems like Western water, knowledge sharing can benefit from *horizontal mentorship*, which emphasizes reciprocity and shared vulnerability among peers with diverse expertise (Martin and Olejnik 2025).

Building upon this idea and applying it to water systems, we argue that *circular mentorship*—wherein knowledge flows across generations, disciplines, and positions of authority non-hierarchically—is a more generative means of learning. Circular mentorship encompasses both horizontal mentorship and *rotating leadership*, where different people "shine" in different moments by drawing on their expertise in group settings (Martin and Olejnik 2025; Murrell et al. 2021; Gosser Jr. et al. 2010). In circular mentorship models, every participant is both a mentor and a mentee on a shifting basis. This form of learning places value on multiple forms of applied knowledge and lived experience, rather than only published scientific knowledge.

Circular mentorship is particularly applicable in water resource management, as it helps early career practitioners build the intra- and intergenerational social ties necessary for knowledge transfer and resilience in water systems (Wolfe et al. 2013). The capacity to listen across differences and bridge perspectives is an undervalued professional skill that is needed in fraught water negotiations across sectors.

CASA ELE's organizers encouraged circular mentorship by inviting six professionals with experience in water-related fields (e.g., ecology, hydrogeology, engineering, and policy) to join for four days of rafting on the Yampa River. Instead of establishing vertical mentor–mentee dynamics (e.g., through assigned advisors or scheduled lectures), participants were encouraged to move fluidly between roles in teaching and learning about each other's work. For example, in one moment, a professional hydrogeologist translated an abstract concept, water budgets, into a tangible lesson, pointing out cottonwood terraces that record wet and dry years. A student then chimed in, using that same environment to highlight the hydrologic and geomorphologic differences between managed and free-flowing rivers. Next, a raft guide described the careful calculations and expert maneuvers required to navigate river currents under high and low water conditions. This exchange would have been unlikely in a traditional classroom or field setting, where deference to senior researchers might have silenced students' perspectives, or where a raft guide's embodied knowledge might have been dismissed as anecdotal.

Spending four days in close proximity outside of formal settings reduced hierarchical barriers to communication, further supporting our circular mentorship model; together, we shaped an expedition ethos rooted in humility, adaptability, and creativity. We also expanded our networks across communities and built trusted relationships that we can call on in the future when confronting tough challenges in the water space. As one student framed it,

> Elevating curiosity empowers those with less expertise in a given subject area to guide group inquiry, leading to richer, more impactful learning. Curiosity and connection is what fuels professionals' lifelong commitment to learning, making them more adaptable to changing contexts they will encounter in the real world.

Deliberately training students using a circular mentorship model can inspire them to carry this approach forward into their home communities and wider settings. As students pass on and apply newly acquired knowledge and skills through their networks, they extend situated learning out into broader communities of practice (Lave and Wenger 1991). While Lave and Wenger's theory centers situated learning within sustained communities of practice, we expand this framework to encompass the downstream effects of intensive but ephemeral programs like CASA ELE. We characterize these ripple effects as *radial impacts*, including but not limited to participants' transfer of

