Report and Recommendations
NORTHEAST MULTISTATE ACTIVITIES COMMITTEE MEETING
September 11, 2024
9:00 AM ET Zoom Teleconference

Members: Puneet Srivastava (Maryland-Chair), Jason White (CT-New Haven), Blair Siegfried (Penn State), Chris Smart (NY Geneva), Bill Miller (MA/NEED), Brian Schilling (NJ/NEED) [Non-voting, ex officio: Rick Rhodes (NERA), David Leibovitz (NERA)]

<u>Request to Approve Peer Reviewed Multistate Activities (MAC recommends to NERA)</u>

- NE_TEMP2401: *Urban Agriculture: Equity, Sustainability, and Community Development*, 10/2024-09/2029 [New Multistate Project, AA: Dwane Jones – District of Columbia]
    - Peer reviews assessed the project as well written with good-to-excellent ratings. Peer reviewers recommended that the technical team (or those undertaking the work) should evaluate municipal irrigation water as an input and measure attributes of the input including pH and electrical conductivity. A reviewer sought a description of the language assessments/translation services related to Extension activities.
    - The proposal was intentionally drafted from a high-level perspective; activities will be site specific to the urban farms and institutions involved in the work.
    - The project is ready for approval, however practitioners in the domain of urban agriculture do not have established multi-state networks and will need the assistance of Experiment Station Directors and administrators to promote the project and garner participation. Urban agriculture continues to rise as an identified discipline area, and more participation could emerge in years to come.
    - If approved, this would be the first urban agriculture multistate research project to be included in the national portfolio.
    - **The MAC unanimously recommended approval of the NE_TEMP2401 proposal. This will be presented to NERA for full approval at the Fall business meeting.**
- NE_TEMP2438: *Carbon Dynamics and Hydromorphology in Depressional Wetland Systems*, 10/2024-09/2029 [Renewal of NE1938, AA: Puneet Srivastava – Maryland]
    - The group has identified 11 sites in varying climates across the Northeast, West, and Mountain West where they will examine carbon dynamics in low lying areas. The group is also interested in hydrology and will study "black carbon".
    - EPA has been funding this research area for 10-15 years because wetlands are not sufficiently modeled in hydrology/water quality studies. This project will contribute to the testing and improvement of the models.
    - Six peer reviews were received: five recommended approval and one recommended rejection. The team responded to all reviewers appropriately.
    - This is long standing project, previously led by Mark Stolt (Rhode Island). This project has a history of leveraging MRF funds to secure competitive funds.

    - Regarding outreach: For the NECI (National Extension Climate Initiative) – carbon capture, wetlands, land use, climate interactions are all hot topics; this project's information could flow naturally into that initiative.
    - **The MAC unanimously recommended approval of the NE_TEMP2438 proposal. This will be presented to NERA for full approval at the Fall business meeting.**
- NE_TEMP1: *Northeast Regional Center for Rural Development*, 10/2024-09/2029 [New Off-the-top project for NERCRD, AA: Blair Siegfried – Pennsylvania]
    - Historically, the NERCRD was provided with ~$41k annually sourced from "off-the-top" Hatch multistate funding. The Northeast has had two established off-the-top projects: NERCRD and the Germplasm center (NE9) at Geneva. Establishment of NE_TEMP1 would create a unique identifier for NERCRD like that of the germplasm center as NE9.
    - The technical team responded to peer reviews appropriately. One reviewer expressed concern that there weren't clear links to Extension activities and the scholarship of Extension. The administrative adviser mentioned that integration of extension and research activities has been historically strong based on the group's past reporting.
    - **The MAC unanimously recommends approval of the technical merit of the NE_TEMP1 proposal.**
    - **The MAC also unanimously recommends a budget increase to $100k. NERA Directors will be asked to provide a more in-depth review of the budget proposal during the Fall business meeting.**

<u>MAC Discussion Items</u>

- NRSP Review Committee: renewal of NADP ($50,000 annually); revision of the Guidelines; two new projects being proposed.
    - New NRSP proposals in the upcoming year: Artificial Intelligence, and National Urban Agriculture Research and Extension Center.
    - Margaret Smith has been solicited to serve as AA for the AI project.

<u>Administrative Adviser Assignments (activities seeking Administrative Advisers)</u>

- NE2201: *Mycobacterial Diseases of Animals*
- NRSP8: *Genomic Capacity: Building Applied Genomic Capacity for Animal Industries*

<u>Informational Items</u>

- NERA activities up for Mid-term review in FY2024
    - NE2140: Sustainable Management of Nematodes in Plant and Soil Health Systems (AA: Anton Bekkerman – New Hampshire)
    - NE2101: Eastern White Pine Health and Responses to Environmental Changes (AA: George Criner – Maine)
    - NECC2103: High tunnel specialty crop production (AA: Anton Bekkerman – New Hampshire)
    - NEERA2104: Northeast Region Technical Committee on Integrated Pest Management (AA: Margaret Smith – Cornell)

- NERA activities ending 09/30/2024
  - NE1939: Improving the health span of aging adults through diet and physical activity (**fully approved as NE2439**)
  - NE1942: Enhancing Poultry Production Systems through Emerging Technologies and Husbandry Practices (**fully approved as NE2442**)
  - NE1943: Biology, Ecology & Management of Emerging Disease Vectors (**fully approved as NE2443**)
  - NE1938: Carbon Dynamics and Hydromorphology in Depressional Wetland Systems (**seeking approval in September**)
  - NECC1901: Integrating Genomics and Breeding for Improved Aquaculture Production of Molluscan Shellfish (**not renewing**)
  - NE1941: Environmental Impacts of Equine Operations (**not renewing**)
- New NERA activities in 2024
  - NE_TEMP2401: Urban Agriculture: Equity, Sustainability, and Community Development, 10/2024-09/2029 – **seeking approval in September**
  - NE_TEMP1: Northeast Regional Center for Rural Development, 10/2024 – 09/2029 **– seeking approval in September**
- NERA activities ending 09/30/2025
  - NECC2001: Sustainable Farm Energy Production and Use
  - NE2001: Harnessing Chemical Ecology to Address Agricultural Pest and Pollinator Priorities
  - NE2045: Onsite Wastewater Treatment Systems: Assessing the Impact of Soil Variability and Climate Change

