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

Annual Technical Report
2019

Products

* Indicates student authors

Roy, S.G., A.J. Daigneault, J. Zydlewski, A. Truhlar, S.M. Smith, S. Jain, D. Hart (2020), Coordinated river infrastructure decisions improve net social-ecological benefits. Environmental Research Letters, 15 104054, https://iopscience.iop.org/article/10.1088/1748-9326/abad58.

Klein, S.J.W., E.L. Fox*, 2020, Dam Decision Toolbox: Resources for Participatory Dam Decision Support. University of New Hampshire Data Discovery Center Online Portal, http://ddc-dam-toolbox.sr.unh.edu/about/project_description/.

Bajracharya, P., and Jain, S. (2020), Estimation of watershed width function: A statistical approach using LiDAR data. Stochastic Environmental Research and Risk Assessment, 1–15. doi: 10.1007/s00477-020-01846-5

Alahmed, Sohaib*, Lauren Ross, Sean Smith, *In Review*, Transport timescales and connectivity in a shallow meso-tidal inland bay estuary system. Science of the Total Environment.

Ross, Lauren, Sohaib Alahmed*, Sean Smith, Gwyneth Roberts*, Tidal and subtidal transport in short, tidally-driven, low-inflow estuaries: A case study in Downeast Maine, USA. Submitted to *Continental Shelf Research*.

Van Dam, Bea*, and Sean Smith, *In Preparation*, Upland microtopography and remote detection of surface water detention storage in deglaciated landscapes. Preparing for submission to Journal of the American Water Resources Association (JAWRA).

Van Dam, Bea*, and Sean Smith, *In Preparation*, Estuary margin watershed characterization and relations to coastal bacteria pollution vulnerability in Maine. Preparing for submission to International Journal of Geographical Information Science (IJGIS).

Thesis/Dissertations

Fox, E. L.*, 2020, A Transdisciplinary Approach to Decision Support for Dams in the Northeastern U.S. with Hydropower Potential. Ph.D. Dissertation, Ecology and Environmental Sciences, College of Natural Sciences, Forestry and Agriculture, University of Maine, Orono, Maine, 460 pages. https://digitalcommons.library.umaine.edu/etd/3156.

Van Dam, Bea*, *In Preparation*, Estuary margin watershed characterization and relations to coastal bacteria pollution vulnerability in Maine. Ph.D. Dissertation, Chapter 2, School of Earth and Climate Sciences, College of Natural Sciences, Forestry, and Agriculture, University of Maine, Orono, Maine.

Information Transfer Program

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

Maine Sustainability & Water Conference – This annual conference, scheduled for March 26, 2020, was cancelled due to the pandemic. In fall 2020, the decision was made to move the 2021 conference to a virtual format. Much of the planning that had taken place before cancellation of the 2020 conference was used as a starting point for this year's virtual conference.

https://umaine.edu/mitchellcenter/news/maine-water-conference/

Mitchell Lecture on Sustainability – The 2019 lecture (10/8/19, UMaine) was attended by over 500 people. The keynote speaker was E.J. Milner-Gulland from the University of Oxford who spoke on, "An Optimistic Vision for a Sustainable, Wild, and Socially Just World". 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. Talks moved to an all virtual format for fall 2020. https://umaine.edu/mitchellcenter/seminars/

Northern Maine Children's Water Festival – This one-day event usually attended by over 650 5th-6th grade students from northern Maine was cancelled for fall 2020 due to the pandemic. A joint Northern/Southern Maine Children's Water Festival will be held in spring 2021. 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 WRRI. An e-newsletter, with over 2,300 subscribers, is published every 3 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/WRRI stories, events, etc. In general, postings are 2-3 items/week. facebook.com/MitchellCenterForSustainabilitySolutions/.

Student Support

Undergraduate students supported – 5
Graduate students supported – 4
Postdoctoral researchers supported – 0

Notable Achievements and Awards

- Faculty and students on WRRI projects gave over 30 presentations about their research.
- Follow on funding for WRRI research projects totaled almost $360,000.
- Sebago Lake Symposium. This was the final output from an earlier WRRI project (2017ME322B). The stakeholder outreach event was held at Saint Joseph's College on Feb. 2, 2019.
- Article in Lincoln County News by Bisi Cameron Yee, *Packed agenda leads to packed house in Waldoboro*, Friday December 11th, 2020.
- Article in UMaine Engineering Magazine, *Aiding Aquaculture: Particle research tackles pollution longevity prediction in estuaries*, 2020/2021.
- Undergraduate student Gwyneth Roberts was awarded the 2018 Outstanding Undergraduate Student Contribution to Sustainability Research, Senator George J. Mitchell Center for Sustainability Solutions.
- Undergraduate student Gwyneth Roberts received High Honors for her thesis titled, *Quantifying tidally driven transport in the Jordan River estuary: an application of the Navier-Stokes equations.*
- Undergraduate student Gwyneth Roberts was awarded Honorable Mention for her poster, *Quantifying tidally driven transport in the Jordan River estuary*, at the 2019 Maine Sustainability and Water Conference in Augusta, Maine.

- Graduate student Bea Van Dam was awarded First Place at the 2018 Maine Water Conference Student Poster Competition, Augusta, Maine.
- Graduate student Emma Fox received the All Maine Women Mentorship Award (2019) by the All Maine Women Honor Society at the University of Maine.
- Graduate student Emma Fox and undergraduate student Kaitlyn Raffier received Edith M. Patch Award Distinguished Nominee (2019) awards by the Friends of Edith Patch at the University of Maine.
- Graduate student Emma Fox was awarded the Outstanding Mentorship of a Student in Sustainability Research Award (2018) by the Senator George J. Mitchell Center for Sustainability Solutions, University of Maine.
- Sharon Klein received the Donald Harward Faculty Service-Learning Award (2019) by Maine Campus Compact.

