

**Maine Water Resources Research Institute
Senator George J. Mitchell Center for Environmental and
Watershed Research**

**Annual Technical Report
2018**

General Information

Products

Warner, Kathryn, "Ecological and Economic Implications of Increased Storm Frequency and Severity for Boreal Lakes" (2019). Electronic Theses and Dissertations. 2954.
<https://digitalcommons.library.umaine.edu/etd/2954>

Gerard, Brett, "Stream Dynamics in the Headwaters of Post-Glacial Watershed Systems" (2018). Electronic Theses and Dissertations. 2948.
<https://digitalcommons.library.umaine.edu/etd/2948>

Warner, Kate A., Jasmine E. Saros (2019). Variable responses of dissolved organic carbon to precipitation events in boreal drinking water lakes. *Water Research* 156 (2019) 315-326.
<https://www.sciencedirect.com/science/article/pii/S0043135419302556>

Kullberg, Alyssa (2018). Presence and Potential Sources of Pharmaceutical and Personal Care Product Chemicals in Messalonskee Lake. "Undergraduate Honors Thesis." Environmental Studies Program, Colby College, Waterville, Maine. 111 pages.

Dorland, Ryan, Brie Holme (Winter 2019). New Sebago Lake Buoy makes real time data available to researchers and the public, Sebago Lake Watershed News, 1-2. <https://www.pwd.org/sites/default/files/2019-watershed-news-winter.pdf>

Whalen, Nate (Summer 2019). Water watch: Sebago Lake Monitoring Buoy can help you catch more fish. Sebago Lake Watershed News, 7. <https://www.pwd.org/sites/default/files/sebago-lake-watershed-summer-2019.pdf>

Saros, Jasmine (2019). Study finds changing dissolved organic carbon in Maine lakes key to maintaining drinking water quality. *UMaine Today*, April 16, 2019. <https://umaine.edu/news/blog/2019/04/16/study-finds-changing-dissolved-organic-carbon-in-maine-lakes-key-to-maintaining-drinking-water-quality/>

Nelson, Sarah. "Changing Winters". Wordpress website, 2019. <https://changingwinters.wordpress.com/>

Leshner, Emily. "Sebago Lake Symposium". St. Joseph's College website, 2019.
<https://www.sjcme.edu/centers/sustainable-communities/sebago-lake-symposium/>

Leshner, Emily. "Sebago Lake Monitoring Buoy". Portland Water District website, 2018. <https://www.pwd.org/sebago-lake-monitoring-buoy>

Information Transfer Program

The Mitchell Center's focus is on innovative stakeholder-engaged, solutions-driven, interdisciplinary research. As such, all research projects, including Maine WRRRI projects, involve active stakeholder involvement in as many project aspects as feasible.

Maine Sustainability & Water Conference – The 2019 conference (3/28/19, Augusta Civic Center, attendance ~390) included a keynote address; 14 concurrent sessions, 8 on water resources; and a student poster competition including 3 high school, 18 undergraduate, and 14 graduate posters. WRRRI researchers are required to present.
<https://umaine.edu/mitchellcenter/2019-conference/>

Mitchell Lecture on Sustainability – The 2018 lecture (10/4/18, UMaine) was attended by over 500 people. The keynote speaker was Senator George Mitchell who spoke on, "Healing our Democracy".
<https://umaine.edu/mitchellcenter/news/mitchell-lecture/>

Sustainability Talks! – A weekly speaker series offered during fall and spring semesters. Talks are streamed for off-

campus researchers, students and stakeholders, and also recorded and posted to Vimeo. Total annual attendance ~800. <https://umaine.edu/mitchellcenter/seminars/>

Northern Maine Children's Water Festival – A one-day event attended by over 650 4th-6th grade students from northern Maine. The 2018 festival (10/9/18, UMaine) included an interactive exhibit hall, quiz show, various hands-on classroom presentations, and a live stage show. <https://umaine.edu/mitchellcenter/childrens-water-festival/>

Mitchell Center Website/e-newsletter – The web site (<http://umaine.edu/mitchellcenter/>) is the most important location for finding information on Mitchell Center activities including for Maine WRI. An e-newsletter, with over 2,000 subscribers, is published every 3-4 weeks. Articles link directly to full posts on the website.

Mitchell Center Facebook Page – The page is used to provide brief updates and links to Mitchell Center/WRI stories, events, etc. In general, postings are 2-3 items/week. facebook.com/MitchellCenterForSustainabilitySolutions/.

Student Support

Students supported by annual base (104b) funds: 3 Doctoral students; 2 Masters students; 4 Undergraduate students.

Notable Achievements and Awards

Emma Fox, PhD Student - All Maine Women Mentorship Award (2019), All Maine Women Honor Society, University of Maine.

Emma Fox, PhD Student - Edith M. Patch Award Distinguished Nominee (2019), Friends of Edith Patch, University of Maine.

Kaitlyn Raffier, Undergraduate Student - Edith M. Patch Award Distinguished Nominee (2019), Friends of Edith Patch, University of Maine.

