

Water Resources Extension: Empowering Action Through Knowledge

*Karen Bareford^{1,2}, Mary J. Donohue³, Michael Mezzacapo^{3,4}, and Darren T. Lerner³

¹Mississippi-Alabama Sea Grant Consortium; ²The University of Alabama, Alabama Water Institute;

³The University of Hawai'i Sea Grant College Program; ⁴The University of Hawai'i Water Resources Research Center;

*Corresponding Author

The topic of water resources is vast in its diversity and complexity as well as its integration with all components of the environment. In 2018, the editors of this special issue, as part of a National Sea Grant Water Resources Visioning Team, participated in an informal assessment of water resources-related efforts across the National Sea Grant College Program network. The Team received information from 25 individuals, representing 19 of the 34 state Sea Grant programs. No less than 56 discrete topics were identified within the context of water resources by this small sampling effort (Sea Grant 2018). The topics ranged from human health issues, such as access to safe drinking water; risks associated with flooding and drought; water infrastructure needs; land and water management; and social and economic issues associated with access to, and competing uses for, water. Clearly, water resources offer an abundance of challenges that demonstrate an ongoing need for reliable and trusted information.

Professional extension can provide this reliable and trusted information to communities in need, especially in critical times—for example, during natural disasters—when access to resources and knowledge may mean survival. At its most basic level, extension is the conveyance of information. However, there is no widely accepted definition for the term. For many years the focus of extension was often farming and farmers. However, the implementation of extension has expanded widely to encompass informational needs at the watershed scale as well as in marine, coastal, and Laurentian

Great Lakes environments. Much of this work in the United States (U.S.) is underpinned by a national academic and legislative foundation (Figure 1).

The U.S. System of Extension (extending science) is directly tied to, and reliant upon, the research capacities of the larger university enterprise. The extension system provides a critical connection between and among institutions and local communities, a mutualistic relationship with synergistic intent that is anchored in a grounded understanding of current needs, challenges, and opportunities to inform applied research. Extension is in turn necessarily responsive, offering needed information in accessible ways that local communities and individuals can and will use to make more informed decisions. The work of the extension agents and specialists that bridge these two worlds is often referred to as a “professional art.” They must understand science and technical data as well as be able to translate it to be easily understood and utilized by their target audience(s). Extension professionals must be agile and able to adjust and adapt to new and changing needs, be problem-solvers, and above all able to communicate and collaborate within the expectations and identities of the local culture without advocacy. This last is an absolutely critical component and the “superpower” of extension professionals; to convey knowledge and understanding without “pushing” any agenda to enrich the recipient’s informed choice.

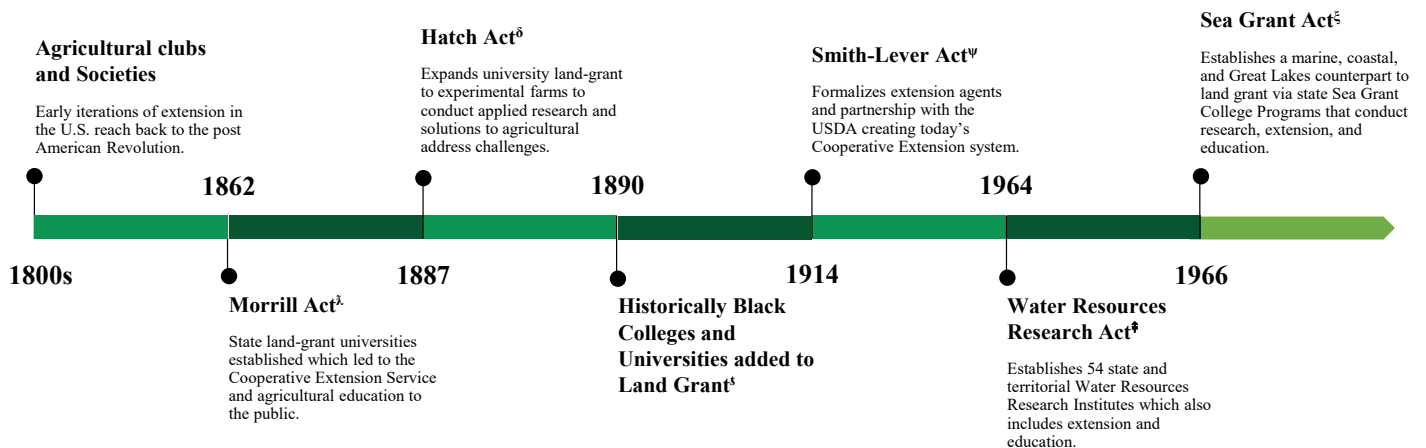
We have seen the expansion of extension needs and audiences over the last 50 years, and expect this trend to continue as our economy and social