NE_TEMP2401: Urban Agriculture: Equity, Sustainability, and Community Development

Status: Submitted As Final

Duration	10/01/2024 to 09/30/2029
Admin Advisors:	[Dwane L Jones]
NIFA Reps:	

Statement of Issues and Justification

Urban agriculture has the potential to contribute solutions to multiple contemporary issues, including food security, sustainable development, and climate change mitigation. The Northeast United States is an excellent region to serve as a research testbed to examine the dimensions of urban agriculture and the potential that urban agriculture poses. The region is a microcosm of urban agricultural issues found across the country: dense population, small land area, large cities, and diverse peoples. Further, the Northeast has a significant concentration of Land-grant Universities and Experiment Stations. Institutional proximity (to each other and to urban areas) constitutes a powerful, accessible intellectual framework. Leveraging the research capabilities and outreach expertise of the regional Land-grant Universities and Experiment Stations is a powerful approach to addressing the challenges of urban agriculture.

While the challenges faced by urban agriculture in the Northeast are multidimensional, they are not intractable. The challenges include: equality and equity surrounding information access and understanding on the part of growers, access to growing space (ownership of space and long-term use), soil suitability, natural resource management, economic viability, agricultural sustainability, and access to growing resources. We propose to examine these challenges, and in doing so, lead research efforts that seek to expand urban agriculture and explore strategies to increase community engagement, promote equitable development of urban agriculture sites, ensure food sovereignty, and provide sustainability of urban agri-food systems.

Our project has four objectives dedicated to: examining how the regulatory environment impacts urban ag; assessing the natural resource inputs for urban ag; identifying the challenges and opportunities for urban ag, farm to table; and determining the human impact of urban ag on community diversity, equity, inclusion, and One Health. The overarching goal of this multistate project is to **assess impact and improve outcomes of urban ag on environmental quality, socioeconomic vitality, food security, and community resilience, and equity**.

Related, Current and Previous Work

Introduction

Urban agriculture provides a wide range of ecosystem services on a variety of spatial and temporal scales. Depending on the design of the green space these ecosystem services can include stormwater management (Almaaitah and Joksimovic, 2022; Fassman-Beck et al, 2013; Gong et al., 2019; Karczmarczyk et al., 2000; Rowe, 2011; Whittinghill et al., 2014a), reduction of the urban heat island effect (UHI) (Jadaa et al., 2019; Saadatian et al., 2013), increased biodiversity and habitat (Baumann, 2006; Benvenitu, 2024; Cook-Patton and Bauerle, 2012; Tonietto et al., 2011; Madre et al., 2013), reduced noise and air pollution (Speak et al., 2012; Van Renterghem and Botteldooren, 2011; Yang and Gong, 2008), and carbon sequestration (Getter et al., 2009; Whittinghill et al., 2014b))

Urban agriculture has been studied from a variety of perspectives, particularly through social lenses pertaining to:

- food access (Metcalf and Widener, 2011; Saha and Eckelman, 2017);
- fresh produce intake (Alaimo et al 2008, McCormack et 2010);
- food justice (Alkon, 2014; Billings and Cabbil, 2011; Horst et al, 2017; Myers and Sbicca, 2015 ; Ramírez, 2015; White, 2011);
- food sovereignty (Jarosz, 2014),
- health benefits (McCormack, 2010; Clatworthy et al, 2013; Kingsley, 2009; Subica, 2015; Van Den Berg and Custers, 2011); and
- politics of land development and access to land (Lindemann, 2022)
- community wellbeing (Hung, 2004; Kingsley et al, 2006; Okvat and Zautra, 2011; Saldivar-Tanaka and Krasny, 2004; Teig, et al 2009).

While research on the horticultural aspects of urban agriculture is growing, and current agronomic knowledge is applicable, urban agriculture specific research is still limited when compared to rural or truck-crop type agricultural production. This especially applies to forms of urban agriculture that do not integrate well with large-scale mechanized farming or emerging forms of urban agriculture, such as the use of green roof technology to produce food.

Soils

These above areas of research have produced a significant body of work examining the possibilities and challenges of urban agriculture, but research on urban soils is not as abundant. Research examining soil quality in urban spaces investigates the effects on biodiversity and ecosystem services (Lin et al, 2015), the significance in terms of reclaiming vacant land (Beniston and Lal, 2012; Carlet et al, 2017; Kremer et al, 2013), sustainable land use planning (Lovell, 2010), and the potential to exist as novel agroecosystems (Pearson et al 2010; Egerer et al, 2018). The most common attention given to urban soils, however, pertains to the presence of ongoing and legacy inorganic and organic contaminants such as a lead and other heavy metals (Brown et al, 2016; Kessler, 2013; Marquez-Bravo et al, 2016; McBride et al, 2014; Mielke et al, 1983; Mitchell et al, 2014; Sipter et al, 2008; Spliethoff et al, 2016).

