Chesapeake Community Research Symposium 2026

Session 5: Balancing agricultural and ecological goals of Chesapeake Bay restoration: Insights from interdisciplinary team science

Session Leads: Lisa Wainger & Caitlyn Grady

Lisa A. Wainger (UMCES-CBL), Dave Abler and Caitlin Grady

Co-developing Resilient Futures: Integrating Agricultural and Ecological Goals Through Interdisciplinary Scenario Modeling

Chesapeake Bay restoration efforts have historically prioritized water quality and habitat goals, often without fully integrating the objectives of the agricultural community. To address this gap, the Thriving Ag project used interdisciplinary team science to evaluate alternative management pathways that balanced agricultural production with ecological restoration. This research leveraged a ""policy sandbox"" approach in which coupled models were used to evaluate co-developed normative narrative scenarios.

We will present what we learned about the diverse goals of stakeholders, their proposed solutions, and the effects of those solutions evaluated with coupled models. Diverse stakeholders contributed to co-learning and scenario development, including farmers, agribusinesses, environmental NGOs and government agencies. The research team systematically translated qualitative storylines into quantitative model drivers through a multi-step process: mapping core narrative themes to measurable indicators, performing model sensitivity analyses, and integrating regional projections for climate and land use. Five distinct scenarios—Business as Usual, Ecosystem Services, Smart Growth, Local Food, and Plant-Based Diet—were evaluated using a suite of simulation models, including the Soil and Water Assessment Tool (SWAT) for biophysical processes, the Regional Environment and Agriculture Programming (REAP) model for economic resource allocation, and a Nitrogen Flow Model (NFCBF) for supply chain analysis.

Crucially, empirical economic models and field investigations provided ""reality checks"" on stakeholder assumptions regarding farm and market behaviors, such as consumer willingness to pay for local food or the additionality of conservation payments. Findings indicate that substantial deviations from current trends are necessary to meet Total Maximum Daily Load (TMDL) water quality goals, as agricultural intensification often poses a greater risk for nutrient runoff than urbanization or climate change. This research demonstrates how interdisciplinary collaboration and stakeholder-driven scenarios can broaden the vision of desirable futures for the Chesapeake Bay watershed while identifying the hard tradeoffs required to reconcile competing socio-ecological goals."

Raj Cibin (The Pennsylvania State University), Jesna Ismail

Can dietary transition improve water quality in the Susquehanna River Basin?

Changes in human dietary preferences significantly influence agricultural production systems. Transitioning to reduced meat consumption or adopting more plant-based diets could decrease demand for livestock products, thereby reshaping these systems by reducing livestock and feed production while boosting plant-based food production. Although global studies have shown that reduced meat consumption can mitigate nitrogen and phosphorus losses, they often overlook the hydrological dynamics that impact local water quality. This study used the Soil and Water Assessment Tool to analyze vegan (plant-based) and ovo-lacto vegetarian (including plant-based foods, eggs, and dairy) diet scenarios in the Susquehanna River Basin, PA. It connected dietary shifts to alterations in land use, livestock agriculture, and associated nutrient flows. The vegan scenario, which eliminated all livestock agriculture in the region, led to a more significant reduction in nutrient levels. In contrast, the ovo-lacto scenario led to increased poultry and dairy production, which is expected to increase phosphorus loading in the basin.

Caitlin Grady (George Washington University)

Identifying Leverage Points for Nitrogen Reduction With a Production-Chain Approach

Agricultural runoff is a major source of nonpoint nitrogen (N) to the Chesapeake Bay, and the remaining gap to restoration goals suggests that field-scale best management practices alone are not enough. This points to the need for management strategies that account for how nitrogen moves through connected parts of the food system, not just within individual fields.
In this study, we use a systems production-chain analysis to evaluate how future agricultural change and management scenarios could affect agricultural N losses across the Chesapeake Bay Watershed. The model tracks nitrogen flows through seven stages spanning production, processing, and consumption. We test scenarios representing agricultural intensification, efficiency-focused management strategies, and combinations of the two to quantify whole-system responses.