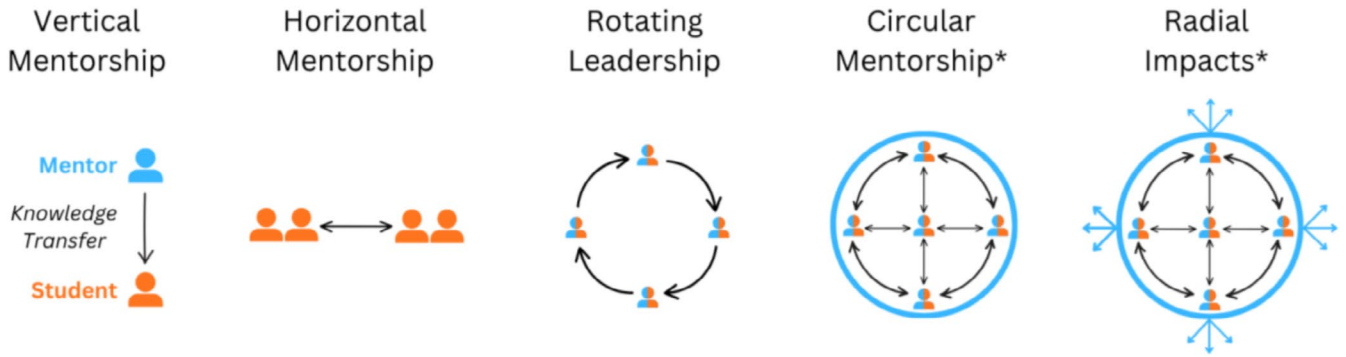

FIGURE 2 | Circular mentorship combines vertical and horizontal mentorship with rotating leadership, where participants alternate between mentor and mentee roles. It provides a reciprocal mode of knowledge sharing that can be carried into other settings, generating *radial impacts* that extend beyond the original learning environment. *Our distinct contributions to experiential learning frameworks.

knowledge, values, and engagement approaches gleaned from an EL experience.

Our cohort's water education initiatives over the past year illustrate how lessons from the UCRB trip have carried forward, producing radial impacts across subsequent efforts. For example, several participants have drawn on their CASA ELE experience to design and lead EL trips in the Noce (Italy), Yuba (CA), and Tuolumne River (CA) watersheds, along with a seminar on the CRB.

2.3 | Site Visits

Facilitated site visits are an essential component of water systems education, revealing the intertwined social-ecological and hydrological realities of water management in situ. While school classrooms build theoretical and technical knowledge bases, learning from practitioners onsite, with rivers and canyons as living classrooms, can anchor concepts in the complexities of the real world (Lave and Wenger 1991). Immersion in these outdoor and community settings can also inspire personal investment and action (Ardoin et al. 2026). This is critical for future water practitioners as we prepare to navigate contested management challenges in regions like the CRB, where deep divides across governance, science, and communities are entrenched in a profoundly altered hydrology (Scanlon et al. 2025).

Our 2025 CASA ELE cohort visited a range of sites in the UCRB as we traveled downriver, from the Shoshone Power Plant, the Colorado River Water Conservation District, and Colorado State University's Western Colorado Research Center to the Ute Indian Tribe Water Resources Department and Commission (WRDC) (Figure 1). These visits showed how larger forces, such as climate change and legacy allocative water policies translate, often unevenly, into local and individual impacts.

Each stop included structured and informal interaction; typically, our host shared a presentation or walking tour to provide historical context and an overview of their organizational responsibilities. During our visit with the Ute Indian Tribe WRDC, leaders presented on the tribe's history of water rights advocacy, leading to a discussion about displacement, structural racism, chronic disinvestment, and attritional water rights negotiations. In Colorado's Western Slope, an extension specialist demonstrated how to read drought in the curl of a grape leaf. At a Palisade cidery, peach farmers recounted their adaptation to shifting land and water rights claims. And along the rivers' edge, anglers and raft guides championed dam releases that promote local recreation economies and healthier fisheries.

At times, hosts' perspectives were in tension, highlighting the trade-offs inherent in water management and prompting us to reconsider our own assumptions about what an equitable outcome might entail. One difference in opinion related to the degree to which policies should prioritize investments in technological fixes versus fundamentally rethinking water governance frameworks, while another related to growers' willingness to forgo water use for compensation, leading to reflection on family legacies and evaporating livelihoods. These debates remained unresolved in our brief time together; yet they offered a window into the conflicting, sometimes existential, considerations water practitioners confront as they navigate cultural identity and hydrosocial relations.

Similarly, our team was not always in consensus about how to reconcile different knowledges and worldviews; a tension intrinsic to wicked water problems (Hargrove and Heyman 2020). The challenges and perspectives shared by each practitioner shifted our own thinking from seeking a single 'right' answer to a pluralistic systems approach that works within the messy politics of water (Börner et al. 2010; Rusca et al. 2026). These multiple pathways mirrored the compromises we will encounter in professional life, where problems rarely have straightforward solutions. We began to understand, as a program leader from our team expressed,

> Sometimes tension isn't going to get resolved and you just have to work within it. In fields like water, the most durable outcomes are often less about consensus and more about sustaining working relationships across differences and disagreements. And that comes back to trust, interpersonal knowledge, and grace you gain and give in these ELE-type settings that is harder to come by elsewhere.