While understanding potential contaminant sources and fluxes in urban agriculture is an important issue, these areas of inquiry are often conducted without consideration of other soil biological, chemical, and physical properties, and rarely consider the soil parent materials therein. Though there may be cases in which urban farmers are growing in soils formed from native, undisturbed soil, most urban farmers deliberately avoid such practices in order to mitigate potential contaminant exposure. As such, most urban agriculturalists grow in soil mixtures that they have constructed over time and are therefore generating a wide range of previously unclassified constructed soils (called Technosols in the World Reference Base for Soils (IUSS, 2022). Research in NYC demonstrates that community growing spaces are less contaminated than home gardens or yards (Cheng et al, 2015). If contaminants are present in soil, it is often physically and logistically challenging to remove or extract them without removing the entire substrate, which may also be quite costly (Mielke, 2015). Additionally, given that urban agriculture is a form of agriculture that is often highly motivated by a social or community-based vision, research on urban soils has not often integrated attention to socio-ecological relationships to the soil, or soil relationality, in understanding how urban farmers relate to and understand their interactions with the soil (Krzywoszynska, 2019; Krzywoszynska and Marchesi, 2020).

Nutrient Leaching

Efficient nutrient and irrigation management are two of the horticultural issues that need to be addressed in urban agriculture. Under application of nutrients or irrigation water can lead to plant stress, increases in pest and disease pressure, a reduction in crop quality, and yield losses. Overapplication of nutrients and irrigation water can lead to nutrient leaching, a known issue in agricultural settings. This is of particular concern in urban areas because of the higher percentage of impermeable surfaces and the impact that stormwater runoff can have in exacerbating nutrient leaching into urban watersheds. Overapplication of irrigation can also lead to plant health and soil quality issues that also impact yield. A growing number of research studies demonstrate the inefficient use of nutrients in urban agriculture, which is sometimes linked with observable increases in soil nutrient content or runoff water measurements or records of fertilizer applications and crop yields (Abdulkdir et al, 2013; Arrobas et al, 2017; Cameira et al, 2014; Dewaelheyns et al, 2013; Huang et al, 2006; Salomon et al, 2020; Small et al, 2019; Weilemaker et al, 2019; Witzling et al, 2011). Fewer studies have examined the issue of irrigation water use in urban agriculture. Numerous barriers to efficient nutrient and irrigation management exist for urban growers, which could be addressed through a combination of research and extension efforts.

Several of these barriers relate to the ability of small-scale urban farmers to access and interpret soil test results and use nutrient recommendations. Soil testing is uncommon in urban agriculture (D. Medina, personal communication, November 3, 2021; Small et al, 2019; Whittinghill and Sarr, 2021; Witzling et al, 2011). There may be a variety of reasons for this including uncertainty about how to collect samples, where to obtain testing, and what tests should be requested. Without soil test results, the use of nutrient recommendations may be difficult as most for phosphorus and potassium, including those available for New England, recommend application rates based on soil test results for those nutrients (Sideman et al., 2023). Even if soil tests have been performed, nutrient recommendations are commonly given in pounds of nutrient per acre for a single crop or crop group (e.g., Sideman et al., 2023) while urban farms grow a high diversity of crops in a small area (McDougall et al, 2019; Salomon et al, 2020; Wielemaker et al, 2019). Converting the pounds per acre measurements down to the smaller scale, in square feet or feet of row, can be a challenge, especially for beginning farmers, and these farms have a greater tendency to over apply nutrients (Wielemaker et al, 2019). Nutrient recommendations are also easier to follow when farmers use commercial or synthetic fertilizers with clear nutrient analyses and release times. Urban growers tend to prefer the use of compost (Cameira et al, 2014; Dewaelheyns et al, 2013; Small et al, 2019; Wielemaker et al, 2019), which have lower fertilizer nutrient equivalencies (Maltris-Landry et al, 2016; Mikkelsen and Hartz, 2008; Wielemaker et al, 2019), and release nitrogen depending on variable climatic and soil factors affecting mineralization, which makes following nutrient recommendations using compost much more complicated.

Considering these issues, a need has been expressed for research to better understand the nutrient management practices may affect nutrient export (Cameira et al, 2014; Dewaelheyns et al, 2013; Huang et al, 2006; McDougall et al, 2019; Shrestha et al, 2020; Wielemaker et al, 2019; Witzling et al, 2011). Urban farm irrigation practices may further influence nutrient export from urban agriculture, and as with nutrient management, record keeping for irrigation is generally non-existent or incomplete (Small et al, 2019; Whittinghill et al, 2016; Whittinghill and Sarr; 2021; Wielemaker et. al, 2019). Although annual precipitation is expected to increase in the Eastern United States, this increase may not take place during the growing seasons (USGCRP, 2018), thus, implementation of efficient irrigation management will become more important under a changing climate. This coupled with increases in temperatures, consecutive dry days, and water costs, stresses the importance of irrigation management for urban growers.

Alternative Growing Methods for Urban Agriculture

A lack of land area for production in urban centers is one of the major barriers to urban agriculture. This has resulted in numerous production methods that make use of space in and on buildings. The use of container gardens, vertical gardens, and green roof technology to produce food on rooftops is not a new concept but is growing in practice in modern urban agriculture (Appolloni et al, 2021; Buehler and Junge, 2016). Green roof technology makes use of light weight growing media and other layers such as filter fabric, water retention fabric and drainage layers, to enable plant growth on rooftops while minimizing added weight to the underlying building structure (Whittinghill and Rowe, 2012). Modern green roofs offer many of the same ecosystem services as urban green space, many of which are well studies including stormwater retention and quality improvement (Almaaitah and Joksimovic, 2022; Fassman-Beck et al, 2013; Karczmarczyk et al, 2020; Rowe, 2011), noise and air pollution reduction (Rowe, 2011; Van Renterghem and Botteldoren, 2011; Yang et al, 2008), mitigation of the urban heat island and energy savings to the underlying building (Jadaa et al, 2019; Saadatian et al, 2013), and increased biodiversity and habitat (Baumann 2006; Benvenuti, 2014; Colla et al 2009; Cook-Patton and Bauerle, 2012; Madre et al 2013; Tonietto et al, 2011) . The extent to which green roofs provide these ecosystem services depends on a variety of factors including media depth and composition, water holding capacity, and the plant community that it supports.