Coastal Maine Estuaries (CoMEE) Response To Freshwater Runoff

Project Type: Annual Base Grant
Project ID: 2019ME121B

Project Impact:

This project aimed to better understand how variations in estuarine hydrodynamic processes alter pollution transport in systems of varied size, shape, and freshwater input. It involved work in close coordination with stakeholders from the Maine Department of Marine Resources, shellfish businesses, and local communities who have goals to implement accurate and safe management and mitigation policies related to bacteria pollution from contaminated freshwater runoff in Maine estuaries. Our team investigated flushing time, residence time, and residual flow strength and structure in several estuaries of various size, shape and freshwater input. The evaluation was framed around combinations of conditions described by fortnightly tidal ranges, high/low river discharge, salinity, and intra-tidal particle release time using a combination of in-situ collected data and modeling. Correlation was observed between estuary size and tidal characteristics. Residual flows dictate transport indicating that the estuary is susceptible to pollution when the tidal excursion is shorter than the estuary length and the shape is relatively simplistic. In estuaries where the width is less than the tidal excursion length, the current magnitude was enhanced and irregularities in coastline shape produced eddies in the residual flow. The flushing and residence times are dictated by tidal flow and the estuary is not expected to retain polluted freshwater in those systems. The outcomes from this study indicate that relatively simple coastal parameters (tidal excursion length, waterbody width) can be used by stakeholders as an initial reconnaissance step to determine estuary vulnerability to coastal pollution problems affecting shellfishing industries and communities in Maine.

Fishy Business: Identifying Synergies Between Researchers And Stakeholders For Improved Transportation Infrastructure And Ecological Resilience Through Coordinated Road Culvert Improvement

Project Type: Annual Base Grant
Project ID: 2019ME122B

Project Impact:

The goal of this project was to identify safety, environmental, and cost benefits of dam and road stream crossing improvement projects for the state of Maine, based on a more comprehensive understanding of how decision-makers collaborate on improvement projects and how dam and road infrastructure overlap with aquatic resources in the state. Our first finding/impact for this research project was to build a comprehensive description of the collaborative network of stakeholders who are involved in decisions for improving aquatic habitat and dam/road stream crossing safety. We further identified certain gaps in engagement between stakeholders that could lead to better outcomes for environmental, safety, and project cost objectives. This information was combined with geospatial datasets of dams and road stream crossings to identify specific improvement projects that could lead to multiple environmental and safety benefits, while attempting to minimize cost. We discovered several opportunities where coordinated decision making in the state of Maine could lead to dramatic improvements in road and river safety, while also improving environmental conditions through reconnecting aquatic habitat. Finally, we developed a generalized machine learning approach that can be adapted to any location to perform a similar analysis. However, we identified that the context of stakeholders and decision makers will differ across locations, and so this machine learning approach must be adapted to fit local needs. For this reason, we also developed a weighted preference approach that can allow stakeholders to fine tune their priorities for environmental and safety improvements, while limiting decisions to specific budgets.

Addressing the mess: developing evaluative methods for group participatory decision support in riverine systems

Project Type: Research
Project ID: 2018ME330B

Project Impact:
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 pulled from the literature, others have been new and surprising. After a series of “visioning” meetings, we held a set of “rubric-building” meetings, where stakeholder participants were introduced to the set of evaluative criteria synthesized from the literature and stakeholder interviews. Participants in both meetings gave feedback about specific criteria definitions, noted areas of possible overlap between criteria, and provided general thoughts about rubric organization. There was a general sense of agreement that the criteria were appropriate for the task of evaluating participatory decision-making. Participants expressed an interest in the final product when it is complete, including our notes about how we plan to evaluate each individual criterion, indicating a positive impact on their own planning for participatory engagement in decision-making processes. It was not part of our original plan to release the evaluation/feedback survey instrument with a guide for users on which question links with which evaluation criterion, but we now think this is a way to instrumentalize the rubric for practical use. Our research has potential impacts for the science of team collaboration; it presents an engaged and co-generative approach to research design, wherein a group participatory dam decision support workshop was reflexively designed with stakeholder-approved criteria in mind, and then evaluated by participating stakeholders and researchers with performance of participatory process in mind.

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

Project Type: Research
Project ID: 2018ME331B

Project Impact:
In order to effectively fulfill the mission of managing the health of Maine's shellfisheries, the Maine Department of Marine Resources requires adequate data and support tools to make scientifically-informed decisions about temporary closures in response to coastal bacteria pollution events. This project, an extension of successful proof-of-concept prior research that examined landscape conditions in coastal stream and river watersheds to find clusters of similarly-behaving watershed units, expanded the problem domain in a bacteria pollution vulnerability analysis of diverse coupled landscape-estuary systems along the length of the state's tidal coastline. In particular, this new analysis incorporated "margin watershed areas" that fall between non-tidal watershed boundaries and shoreline and contribute overland flow directly into estuaries.
Detailed overland flow path data delineated from high-resolution remotely sensed elevation data and proxy metrics related to bacteria sources, delivery, and estuary residence time were assembled for over 5,000 km^2 of coastal landscape and used to build an ArcGIS tool that allows managers to draw a line across any coastal concavity and see aggregated data – and estuary response unit cluster number and descriptor – for that embayment and its contributing landscape. With the tool and resulting estuary response units based on a cluster analysis of 500 tidal embayments and sub-embayments along the Maine coast, MEDMR and other shellfish managers can leverage limited bacteria monitoring capacity by transferring management strategies, including general closure and reopening timings, from well-monitored estuary sites to shellfish flats with limited or no historic bacteria monitoring data that belong to the same estuary response cluster.