Systemic reflection gave us a framework, but it was time on the river that instilled embodied knowledge and strengthened mutual trust, reinforcing our commitment to a more equitable water future. At the confluence of the Yampa and Green Rivers, we paused near the proposed site of Echo Park Dam, whose construction would have altered canyon ecosystems and flooded upstream reaches were it not for dedicated conservation advocacy. In this moment, the confluence symbolized the conflicting priorities at the heart of the basin, bringing our future water imaginaries[4] into clearer alignment with the lived consequences of policy and politics. Together, we grappled with the potential impacts of water allocation reforms and considered the reparative actions necessary to sustain the UCRB's long-term future.

While systems-level understanding and cultural competence cannot be fully developed over the course of a 10-day trip, EL can provide concentrated practice applying these skills, generating radial impacts as students embody this approach in future work.

2.4 | Funding

The existence of EL programs, and their accessibility to students from diverse backgrounds, depends on sustained funding and strong institutional support. Dedicated funding for staff time enables program leaders to design a cohesive itinerary and to build meaningful relationships with hosts, mentors, and students. Meeting onsite with practitioners requires robust funds for transportation, lodging, food, equipment, and course materials. Ensuring full financial support for every participant removes barriers to participation,[5] enabling students to focus on learning.

For Secure Water Future, sustained federal funding enabled the CASA ELE program to support 59 participants over 4 years of fully funded field experiences in highly contested watersheds across the West, including the Tuolumne River (CA) and the Rio Grande (NM). This continuity allowed organizers to iteratively evolve the program design, which annual funding cycles would not have allowed, and to lead several other programs, including a water science academy for Central Valley (CA) middle schoolers and Tuolumne River rafting trips for water sector professionals. Program leaders intentionally carried forward the ethos and circular mentorship structure of the UCRB trip by facilitating similar team orientation and field activities.

Funding one trip can have ripple effects. As graduate students at public institutions, we recognize the valuable and transformative opportunity we were given. Following our ELE, our cohort has remained in close conversation, sharing opportunities, co-authoring this paper, and leading previously mentioned learning experiences for other students. We have also stayed in touch with program mentors about research and professional pathways. This continued engagement demonstrates the radial impacts of EL in shaping lasting support networks across geographies, institutions, and disciplines, which secure funding enables.

3 | Conclusion

One of the challenges perpetuating our Western water paradigm is the siloed, distributed nature of water management. As the forces of past water governance decisions and resource management and present socio-ecological conditions collide, water practitioners find themselves facing complex and charged crises. To imagine solutions that move toward a more secure water future, we need to train water practitioners in ways that encourage them to build solutions that bridge disciplinary divides and competing priorities without perpetuating injustice.

In this commentary, we present four components critical to successful EL: (1) orienting as a team, (2) circular mentorship, (3) site visits, and (4) funding. Further, we argue that EL offers one of the most powerful pathways to equip early career water practitioners with the systems understanding, transdisciplinary expertise, collaborative capacity, and cultural competencies they need to address water challenges across contested, resource-limited water basins in the U.S. West and beyond. We offer these reflections in support of EL opportunities that invest in the adaptable, grounded, and culturally skilled future water leaders we need to address the evolving challenges of this and future eras.

Author Contributions

Cora Cliburn: conceptualization, writing – original draft, writing – review and editing, visualization. **Britta L. Schumacher:** conceptualization, writing – original draft, writing – review and editing, visualization. **Kira Zalis Waldman:** conceptualization, visualization, writing – original draft, writing – review and editing. **Daniel Rothberg:** conceptualization, writing – original draft, writing – review and editing. **Aneesa Gomez-Cervantes:** conceptualization, writing – original draft, writing – review and editing. **Masoumeh Hashemi:** conceptualization, writing – original draft. **Moises R. Duran-Gomez:** conceptualization, writing – review and editing. **Lindsay Murdoch:** conceptualization, writing – review and editing, visualization. **Jack Severson:** conceptualization, visualization, writing – original draft, project administration. **Lauren E. Parker:** conceptualization, writing – review and editing, writing – original draft, project administration. **Joshua H. Viers:** writing – review and editing, funding acquisition.