Ornamental green roofs installed on existing buildings are shallow with a limited plant pallet (typically mixes of sedum species) because of roof-load restrictions (Dvorak and Volder, 2010). These green roofs are often designed to require little maintenance after the plant community is established and are often composed of drought resistant plants with limited nutrient requirements. Switching from these ornamental plant communities to an agricultural crop system requires changes in management. First, green roof media is designed to hold water but drain quicky, and even deeper media depths are recommended for ornamental herbaceous perennials and crop plants. Regardless of media depth, if deeper media is possible, crop plants will likely require the use of irrigation. The use of irrigation on a green roof changes its capacity to retain stormwater (Almaaitah and Joksimovic, 2022; Harada et al, 2018a; Harada et al, 2020; Whittinghill et al, 2014a; Whittinghill et al, 2015). The few studies that have examined this issue have found that agricultural green roofs retain less storm water than their ornamental counterparts. This can be linked to reduced media dry down between storms because of irrigation and therefore lowered capacity to hold water in following storms, with cropping cycles, and with media composition. Second, greater nutrient inputs will be required for the rooftop to support crop plant growth and production. This can be supplied in the form of fertilizers, composts, and other amendments (Grard et al, 2015; Harada et al, 2018a; Whittinghill et al, 2016). Currently, there are no nutrient application recommendations for growing crops in green roof media, so recommendations for soil-based agriculture are likely used. Green roof media does, however, differ from agricultural soils in several ways, including having a low cation exchange capacity (Whittinghill et al, 2016). This suggests that nutrient applications may need to differ from typical agriculture. The use of fertilizers and composts has been examined in ornamental green roofs, and both are linked with increased nutrient leaching (Buffam et al, 2016; Clark and Zheng, 2013, 2014; Czemiel Berndtsson, 2010; Hathaway et al, 2008; Ntoulas et al, 2015; Rowe, 2011). There are many fewer studies examining the effects of nutrient applications to agricultural rooftops are fewer, demonstrate high nutrient leaching with some differences among nutrient sources for the extent to which they contribute to leaching (Elstien et al, 2008; Harada et al, 2017; Harada et al, 2018b; Harada et al, 2020; Kong et al, 2015; Matlock and Rowe, 2017; Whittinghill et al, 2015; Whittinghill et al, 2016; Whittinghill et al, 2024). Few of these studies examine nutrient cycling withing the green roof media or the potential dynamics that microbial communities or other media factors could play in nutrient leaching on agricultural green roofs (Harada et al, 2018b; Harada et al, 2020).

Few studies have examined the impacts of switching from ornamental to agricultural plant communities have on ecosystem services typically provided by green roofs beyond stormwater management. No studies have been found that examine air and noise pollution reduction by agricultural green roofs; although three monitored atmospheric deposition (Harada et al, 2018b; Harada et al, 2019; Tong et al, 2016). The first study (Harada et al, 2018b) focused on atmospheric deposition of nitrogen, the second (Harada et al, 2019) focused on heavy metal atmospheric deposition and media content. The third compared particulate matter on the roof to street level but did not make comparisons to a nearby conventional roof. Another study measured heavy metals in green roof media, and vegetables grown on that roof, but did not monitor atmospheric deposition (Grard et al, 2015). They did test the media three times a year over a two-year experiment but saw no changes over time. It is unclear how the results from any of these studies could be generalized to discuss the system's ability to reduce air pollution. Two studies have explored carbon sequestration (Begam et al, 2021; Whittinghill et al, 2014b). Of these, only the study by Whittinghill et al. (2014b) compared carbon sequestration on agricultural green roofs with ornamental green roofs. Three other studies investigated how green roofs can mitigate urban heat islands and reduce building energy use (Almaaitah and Joksimovic, 2022; Begum et al, 2021; Elstein et al, 2008). These observed that the growth stage of the vegetation affects the extent of cooling but that agricultural green roofs do provide a cooling benefit when compared to a bare roof (Almaaitah and Joksimovic, 2022; Begum et al, 2021). One of those studies also identified differences in cooling among different crop plants (Almaaitah and Joksimovic, 2022).

Very little work has examined the impacts of agricultural green roofs on urban wildlife habitat and biodiversity, especially as compared to ornamental green roofs or ground level systems. More, but still limited work has been done on how the green roof environment affects agricultural production, including aspects like crop variety selection, yields, crop quality and food safety. In this work the focus has been predominantly on yield (Aloisio et al. , 2016; Buckley et al., 2022, Butts, 2017; Eksi et al., 2015; Eksi et al., 2016; Lacarne et al., 2021; Martini et al., 2017, Matlock and Rowe, 2017, Mower e tal., 2019, Olsezewski and Eisenman, 2017; Orsini et al., 2014; Oullette et al., 2013; Varela et al., 20221, Walters et al., 2022, Walters et al., 2023, Whittinghill et al., 2013; Whittinghill et al., 2016b; Whittinghill and Poudel 2020) and not crop quality (Ahmed et al., 2017; Eksi et al., 2015; Lacarne et al., 2021; Whittinghill et al. 2013; Whittinghill et al., 2016b) or food safety (Grard et al., 2015). However, only a few of these include comparisons with more traditional agricultural yields (Aloisio et al., 2016; Whittinghill et al., 2016b; Whittinghill and Poudel, 2020) or include ground level soil-based plots in the experiment for comparison (Eksi et al., 2015; Whittinghill et al., 2013; Whittinghill et al., 2016b; Whittinghill and Poudel, 2020), making it difficult to determine the effects of the green roof systems on crop production. This indicates a need for more research to develop best management practices for green roof crop production. Such practices would help optimize the tradeoffs between crop production and the provisioning of ecosystem services.