needs change. Revolutionary technologies and the democratization of science learning has brought new ways to connect people with information, equipment, and each other. Accessibility is enhanced through online engagement and dialogue, though awareness and care are needed to not repeat injustices of the past and ensure access to everyone, e.g. bridging the digital divide. Like many systems built in the past, extension has not been without its own injustices toward people of color, Indigenous, and other disenfranchised individuals. We recognize that the extension of the future must necessarily face this past while seeking to develop and share information for the betterment of all persons residing in our country and across our globe. The activities described in this special issue demonstrate that extension remains a vital, critical service by which to improve the experience of individuals, communities, and our nation.

Many communities face acute and chronic water related challenges across the U.S. in both times of crises and everyday life. Access to clean water is vital, yet sometimes not given the critical attention it deserves, due to assumptions of a robust water treatment and delivery system in the U.S. This is especially demonstrated by those who themselves are not subject to questionable water quality or supply in their routine activities and homes. However, according to a recent analysis

by Mueller and Gasteyer (2021), approximately 490,000 households in the U.S. lack complete plumbing and have poor overall water quality. Many of these households are associated with rural locations, Indigenous populations, and social dimensions surrounding poverty, education, and age (Mueller and Gasteyer 2021). Water related challenges are exacerbated by the global climate crisis and associated impacts such as more frequent natural disasters such as hurricanes and floods. Extension offers opportunities to link community, local, state, and national government agencies; non-profits; and industry with university capacity and resources to better understand and address water resources issues in the communities in which we live, work, and play.

Given the complex and interrelated nature of the water-related issues currently faced, including the resulting social and economic dilemmas and inequities, the need for water extension has never been more paramount. After all, water is needed for every aspect of life, directly or indirectly. Because the necessity is so great, and extension provides a pathway to broadly empower action and change, the editorial team sought to highlight a diverse set of water-related extension efforts at multiple scales and geographic locations. This work demonstrates the impact of extension work being done across our nation now, and highlights the importance and need for more integration of extension across



¹Morrill Act of 1862, 37 Cong. Ch. 130, 12 Stat. 503 (July 2, 1862) (codified at 7 U.S.C. § 301 et seq.)
²Hatch Act of 1887, 49 Cong. Ch. 314, March 2, 1887, 24 Stat. 440 (Mar. 2, 1887) (codified at 7 U.S.C. § 361a et seq.)
³Second Morrill Act of 1890, 51 Cong. Ch. 841, 26 Stat. 417 (Aug. 30, 1890) (codified at 7 U.S.C. §§ 321 to 326, 326a, 328)
⁴Hatch Act Amendment extending to Alaska, Hawaii, and PR: [no short title], 84 Cong. Ch. 790, 69 Stat. 671 (Aug. 11, 1955) (same codification as original)
⁵Smith-Lever Act of 1914, 63 Cong. Ch. 79, 38 Stat. 372 (May 8, 1914) (codified at 7 U.S.C. § 341 et seq.)
⁶Water Resources Research Act of 1984, Pub. L. 98-242, 98 Stat. 97 (Mar. 22, 1984) (codified at 42 U.S.C. § 10301 et seq.)
⁷National Sea Grant College and Program Act of 1966, Pub. L. No. 89-688, 80 Stat. 998 (1996) (codified at 33 U.S.C. Ch. 22, Subch. II).