Acknowledgments

We thank the mentors and practitioners who joined the authors on the Climate Adaptation Science Academy Experiential Learning Expedition (CASA ELE) in May 2025. To program mentors Drs. Alex Fremier, Erika Gallo, Zeb Hogan, Sarah Otterstrom, and Ann Willis; and to CU-Boulder's Water Desk, the Western Colorado Research Center—Grand Valley, the Shoshone Power Plant, the Colorado River Conservation District, the Western Colorado Research Center—Orchard Mesa, Talbott Farms, and the Ute Indian Tribe Water Resources Department and Commission, we offer our deepest gratitude. Finally, thanks to our colleague and CASA ELE alumna Dr. Jenny Rempel for generous feedback on the arguments we present here, and to Abigail Chen and Melissa Chen for realizing Figure 1.

Funding

This work is supported in part by the Agriculture and Food Research Initiative Competitive Grant 2021-69012-35916 from the USDA National Institute of Food and Agriculture.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The authors have nothing to report.

Endnotes

[1] Drawing on multiple scholarly framings (Barry et al. 1999; Allen et al. 2019), our team defines "reflexivity" in research as an ongoing, critical process of individual and collective introspection on one's positionality (i.e., realities, identities, and knowledge) within a given context, undertaken in the pursuit of transformative learning and to deepen academic and societal relevance of a collaboration.

[2] Here we define "practitioners" as policymakers, organizational and civic leaders, agriculturalists, water operators, educators, scholars, and others who contribute to studying and stewarding water systems.

[3] Building on scholarship that conceptualizes water justice as relational and context-dependent (Zwarteveen and Boelens 2014; Harris et al. 2017; Sultana 2018), we define "water injustice" as the inequitable allocation of water-related resources, benefits, and harms within and across communities and scales. This includes inequities in the decision-making processes that affect participation, agency, and accountability.

[4] Water, or hydrosocial, imaginaries help us view water not only as a physical resource, but also as mediated and co-produced by the institutions and technologies that govern its social nature (Berry and Jackson 2018). These imaginaries encourage and constrain the kinds of actions we feel we can take (as possible, appropriate, reasonable, and legitimate).

[5] There are also substantial opportunities to innovate experiential learning programs to offer multimodal experiences that accommodate diverse physical, sensory, and cognitive needs (e.g., virtual field trips

leveraging interactive GIS tools or tactile maps or models). Funding is thus essential for expanding programmatic capacity and implementing more inclusive approaches to place-based water education.

References

Allen, S., A. L. Cunliffe, and M. Easterby-Smith. 2019. "Understanding Sustainability Through the Lens of Ecocentric Radical-Reflexivity: Implications for Management Education." *Journal of Business Ethics* 154: 781–795. https://doi.org/10.1007/s10551-016-3420-3.

Annin, P. 2019. *The Great Lakes Water Wars / Peter Annin*. Island Press.

Ardoin, N. M., A. Reid, A. W. Bowers, H. Ballard, and M. C. Monroe. 2026. "Engaging People in Educational Processes That Foster Environmentally Valuable Outcomes: A Synthesis of Key Findings Across Eight Systematic Reviews." *People and Nature*. https://doi.org/10.1002/pan3.70265.

Barry, C. A., N. Britten, N. Barber, C. Bradley, and F. Stevenson. 1999. "Using Reflexivity to Optimize Teamwork in Qualitative Research." *Qualitative Health Research* 9, no. 1: 26–44. https://doi.org/10.1177/104973299129121677.

Bennett, L. M., and H. Gadlin. 2012. "Collaboration and Team Science: From Theory to Practice." *Journal of Investigative Medicine* 60, no. 5: 768–775. https://doi.org/10.2310/JIM.0b013e318250871d.

Berry, K. A., and S. Jackson. 2018. "The Making of White Water Citizens in Australia and the Western U.S.: Racialization as a Transnational Project of Irrigation Governance." *Annals of the American Association of Geographers* 108, no. 5: 1354–1369. https://doi.org/10.1080/24694452.2017.1420463.