Urban Grower Changing Demographics

A national urban agriculture needs assessment was conducted by the National Center for Appropriate Technology (NCAT) in 2013 and received a total of 315 responses (Oberholtzer et al., 2016). The assessment found most urban farmers are generally younger (average 44 years) and have been farming for 10 years on average. This aligns with findings in a needs assessment conducted by the Cornell Vegetable Program in 2019 for urban growers in the City of Buffalo, where 14/15 (93%) of growers have been growing for 10 years or less. The USDA defines "beginning farmers" as those that have been farming for 10 years or less. These farmers are often targeted for special funding and research opportunities as it is likely they have less production experience, limited access to capital, and are less likely to be tied into service provider networks. Across the United States, only 908,274 producers (27%) have been farming for 10 years or less out of a total of 3,399,834 producers. (USDA 2017). In Buffalo, NY, not only are many urban farmers classified as "beginner" they are also predominantly located in USDA designated "food deserts", neighborhoods that are low-income and have limited access to healthy and affordable foods (Van Ploeg, 2011).

Oberholtzer et al. (2016) also found that 37.3% of growers farm on multiple production sites and approximately 71.3% of growers do not own land that was purchased. The bulk of respondents are either borrowing land through an informal agreement, are on a short term (year to year) lease, or a long-term lease. The lack of secure tenancy and number of production sites adds another layer of challenges for pest management in urban settings. Urban growers may be less likely to invest in long-term crop rotation plans, infrastructure, or IPM controls like developing beneficial habitat for natural enemies if they do not know how long they will have access to a property. When asked to rank production risks and challenges, managing pests and managing weeds ranked as the second and third most challenging below production costs.

Urban communities are more demographically diverse than rural areas and urban farms often strive to grow culturally relevant foods for their neighborhoods. This may mean growing crops that are not typical for that climate and very little may be known about managing pests or diseases of these new crops (Parket, 2018). Distinct from most rural agriculture, urban farmers are often nested within not-for-profits that prioritize social issues. (Anderson and Gonzalez, 2018).

Summary

Numerous sources offer evidence of social benefits of urban agriculture. The context of production methods and their risks and benefits reveals opportunities for further research on urban soils, green roofs, nutrient and irrigation management, and effective outreach methods to these audiences.

Objectives

1. Investigate the regulatory, policy, and economic environment on the establishment and sustainability of urban agriculture enterprises.
   Comments: This objective is dedicated to the examination of the impact of the regulatory environment which could include federal, state, municipal, financial, environmental, and other policies on urban agriculture. This objective also includes economic feasibility as it relates to access to financial resources.
2. Assess the availability, use, and sustainability of natural resources in urban agriculture.
   Comments: This objective examines resource inputs associated with urban agriculture and the potential contributions of urban agriculture to biodiversity, climate change adaptation, and mitigation.
3. Identify and examine the challenges and opportunities for improving the equitable development and promotion of urban agri-food systems.
   Comments: This objective focuses on urban agricultural endeavors, from farm to plate, and assesses the impact that urban agriculture has on agricultural sustainability and food security.
4. Identify and examine the factors that contribute to advancing human diversity, inclusion, and community engagement in urban agriculture.
   Comments: This objective also examines issues of food sovereignty and promotion of One Health.

Methods

Objective 1. Investigate the impact of the regulatory policy, and economic environment on the establishment and sustainability of urban agriculture initiatives.

We propose to comprehensively investigate the multifaceted impact of the regulatory environment on urban agriculture. This entails a thorough analysis of federal, state, municipal, financial, environmental, and other pertinent policies that shape the landscape of urban agriculture. Our focus will also explore the economic feasibility of urban agriculture, with a particular emphasis on the accessibility of financial resources for prospective urban farmers. By integrating a holistic approach, this research aims to provide a comprehensive understanding of the challenges and opportunities inherent in urban agriculture, with the ultimate goal of facilitating informed policy decisions and promoting sustainable urban agricultural practices.

Examples of studies to be undertaken include policy-oriented, community-based, or applied research projects that:

- Analyze urban zoning policy across different geographies, including assessment of zoning tools and implementation of such tools.

- Perform quantitative and/or qualitative analyses of scope of urban agriculture as it relates to different zoning or urban planning contexts.

- Assess how different zoning tools are used to promote or exclude urban agriculture; assessment of innovative zoning policies and/or tools (including different types of land banks).

- Map (including participant/resident mapping) of different urban land uses across cities.

- Interview focus groups, city planners, and other relevant officials (e.g., CDC staff, departments of sustainability or community development) about the tools they use to support urban ag and their perception of success of these tools.

- Investigate knowledge of or experience with local zoning ordinances, food policy, urban policy, or others that might present barriers to or opportunities for urban food production.

- Perform interviews with focus groups or individual participants related to knowledge, perspectives, and advocacy of participants in urban agriculture.

- Engage in qualitative and comparative analyses of key stakeholders (e.g., people, organizations, land banks, local officials, municipalities, counties, etc.) involved in creating and implementing land policy, as well as the extent of resident involvement in such endeavors.