Figure 1. Key national legislation underpinning professional extension in the United States.

all research, management, and policy endeavors. This issue provides specific research and outreach examples by which extension is addressing on-the-ground water resources challenges and supporting actionable community change.

If we are to meet the needs of our changing world and society, it will require the full extension enterprise (including Cooperative Extension, The National Oceanic and Atmospheric Administration (NOAA) National Sea Grant College Program, and the United States Geological Survey (USGS) Water Resources Research Institutes and Centers, among others). The Cooperative Extension System includes a network of education and extension agents in each state. This network of faculty and staff experts largely work within the Land Grant University System. The National Sea Grant College Program includes a network of more than 500 on-the-ground extension specialists and agents who are trusted experts and have earned a reputation as conveyors of science-based information within their communities. Sea Grant extension specialists and agents are part of a network of professionals, including communicators and educators, who connect university resources and expertise with local communities and user groups in 34 coastal and Laurentian Great Lakes states, as well as Puerto Rico, Guam, and the U.S. Affiliated Pacific Islands (USAPI). The USGS Water Resources Research Institutes and Centers provide outreach, technology transfer, and education services based on the research conducted in their respective states and communities to aid in the resolution of state and regional water problems. One Water Resources Institute or Center exists in each of the 50 states as well as the District of Columbia, Puerto Rico, the U.S. Virgin Islands, and Guam. Here too, through programs in Hawai'i and Guam, programmatic content and activity spans the USAPI.

This issue presents five original research articles and five case studies. The original research spans the U.S. geographically and socioeconomically from Vermont, Ohio, and California to Texas and also includes one paper that focuses on a project in Columbia. The case studies include two examples with national scope, along with state-based studies from Wisconsin, Minnesota, and Mississippi and Alabama. Topics addressed include a breadth of critical water resources concerns from water quality

(including harmful algal blooms, environmental plastic pollution, and drinking water contaminants) to implementation of best management practices, conservation agreements, a serious game that addresses nonpoint source pollution and resilience, a fellowship program, an urban stormwater research program, and oyster aquaculture. These manuscripts offer exceptional examples of extension, with contributions representing multiple extension enterprise organizations. They also demonstrate the diversity of water resources challenges and the myriad ways extension is being used to address those challenges. A short synopsis of each paper is provided below. We hope you find yourself informed and inspired by the work of these dedicated extension scholars.

Vaughan et al. describe how Lake Champlain has witnessed an increase in cyanobacteria blooms, impacting public health and recreation. A lake-wide cyanobacteria monitoring program has existed since 2000. However, advances in science and technology have brought programmatic changes to sampling efforts and the communication of risks. The article follows the evolution of the program and highlights the shift in focus to a qualitative approach, consisting of visual assessments, ground-truthed by water samples. Expanding monitoring, communication, and inclusion of a greater number of stakeholders has improved the monitoring program. Community volunteers generate timely data on bloom conditions, strengthening the geographic coverage of the program and the environmental literacy of lake users.

Talley et al. developed a community science program model to recruit, retain, and educate diverse populations in a study about trash in an urban watershed. The program was piloted, and found that recruitment strategies were successful, and that environmental stewardship was increased. In addition, the programs collected data about the trash found in the urban watershed, showing that the sources included homeless encampments, illegal dumping, and flow from stormwater drains. The study offers critical advancements in understanding how to empower diverse populations to contribute to, influence, use, and participate in science.