Börner, K., N. Contractor, H. J. Falk-Krzesinski, et al. 2010. "A Multi-Level Systems Perspective for the Science of Team Science." *Science Translational Medicine* 2, no. 49: 49cm24. https://doi.org/10.1126/scitranslmed.3001399.

Dettinger, M., B. Udall, and A. Georgakakos. 2015. "Western Water and Climate Change." *Ecological Applications* 25, no. 8: 2069–2093. https://doi.org/10.1890/15-0938.1.

Dilling, L., M. E. Daly, W. R. Travis, A. J. Ray, and O. V. Wilhelmi. 2023. "The Role of Adaptive Capacity in Incremental and Transformative Adaptation in Three Large US Urban Water Systems." *Global Environmental Change* 79: 102649. https://doi.org/10.1016/j.gloenvcha.2023.102649.

Doremus, H. D., and A. D. Tarlock. 2008. *Water War in the Klamath Basin: Macho Law, Combat Biology, and Dirty Politics / Holly Doremus, A. Dan Tarlock*. Island Press.

Freeman, D. M. 2000. "Wicked Water Problems: Sociology and Local Water Organizations in Addressing Water Resources Policy." *Journal of the American Water Resources Association* 36, no. 3: 483–491. https://doi.org/10.1111/j.1752-1688.2000.tb04280.x.

Gosser, D. K., Jr., J. A. Kampmeier, and P. Varma-Nelson. 2010. "Peer-Led Team Learning: 2008 James Flack Norris Award Address." *Journal of Chemical Education* 87, no. 4: 374–380. https://doi.org/10.1021/ed800132w.

Hargrove, W. L., and J. M. Heyman. 2020. "A Comprehensive Process for Stakeholder Identification and Engagement in Addressing Wicked Water Resources Problems." *Land* 9, no. 4: 119. https://doi.org/10.3390/land9040119.

Harris, L. M., S. McKenzie, L. Rodina, S. H. Shah, and N. J. Wilson. 2017. "Water Justice: Key Concepts, Debates and Research Agendas." In *The Routledge Handbook of Environmental Justice*. Routledge. https://doi.org/10.4324/9781315678986-27.

Keinänen, M., and H. Gardner. 2004. "Vertical and Horizontal Mentoring for Creativity." In *Creativity: From Potential to Realization*, edited by R. J. Sternberg, E. L. Grigorenko, and J. L. Singer, 169–193. American Psychological Association. https://doi.org/10.1037/10692-010.

Kolb, D. A. 2015. "Experiential Learning: Experience as the Source of Learning and Development." Pearson Education.

Lave, J., and E. Wenger. 1991. *Situated Learning: Legitimate Peripheral Participation*. Cambridge University Press. https://doi.org/10.1017/CBO9780511815355.

Macpherson, E., R. I. Cuppari, A. Kagawa-Viviani, et al. 2024. "Setting a Pluralist Agenda for Water Governance: Why Power and Scale Matter." *Wiley Interdisciplinary Reviews: Water* 11, no. 5: e1734. https://doi.org/10.1002/wat2.1734.

Martin, C., and M. Olejnik. 2025. ""I Couldn't Have Done This Without You": Encouraging Horizontal Mentoring in Graduate Degree Programs." *Composition Forum* 55. https://compositionforum.com/issue/55/horizontal-mentoring/.

McKinney, M., J. Weiner, and D. Vigil. 2023. "First in Time: The Place of Tribes in Governing the Colorado River System Part II: Reprints." *Foundation Journal for Natural Resources and Energy Law* 60, no. 2: 359–406.

McLoughlin, C. A., M. C. Thoms, and M. Parsons. 2020. "Reflexive Learning in Adaptive Management: A Case Study of Environmental Water Management in the Murray Darling Basin, Australia." *River Research and Applications* 36, no. 4: 681–694. https://doi.org/10.1002/rra.3607.

Moleka, P. 2026. "Adaptive Water Governance Under Climate Uncertainty." In *The Palgrave Encyclopedia of Sustainable Resources and Ecosystem Resilience*, 1–10. Springer Nature Switzerland. https://doi.org/10.1007/978-3-030-67776-3_87-1.