- Analyze how urban producers access land in cities across the U.S. (e.g., private vs. public land, leased or purchased land).

- Undertake qualitative or mixed methods case studies (e.g., focus groups, surveys, semi-structured or structured interviews, policy review, archival methods, document analysis) focused on residents, and other key stakeholders, as well as past and present urban agriculture in a place. Analyze zoning records, land and deed transfer records.

- Assess the criteria groups/organizers/people use to select land for urban agriculture and how do they differ from recommended criteria.

- Perform quantitative assessment, mapping, of health indicators of community members in places (e.g., census defined places, census tracts) with differing percentages of urban land under agricultural production.

- Perform time lag regression or spatial analysis to investigate impacts of urban food production across time and space.

Objective 2. Assess the availability, use, and sustainability of natural resources in urban agriculture.

We propose to conduct a thorough examination of the reciprocal relationship between resource inputs and urban agriculture activities, with a specific emphasis on the potential contributions of urban agriculture to biodiversity, climate change adaptation, and mitigation. Our research will entail a comprehensive analysis of the diverse inputs available in urban areas, ranging from brownfields, waste streams, and urban infrastructure to local labor forces, and the potential roles these inputs have on shaping the dynamics of urban agriculture. Concurrently, we will investigate the impact of urban agriculture on biodiversity, climate change adaptation, and mitigation, considering factors such as green infrastructure, carbon sequestration, and the promotion of sustainable ecosystems. This multifaceted approach aims to shed light on the intricate interplay between urban settings and agriculture, with the ultimate goal of identifying strategies that enhance urban agriculture's role in fostering biodiversity, climate resilience, and mitigating the effects of climate change in urban environments.

Examples of studies to be undertaken include basic or applied research projects that:

- Analyze how urban farm irrigation and nutrient management practices impact plant stress and nutrient leaching.
- Evaluate instrumentation on urban farms that monitor water use, soil moisture at several depths, and local environmental conditions.
- Monitor water and nutrient losses from the root zone including the impact that changes in farm management practices have on nutrient leaching.
- Soil test for nutrient content.
- Create strategies for nutrient applications by farm management.
- Analyze nutrient budgets and create nutrient best management application recommendations.
- Monitor how soil health or compost use changes agronomic outcomes (e.g., soil moisture, nutrient leaching, and plant stress).
- Assess contamination in urban soils.
- Examine the development of XRF calibrations for local soils to test for heavy metal contamination
- Link to the effectiveness of heavy metal contamination mitigation measures on urban farms and assess the effectiveness of organic amendments, such as compost and biochar, on contaminant retention and immobilization in a time study.
- Evaluate the impact of heavy metal contamination on food safety from urban agriculture by developing portable XRF method on testing on plant and fruit tissues.
- Analyze the types of materials that are reused, recycled, or utilized as an input/advantage on urban farms or community gardens and quantify economic and environmental value of use of the materials.
- Consider grey water capture and storm water management as a means for irrigation.
- Examine the quality of municipal water for irrigation and its possible effects on soil properties.
- Assess the quality of locally sourced composts used by urban agriculture practitioners.
- Determine micro- and macro-plastic contamination in the urban environment.

Examples of approaches to be used to accomplish basic or applied research projects:

- On farm research or research in collaboration with urban farms and gardens involving:
  - Soil sample collection
  - Leachate water sample collection using lysimeters buried under productive areas
  - Instrumentation for water use monitoring, soil moisture monitoring, ET and weather monitoring
  - Compost sample collection
  - Collection of produce samples
  - In situ testing of soil and crop produce with XRF technology

- Controlled experiments on research farms involving using relevant urban agricultural production practices:
  - Soil sample collection
  - Leachate water sample collection using lysimeters buried under productive areas
  - Instrumentation for water use monitoring, soil moisture monitoring, ET and weather monitoring

- Soil and compost testing including but not limited to:
  - Extraction and spectrographic analysis for nitrate, ammonia, and phosphate
  - Acid digestion and analysis using ICP-OES or ICP-MS for mineral nutrients and heavy metals
  - XRF testing in laboratory conditions to assist in the validation of in situ test results

- Leachate, municipal, and gray water analysis including but not limited to:
  - Volume measurements in the field
  - pH and conductivity measurements
  - Spectrographic analysis for nitrate, ammonia, and phosphate
  - Analysis using ICP-OES or ICP-MS for mineral nutrients and heavy metals.

- Produce analysis including but not limited to:
  - Total and marketable yield measurements
  - Spectrographic analysis for nitrate
  - Acid digestion and analysis using ICP-OES or ICP-MS for mineral nutrients and heavy metals

- Plant stress indicators including but not limited to:
  - Canopy temperature measurements by thermal imaging
  - Leaf water potential
  - Leaf chlorophyll fluorescence
  - Stomatal conductance

Objective 3. Identify and examine the challenges and opportunities for improving the equitable development and promotion of urban agri-food systems.

The focus of this objective is to rigorously examine urban agricultural practices, processes, and endeavors along the entire supply chain, from farm to plate, and to evaluate the broader impacts of urban agriculture on urban agricultural sustainability and food security. Our research approach will encompass a comprehensive investigation into various facets of urban agricultural systems, including cultivation techniques, distribution networks, and consumption patterns, and the role of NGOs and/or community-based organizations (CBOs) community residents in hyper-local agrifood systems. This analysis will enable an understanding of how urban agriculture affects not only the ecological and economic dimensions of urban food production but also its role in enhancing food security within urban areas. We will investigate the complex dynamics and potential synergies between urban agriculture and sustainable food systems, with an aim to provide valuable insights for urban planners, policymakers, and practitioners to foster resilient and secure food production in urban environments.