Emma Fox, PhD Student - Outstanding Mentorship for a Student in Sustainability Research Award (2018), Senator George J. Mitchell Center for Sustainability Solutions, University of Maine.

Sharon Klein, Faculty - Donald Harward Faculty Service-Learning Award (2019), Maine Campus Compact.

Kaizad Patel and Sarah Nelson developed a syllabus for an undergraduate/graduate Special Topics course, EES 4XX/5XX Measuring the Changing Winter Environment, that will serve as the template for future winter course offerings.

Related proposal submissions:

Weiskittel et al., 2019. NSF RII Track 2 FEC: Leveraging Intelligent Informatics and Smart Data for Improved Understanding of Northern Forest Ecosystem Resiliency (INSPIRES). Funded. \$6 million.

De Urioste-Stone et al. 2019. NRT-Enhancing Conservation Science and Practice: An Interdisciplinary Program. National Science Foundation (NSF). Funded. \$2.9 million.

Leshner et al., 2019. Enriching K-12 Science Education in York and Cumberland Counties and Protecting Sebago Lake-Greater Portland's Water Supply Through a Research Project on Microplastics. Narragansett Number One Foundation. Funded.

Projects

Contamination of Messalonskee Lake by pharmaceuticals and chemical ingredients in personal care products: an emerging ecological and public health threat (seed project)

Project Type: Annual Base Grant **Project ID:** 2017ME326B

Project Impact: The team investigated the presence and potential sources of 18 pharmaceutical and personal care products (PPCPs) in Messalonskee Lake, Maine. Five PPCPs were detected in the lake: caffeine, 1,7-dimethylxanthine (a caffeine metabolite), acetaminophen, sulfachloropyridazine (a veterinary antibiotic), and amphetamine. PPCPs were more prevalent at public high-use sites on the lake, notably a public beach and a boat launch. Some sites had no PPCP detections. The number of detections and concentrations are similar to other studied lakes not impacted by wastewater treatment plants. Overall, Messalonskee Lake is not highly contaminated with PPCPs, but the potential ecological and human health impacts of long-term exposure to the low levels of PPCPs found in this study should be investigated. Sources of the five PPCPs was undetermined, but the most likely source may be direct human input via urination, other direct contact with water, or dumping of beverages or consumer products containing these chemicals directly into the lake. A survey of lake residents about their septic systems did not collect any evidence that old or leaking septic systems may be to blame. The team collaborated with the Friends of Messalonskee, a group comprised of lake residents, and communicated their findings to them. Researchers were not able to identify the sources of PPCPs in the lake, but preliminary data do not point to leaking septic systems as a primary source. As these chemicals were found at low levels and break down fairly rapidly in freshwater, a need for remediation is not seen.

Developing evaluative methods for group participatory decision support in riverine systems

Project Type: Annual Base Grant **Project ID:** 2018ME330B

Project Impact: The research team finds that stakeholders have a wealth of experience from which to draw on to co-generate ideas about evaluative criteria to consider in the assessment of participatory decision-making. While some of these evaluative criteria overlap with those from the literature on public participation in environmental decision making (National Research Council, 2008), collaborative learning relevant to contentious natural resource issues (Daniels & Walker, 2001, 2012), and praxis in environmental communication (Depoe, Delicath, & Elsenbeer, 2004; McGreavy, Druschke, Sprain, Thompson, & Lindenfeld, 2016), others have been new and surprising. We explore the similarities and differences between the stakeholder-developed criteria and literature-inspired criteria in a technical report (in progress), concluding that the criteria type with the most similar categories is process (rather than model or outcome), e.g. fairness, individual and group learning, utility of process. The research impact of this project will be explicitly addressed in the “rubric-building” phase of the research to make sure that the connection between evaluative criteria and the potential for improved participatory processes is clearly outlined. This set of “rubric-building” meetings is scheduled for August 19th and 21st. A few stakeholders who see the possible uses for the evaluative rubric for their own participatory engagement-based work have elected to work more closely with us to identify evaluative criteria to share in the draft rubric during those meetings scheduled for August.

Estuary Margin Watershed Characterization to Compare Coastal Bacteria Pollution Vulnerability in Maine

Project Type: Annual Base Grant **Project ID:** 2018ME331B

Project Impact: This research has produced Maine's most detailed and comprehensive near-coastal watershed runoff maps, updated coastal watershed boundaries, and parameterized data layers with landscape attributes that serve as proxy metrics for bacteria pollution sources and runoff delivery. Research addresses the problem of bacterial pollution in estuaries, more specifically differences in vulnerability to pollution following precipitation events of various coupled land-sea settings defined by diverse patterns of landscape bacterial sources, runoff delivery, and embayment residence time. Maine's estuaries are home to valuable shellfisheries; high bacteria loads threaten shellfish and shellfishers' livelihoods. Understanding the factors that cause different estuaries to be more/less

vulnerable to pollution events allows regulators to commit scarce monitoring resources effectively. The key partner is the Maine Dept. of Marine Resources (DMR) which has regulatory jurisdiction over shellfishing. Investigators engage with DMR officials to coordinate prioritization of estuary areas of greatest significance. As a result, a decision support tool is under development that allows end users to automatically delineate any embayment/sub-embayment of their choosing and examine its characteristics. By investigating the influence of tidal “margin” sections on coastal bacteria pollution, the research has helped close a spatial data gap. The “margin” areas between non-tidal watershed outlets encompass a range of features from tidal marshes to many of Maine’s developed cities and towns, where precipitation runoff may wash bacteria and pollutants directly from impervious surfaces into coastal waters. The vulnerability analysis provides a fuller understanding of which factors make some estuaries more vulnerable to bacteria pollution events than others.