Morris, T. H. 2020. "Experiential Learning–A Systematic Review and Revision of Kolb's Model." *Interactive Learning Environments* 28, no. 8: 1064–1077. https://doi.org/10.1080/10494820.2019.1570279.

Murrell, A. J., S. Blake-Beard, and D. M. Porter Jr. 2021. "The Importance of Peer Mentoring, Identity Work and Holding Environments: A Study of African American Leadership Development." *International Journal of Environmental Research and Public Health* 18, no. 9: 4920. https://doi.org/10.3390/ijerph18094920.

Overpeck, J. T., and B. Udall. 2020. "Climate Change and the Aridification of North America." *Proceedings of the National Academy of Sciences* 117, no. 22: 11856–11858. https://doi.org/10.1073/pnas.2006323117.

Quigley, D. 2015. "Building Cultural Competence in Environmental Studies and Natural Resource Sciences." *Society & Natural Resources* 29, no. 6: 725–737. https://doi.org/10.1080/08941920.2015.1080338.

Richter, B. D., K. Abdelmohsen, S. Dhakal, et al. 2025. "Overconsumption Gravely Threatens Water Security in the Binational Rio Grande-Bravo Basin." *Discover Water* 5: 104. https://doi.org/10.1007/s43832-025-00301-2.

Richter, B. D., G. Lamsal, L. Marston, et al. 2024. "New Water Accounting Reveals Why the Colorado River No Longer Reaches the Sea." *Nature Communications Earth & Environment* 5, no. 1: 134. https://doi.org/10.1038/s43247-024-01291-0.

Rusca, M., M. Zwarteveen, A. Acharya, R. Alba, M. Haeffner, and T. Krueger. 2026. "Water Justice Needs Careful Interdisciplinary Research." *Nature Water* 4, no. 3: 277–286. https://doi.org/10.1038/s44221-026-00595-z.

Scanlon, B. R., D. R. Pool, A. Rateb, et al. 2025. "Multidecadal Drought Impacts on the Lower Colorado Basin With Implications for Future Management." *Communications Earth & Environment* 6, no. 1: 214. https://doi.org/10.1038/s43247-025-02149-9.

Schmidt, J. C., C. B. Yackulic, and E. Kuhn. 2023. "The Colorado River Water Crisis: Its Origin and the Future." *WIREs Water* 10, no. 5: e1672. https://doi.org/10.1002/wat2.1672.

Schook, D. M., E. A. Carlson, J. S. Sholtes, and D. J. Cooper. 2016. "Effects of Moderate and Extreme Flow Regulation on Populus Growth Along the Green and Yampa Rivers, Colorado and Utah." *River Research and Applications* 32, no. 8: 1698–1708. https://doi.org/10.1002/rra.3020.

Steger, C., J. A. Klein, R. S. Reid, et al. 2021. "Science With Society: Evidence-Based Guidance for Best Practices in Environmental Transdisciplinary Work." *Global Environmental Change* 68: 102240. https://doi.org/10.1016/j.gloenvcha.2021.102240.

Sultana, F. 2018. "Water Justice: Why it Matters and How to Achieve It." *Water International* 43, no. 4: 483–493. https://doi.org/10.1080/02508060.2018.1458272.

U.S. Bureau of Reclamation. 2021. "Colorado River Basin—SECURE Water Act Section 9503(c)—Report to Congress." Bureau of Reclamation, U.S. Department of the Interior. https://www.usbr.gov/climate/secure/docs/2021secure/basinreports/ColoradoBasin.pdf.

Wolfe, S. E., S. Davidson, and T. Reid. 2013. "Mentorship, Knowledge Transmission and Female Professionals in Canadian Water Research and Policy." *Water Policy* 15, no. 4: 610–627. https://doi.org/10.2166/wp.2013.200.

Zwarteveen, M. Z., and R. Boelens. 2014. "Defining, Researching and Struggling for Water Justice: Some Conceptual Building Blocks for Research and Action." *Water International* 39, no. 2: 143–158. https://doi.org/10.1080/02508060.2014.891168.