Examples of studies to be undertaken include basic or applied research projects that:

- Monitor plant stress indicators during the growing season and drought.
- Classify farm practices for comparisons between farms.
- Evaluate innovative agronomic strategies that are easily implemented and consider scale of implementation.
- Determine the extent the built environment can be and is being used to develop urban agriculture (e.g., rooftop urban agriculture).
- Evaluate vegetable production in open air, media-based rooftop systems and determine how such systems might provide environmental benefits by green roof agriculture.
- Determine how growing in green roof media affects crop management (e.g., irrigation, nutrient management recommendations, crop variety selection) and how growth in the rooftop environment affects plant yield and nutrient content.
- Assess the impact of nutrient management/compost additions to such roofs on nutrient leaching.
- Evaluate the opportunities and challenges of urban areas serving as heat sinks.
- Determine and categorize underutilized resources that urban farmers could incorporate into their operation that could have an economic or environmental benefit.
- Identify criteria for siting urban agricultural enterprises.
- Develop nutrient management recommendations that increase yields and crop nutrient quality.
- Develop or assess the impact and improve outcomes of urban agriculture on environmental and equitable socioeconomic sustainability.
- Examine and evaluate the landscape of NGOs or CBOs and their role in education or promotion of urban ag-related practices.
- Research with urban growers that identifies challenges and barriers in growing, access to markets, assessing market demand, and/or aggregating product for marketability.

Examples of approaches to be used to accomplish basic or applied research projects:

- On farm research or research in collaboration with urban farms and gardens involving:
    - Testing and monitoring methods as in objective 2
    - Surveys of farm and garden practices

- Controlled experiments on green roof experimental platforms that would be monitored for:
    - Media properties over time
    - Leachate water volume and quality over time
    - Crop yields, USDA quality standards, and nutrient content (using methods described in objective 2)

- Soil and growing media testing as in objective 2
- Leachate water analysis as in objective 2
- Plant stress indicators as in objective 2

Objective 4. Identify and examine the factors that contribute to human diversity, inclusion, and community engagement in urban agriculture.

We plan to identify and comprehensively examine the multifaceted factors that underpin human diversity, equity, inclusion, and community engagement within the urban agriculture domain. This research will provide a nuanced understanding of how urban agriculture not only addresses food security but also serves as a catalyst for fostering diversity, inclusivity, and community cohesion. This objective also includes consideration of food sovereignty and the promotion of One Health, the nexus between human and environmental health. Ultimately, we expect to offer valuable insights for policy development and implementation that can promote equitable and sustainable urban agricultural practices, thereby contributing to the broader well-being of urban populations.

Examples of studies to be undertaken include basic or applied research projects that:

- Directly utilize longitudinal, cross-sectional, causal, or correlational study design to inventory, survey, and analyze programs and projects involved in urban agriculture for DEI measures.
- Analyze spatial relationships between social determinants of health, presence of urban agriculture operations, resources (financial and otherwise) dedicated to such operations, location of other food retail infrastructure, and vacant land and/or green space availability for urban food production.
- Perform urban agriculture-focused primary and meta-analyses of participant and production data, engaging in action research, or executing experimental research related to measures of race and ethnicity, gender/gender identity and sexual orientation, socioeconomic composition, neurodiversity, and disability status.
- Undertake qualitative, quantitative, mixed method, interpretive research or ethnographies related to participants attitudes, beliefs, group dynamics, life experiences, sense of community, cultural norms, and talents of those engaged in urban agriculture projects and programs.
- Collect data, analyze, and interpret expressions of ideas, perspectives, and abilities of participants in urban agriculture.
- Employ case studies, focus groups, structured interviews, or implementation of methods in programs that are thought to elevate equity, activate diversity, lead with inclusivity, or promote relevant activities in socially, culturally, and economically disadvantaged populations.
- Implement and analyze informal and formal educational opportunities or mentorship/sponsorship outcomes related to urban agriculture and their effectiveness toward DEI goals, including career outcomes; educational matriculation, retention, and recruitment; and measurements of participant well-being.
- Map, inventory, and assess local and regional food supply chain engagement by participants of urban agriculture.
- Implement and analyze projects that promote community engagement or provide mutual aid in the context of regional food systems and agriculture-centered activities.
- Develop, implement, and analyze talent and culture practices, mentorship, or education strategies within urban agriculture, community food program development, or regional food system development, with special focus on outcomes.
- Identify and engage in professional development opportunities for DEI-focus participants.

Prioritize accessibility of project research processes and educational outputs for diverse audiences by conducting language and preferred delivery assessment of translation services at cooperating urban farms. Language preference will be assessed via in-person interviews and written materials translated into appropriate languages and where possible contract interpreters for verbal research and education events.

Measurement of Progress and Results

Outputs

- The multistate research team will train undergraduate and graduate students in qualitative research (e.g., conducting focus groups, qualitative data collection and analysis, participant observation, collaborative and engaged research methodologies analyzing focus group transcripts), quantitative research (e.g., data collection, data analysis), professional and scientific writing, and laboratory skills.
- The multistate research team will submit collaborative grant applications to external funding agencies and organizations.
- The multistate research team will publish research findings in refereed journal publications.
- The multistate research team will present research findings at scientific meetings and other public presentation events.
- The multistate research team will work closely with colleagues in Extension to create and disseminate relevant findings to stakeholders per the Outreach plan.
- The multistate research team will work closely with communications experts to craft compelling, accessible, and relevant messaging to all constituencies.