Berthold, Olsovsky, and Schramm describe research to understand if direct mailing educational materials to landowners in Lavaca County, Texas

could be used as an effective outreach approach to increase adoption of best management practices. They implemented a mass mailing campaign that included four mailings with the same messaging to more than 4900 landowners over approximately six months. Their findings showed that the mailings were effective in increasing the adoption of best management practices.

Bartolotta and Hardy utilize mixed methods to explore consumer support for, evaluate the ramifications of, and ascertain the effectiveness of a plastic bag ban in Cleveland, Ohio. The research showed that participants were supportive of limiting access to plastic bags, and that most individuals had access to reusable bags. However, they also found that voluntary reduction in plastic bag use by consumers was not effective, indicating that restrictive store policies or legislation would be required to reduce the use of plastic bags. This study contributes to the understanding of best management practices in implementing potential plastic bag bans.

Meza Prado et al. analyze the goals and motivations of upstream actors in a watershed investment program in Columbia to show the benefits for and contributions of those actors in addition to downstream participants. While upstream actors found value in the conservation benefits, they were also motivated by personal and community goals. As the program took time to build trust in this rural community, researchers learned how upstream participants' goals and motivations could be used to help downstream actors engage in more productive and equitable ways with upstream participants. This study offers useful lessons for watershed managers in recognizing the efforts of local landowners and connecting up and downstream actors.

Janasie, Deans, and Harris review efforts by the National Sea Grant Law Center to increase awareness and understanding of the legal framework for drinking water protection in regard to three contaminants: lead, nitrates, and PFAS. The team conducted comprehensive legal research, identified gaps and potential solutions, and finally developed outreach programming to inform stakeholders for each contaminant. The outreach approaches were specific to the audiences most in need of information to inform critical decisions

related to that contaminant. The case study offers synergies between the legal analysis and extension by introducing readers to the legal analysis and solutions and by engaging stakeholders through an informed decision-making process.

Bareford et al. chronicle a case study where a multi-method needs assessment was conducted to identify water quality and management challenges in U.S. coastal regions and inform the expansion of a serious game to include coastal watersheds. Results showed high agreement among assessment methodologies regarding the most critical coastal challenges and important land uses to feature in the game. The results were used to produce a new model of an existing serious game that helps teach adults about how land use choices impact water quality and resilience to flooding across an entire watershed basin.

Voter et al. detail an adaptive fellowship model for early-career researchers in water resources. The fellowship allows post-masters and post-doctoral fellows to lead research projects focusing on high priority challenges identified by governmental agencies. The fellows receive mentorship from academic and agency personnel, and co-produce actionable knowledge. The model has proven to be a "win" for the fellows, the university, state agency partners, and the stakeholders that ultimately use the knowledge produced. The manuscript describes the model from the perspective of the fellows, agency mentors, and the university, and offers insights on how the model could be adapted for use in other states.

Bilotta and Peterson describe a collaborative process which developed a research program in urban stormwater management. The program obtains funding and engages diverse entities to build partnerships and identify strategic priorities for research. It then oversees a research competition and aids in the transfer of technology developed from the funded research. The program is a robust, comprehensive, and well-funded urban stormwater research program that advances science that embraces a collaboration of stormwater practitioners, policymakers, and professional researchers. The program has the potential to serve as a model of stormwater research collaboration, and could grow to address local, regional, and national needs.

Walton and Swann present the unique approach and investments by the Mississippi-Alabama Sea Grant Consortium to develop commercial off-bottom oyster aquaculture (COOA) in Alabama and Mississippi. The program utilized a network of partnerships, collaborations with other Sea Grant programs, Cooperative Extension, and stakeholders to establish COOA farms along the coast of the northern Gulf of Mexico. The core model can be used to leverage additional support from other funding agencies, helping to exponentially increase outcomes and impacts across the community. By combining applied research projects on farms, Extension projects, and outreach efforts, the approach demonstrates that COOA farms can yield measurable outcomes with significant impacts in coastal communities.