Improved delineation of natural infrastructure and capital as improved strategies for flood attenuation in support of State’s “Clean Water for Maine” bond (P.L. 2013, Chapter 589)

Project Type: Annual Base Grant **Project ID:** 2017ME324B

Project Impact: Existing hydrologic modeling approaches and hydromorphological metrics were studied. The upper Sheepscot River watershed was chosen as the study area due to the availability of data and its complex postglacial topography. The limitations of these approaches in addressing the geospatial complexities in flow generation and accumulation in the watershed were observed. A need to better incorporate the spatial distribution of watershed features was realized. High-resolution LiDAR-based Digital Elevation Model data was used to study the flood response and potential storage benefits by wetlands. The topography of the study area was examined using morphometric functions and relations. The hydrologic response was studied using the width function, which is closely related to the time distribution of flow at the outlet point. By incorporating these additional parameters into existing metrics, an index was developed to help prioritize wetlands on the basis of their potential storage benefits and assist in decision making. The research sought to quantify the relative benefits that wetlands provide in attenuating flood pulses. Given scarce financial resources for investment, identifying high benefit wetlands is a key step in decision-making. By studying the flow generation patterns over a watershed, quantifying relative storage potential of wetlands, and accounting for the spatial distribution of these wetlands, ongoing work aims to develop hydrogeomorphological metrics that can indicate their relative benefits. We examined existing metrics (e.g. the Compound Topographic Index) currently being used to quantify storage potential and are working to improve upon this metric by adding key parameters such as hydrologic response.

Maine’s Changing Winter: focus on natural resources, ecology, and the economy (seed project)

Project Type: Annual Base Grant **Project ID:** 2017ME327B

Project Impact: There is currently no statewide effort to coordinate knowledge, research priorities, and stakeholder concerns regarding changing winter conditions and its effects on water resources. The team conducted a two-day workshop to bring together researchers and professionals from academic and research institutions, government agencies, and non-profit organizations to establish a network of researchers interested in studying the ecosystem and societal impacts of Maine’s changing winters. Attendees included representatives from University of Maine System (UMS) campuses, Maine Dept. of Inland Fisheries and Wildlife, and US Geological Survey interested in developing an interdisciplinary focus on a changing winter and the impacts on Maine’s freshwaters, wildlife, and natural resource-based economy. Coordination among scientists and resource managers has led to engagement by other stakeholders interested in addressing priorities identified by this effort. Research arising from these collaborations will provide greater understanding of how changing winters will influence: a) freshwater systems; b) forested watershed systems; c) wildlife; d) human activities including recreation; all of which have significant impacts on Maine’s economy. The principal outcomes of the workshop were: development of collaborations to create a foundation for future research proposals; stronger relationships between researchers and stakeholders; improved awareness of stakeholder interests; identification and establishment of a common field site for monitoring and research; and leveraged efforts aimed at natural resource use and conservation. Efforts are ongoing, and researchers are working to establish new research and monitoring sites in Maine, as well as the development of an integrated winter ecology

course to be taught at multiple institutions.

Real Time Data for Sebago Lake to Support Sustainable Water Resource Management, Lake Research, Undergraduate Research Training, and Community Engagement

Project Type: Annual Base Grant **Project ID:** 2017ME322B

Project Impact: Sebago Lake, the water source for 15% of Maine's population, lacked a mechanism for high-frequency, depth-dependent sampling of water quality parameters. This project enabled the successful installation of a water quality monitoring buoy in Lower Bay of Sebago Lake. Researchers are now able to monitor in real-time water quality parameters including dissolved oxygen, pH, temperature, chlorophyll, and PAR at varying depths. Models using the data are yielding insights into lake physics including the timing and nature of lake turnover. The high frequency data has led to new research collaborations. Specifically, the temperature data is informing a collaborative study between PI Leshner and the Lakes Environmental Association on microplastic occurrence in the lake. The collaboration has received funding from the Narragansett Number One Foundation. A symposium (Sebago Lake Symposium) was held on Feb. 2, 2019 which brought together 150+ participants to learn and share about lake protection. Stakeholders, including researchers, non-profit groups, fishing clubs, and businesses that rely on Sebago Lake water, were deeply involved in symposium planning. Feedback from the event was overwhelmingly positive, leading Saint Joseph's College to commit to supporting future symposiums every two years. A student intern also led development of a 'Discovering Lakes' curriculum for 9th grade earth science in collaboration with Windham High School. On-going support for the curriculum and symposium guarantees public dissemination venues will outlast the project, and the long-term nature of the data collection also enable science and monitoring well into the future.