Results show that total nitrogen loss is controlled by multiple interacting factors. Expected drivers such as crop and livestock production levels and fertilizer application rates are important, but less commonly emphasized variables also matter. In particular, live animal weight gain and feed conversion ratio have a strong influence on total N loss. While these variables have been identified as sensitive in previous applications of the model, this work quantifies their relative importance at the watershed scale.

We also extend the analysis to future, climate-impacted conditions by incorporating climate-driven changes in crop yields and projected growth in animal production. This allows us

to evaluate how the importance of key drivers changes under different environmental and production trajectories and to identify leverage points that remain consequential across scenarios.

For this presentation, we will discuss the challenges and opportunities of working across modeling scales and approaches, from field-level practices to full production-chain accounting. We will also show how different modeling choices shape what can be learned, which questions can be answered, and how results can inform nitrogen management in the watershed.

Kristin Fisher (The Nature Conservancy), Matthew Houser

Leveraging natural and social science to maximize impact of agricultural stakeholder driven conservation in the Chesapeake Bay watershed.

The widespread adoption of advanced nutrient management practices remains limited in many nutrient-impaired watersheds, despite decades of agricultural conservation investment. Reasons for this lack of widespread implementation likely include a combination of natural and social science challenges: a lack of data or farmer knowledge about nutrient use inefficiencies, challenges surrounding increased management complexity, and market influences that reward farmers for production rather than environmental sustainability, among others. Recognizing these realities and designing interventions that address them is imperative to moving toward a more sustainable agricultural system in the Bay watershed – both environmentally and economically. To pursue this end, The Nature Conservancy works with a transdisciplinary network of partners including conservation organizations, state and local government, the research community, and private sector agribusinesses to co-create and test new technologies, incentive structures, and risk mitigation strategies to better support the widespread adoption of regenerative agricultural management. These interventions are then systematically evaluated for both agronomic and environmental benefits as well as their impact on farmers' decision-making. This presentation will provide details about our partnership framework, its successes and challenges, the advantages of a co-creation process, and discuss two examples of how pairing social and natural sciences have led to conservation incentive programs that more effectively promote farmer behavior change.

Lora Harris (UMCES), Cathlyn Davis, Sarah Garvey, Xin Zhang, Matt Houser, Mathieu Proulx, Taehoon Kim, Andrews Sai, Annika Fife, Joy Amadi, Jun Suk Byun, Chun Dai, Ayoub ELMOUTTAQI, William MAKAZA, Hammed OPEYEMI RASAQ, Zineb EL GORAI, Bruno Gerard, Claudia Wagner Riddle

Emerging Nitrogen Technology And Sustainability Challenges From Farm To Fork : An International, Transdisciplinary Course.

This unique course offered by the Global Nitrogen Innovation Center for Clean Energy & the Environment (NICCEE) brought together interdisciplinary graduate students from three countries: the U.S. (UMCES, UMES, UMD), Canada (University of Guelph, University of Manitoba, McGill University), and Morocco (UM6P). Students investigated action-oriented solutions to address the challenge of sustainable nitrogen management in the context of agricultural systems. This included learning about emerging nitrogen technologies, collecting and analyzing data on farmers' attitudes regarding new technologies, and producing science communication products informed by student interviews with farmers. Students learned about agricultural nitrogen use efficiency, nitrogen management and policy, social science aspects of farmers' technology adoption, and strategic science communication. They gained skills in qualitative data experience and ethical ways to work with human study participants. They applied these skills to develop and implement a new interview protocol during farm visits, and code resulting data into salient themes around topics of technology, nitrogen management, and socio-cultural themes. At the NICCEE Nitrogen Summer Institute, the students integrated findings from this analysis to create an interactive game on effectively engaging with farmers about nitrogen technology. The Farmer Approved! game was played and well received by Institute attendees, including interest to apply it in other contexts to practice communication skills central to productive stakeholder engagement.