Acknowledgements

This issue was funded in part by a grant/cooperative agreement from the National Oceanic and Atmospheric Administration, Project A/AS-1, which is sponsored by the University of Hawaii Sea Grant College Program, SOEST, under Institutional Grant No. NA18OAR4170076 from NOAA Office of Sea Grant, Department of Commerce. The views expressed herein are those of the author(s) and do not necessarily reflect the views of NOAA or any of its subagencies. UNIH-SEAGRANT-JC-21-07.

Author Bio and Contact Information

KAREN BAREFORD, PH.D. (corresponding author) is the Sea Grant Water Resources Lead. Karen works for the University of Alabama, in conjunction with the Mississippi-Alabama Sea Grant Consortium. She is working to develop a roadmap for Sea Grant water resources initiatives and improve communication and coordination across the network and among key partners. Prior to her current position, Karen spent more than 15 years working in coastal and ocean conservation and management, coastal planning, and in facilitating access to critical water data to inform local planning. Karen has a Ph.D. in Urban and Regional Planning, a Master of Science in outdoor recreation, and a Bachelor of Science in public affairs. She can be contacted at kjbareford@ua.edu or via mail at Alabama Water Institute, Box 870206, Tuscaloosa, AL 35487-0206.

MARY J. DONOHUE, PH.D. is the Program Development and National Partnership Specialist at the University of Hawai'i Sea Grant College Program. Her prior position was as a Federal Research Biologist with the

National Oceanic and Atmospheric Administration, Pacific Islands Fisheries Science Center. She has served as an invited subject matter expert on two National Academies of Sciences, Engineering, and Medicine Committees and associated reports. In 2021, she served as senior author on a strategic vision document for the United States Geological Survey (USGS) Water Resources Research Act Program (WRRAP) that will guide and direct national activities of the WRRAP for the next ten years. She can be contacted at donohuem@hawaii.edu or via mail at The University of Hawai'i Sea Grant College Program HIG 238, Honolulu, HI, 96822.

MICHAEL MEZZACAPO, M.S. is a research affiliate in environmental policy at The University of Hawai'i Water Resources Research Center and Hawai'i Sea Grant College Program. His professional interests include water quality, human health, and behavioral change. Michael was appointed to the State of Hawai'i Cesspool Conversion Workgroup in 2019 and is assisting with the development of a statewide outreach plan and prioritization and upgrade scheme to convert the state's cesspools. He can be contacted at mmezz@hawaii.edu or via mail at The University of Hawai'i Water Resources Research Center 2540 Dole St., Holmes Hall 283, Honolulu, HI 96822.

DARREN T. LERNER, PH.D. is director of the Hawai'i Sea Grant College Program, guiding and overseeing a program of research, extension, and education in Hawai'i and the USAPI. He also serves as Consortium Director for the Pacific Islands Climate Adaptation Science Center and affiliate research faculty at the Hawai'i Institute of Marine Biology. Lerner earned his bachelor's degree in political science (minor in psychology) from the University of Missouri, master's degree in zoology from Oregon State University, and Ph.D. in organismic and evolutionary biology from the University of Massachusetts. He moved to Hawai'i in 2006 and was hired by Hawai'i Sea Grant in 2007. He can be contacted at lerner@hawaii.edu or via mail at The University of Hawai'i Sea Grant College Program HIG 238, Honolulu, HI, 96822.

References

- Mueller, J.T. and S. Gasteyer. 2021. The widespread and unjust drinking water and clean water crisis in the United States. *Nature Communications* 12: 3544. Available at: <https://doi.org/10.1038/s41467-021-23898-z>. Accessed October 29, 2021.
- Sea Grant. 2018. 10-Year NOAA Sea Grant Water Resources Vision. Available at: https://seagrant.noaa.gov/Portals/1/2018%20SG%20Water%20Resources%20Vision_1.pdf. Accessed October 25, 2021.