Outcomes or Projected Impacts

- Clearly identify the regulatory, policy, and economic environment on the establishment and sustainability of urban agriculture enterprises.
- Create models for economic feasibility of urban agricultural enterprises.
- Identify the availability, use, and sustainability of natural resources in urban agriculture.
- Improve the equitable development and promotion of urban agri-food systems.
- Identify and examine the factors that contribute to advancing human diversity, inclusion, and community engagement in urban agriculture.

Milestones

Outreach Plan

This multistate research project focuses on the impact of urban agriculture on environmental quality, socioeconomic vitality, food security, community resilience, and equity. While there are many stakeholder groups to interact with, our Multistate project team is well positioned to provide broad dissemination of the results of this project. To that end, project participants include individuals with Extension appointments and station scientists closely linked to Cooperative Extension faculty, educators, and staff at their Land-grant university. Hence, research findings will be disseminated to urban farmers, agricultural businesses, urban stakeholders, decision makers, scientists, and other clientele through a variety of outreach strategies. The technical team also plans to seek input from all stakeholder groups to ensure that the research is meeting the needs of stakeholders. To move information in a two-way fashion, we expect to use the following strategies:

- **Traditional Extension Outputs:**
  - Develop concise and informative fact sheets summarizing key research findings.
  - Utilize Extension networks and channels to distribute fact sheets to urban farmers and stakeholders.
  - Host informational workshops at urban and peri-urban Extension offices to engage directly with local communities.

- **Digital Tools and Platforms:**
  - Create user-friendly digital tools (e.g., decision making tools, interactive maps, etc.) to enhance accessibility to research outcomes.
  - Employ the project website on NIMSS to aggregate a list of resources generated by project participants.
  - Leverage social media platforms for regular updates and engagement.

- **Workshops and Field Days:**
  - Organize hands-on workshops and field days to provide practical insights and demonstrations.
  - Deploy Extension educators to coordinate regional events that cater to diverse urban agricultural communities.
- **Peer-Reviewed Publications:**
  - Produce peer-reviewed publications for professionals in the field.
  - Collaborate with academic journals and Extension publications to disseminate in-depth research findings.
- **Professional Conferences, Groups, and Organizations:**
  - Present research results at relevant national and regional professional conferences.
  - Foster partnerships with other multistate research projects, especially those with urban ag dimensions.
- **Reaching Underrepresented Communities:**
  - Develop tailored outreach materials addressing the specific needs and challenges of underrepresented communities.
  - Collaborate with community leaders and organizations to ensure effective communication and engagement.
- **Engage With Urban Agriculture Networks:**
  - Engage with existing urban agriculture networks and projects (e.g., NE2206: Green Stormwater Infrastructure and Agriculture.)
  - Attend and present at conferences focused on urban agriculture to expand the project's reach.
- **Recruitment and Participation:**
  - Implement inclusive recruitment strategies to ensure a diverse and representative participant pool.
  - Establish mentorship programs to support underrepresented participants throughout the project.
- **Stakeholder Interaction:**
  - Incorporate diversity, equity, and inclusion principles in all interactions with stakeholders.
  - Solicit feedback from diverse stakeholders to inform project direction and priorities.

- **Cultural Sensitivity:**
    - Ensure that all outreach materials and events are culturally sensitive and accessible.
    - Collaborate with community organizations to facilitate the dissemination of research in a manner that respects and aligns with diverse cultural perspectives.

Last, the Technical Team will implement feedback mechanisms, such as surveys and focus groups, to assess the effectiveness of outreach strategies and use feedback to adapt and refine outreach efforts throughout the project.

Organization/Governance

The technical committee will organize itself by annually appointing an incoming secretary, who will then serve as the secretary for the following year. The secretary will complete a one-year term and then serve as the committee chair the following year. Therefore, officers serve two-year terms. This limits the time commitment requested from incoming officers yet provides sufficient institutional memory about the project. Annual meetings will be organized on a rotating basis after the technical committee membership has been polled for availability and interest. If a face-to-face meeting is not feasible, a virtual annual meeting will be held. For decision making, all Appendix E participants may vote. A quorum for technical committee deliberations will be 51% of the Appendix E participants. Motions pass by simple majority.

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Land Grant Participating States/Institutions

PA,CT

Non Land Grant Participating States/Institutions

Participation

Participant	Is Head	Station	Objective	Research						Extension	
				KA	SOI	FOS	SY	PY	TY	FTE	KA

Combined Participation

Combination of KA, SOI and FOS	Total SY	Total PY	Total TY
Grand Total:	**1.40**	**10.00**	**0.00**
101	1	10	0
102	0.07	0	0
131	0.07	0	0
133	0.07	0	0
205	0.07	0	0
701	0.07	0	0
711	0.07	0	0

Program/KA	Total FTE
Grand FTE Total:	**0**
0	0

Appendix G: Peer Review (Submitted)

Status: Complete

Project ID/Title: NE_TEMP2401: Urban Agriculture: Equity, Sustainability, and Community Development

Rate the technical merit of the project:

1. Sound Scientific approach:
Approve/continue project
2. Achievable goals/objectives:
Excellent
3. Appropriate scope of activity to accomplish objectives:
Excellent
4. Potential for significant outputs(products) and outcomes and/or impacts:
Excellent
5. Overall technical merit:
Excellent

Comments
The proposed research addresses a timely and relevant issue across multiple states and regions. The objectives are clear, and the expected outcomes and impacts are well-defined. The challenges faced by urban agriculture are multidimensional, and sufficiently addressing them requires an interdisciplinary approach. The proposal, as well as the composition and expertise of the technical committee, reflect that. This is a very well-written document — it was a pleasure to read.
Your Recommendation:
Approve/continue project

Appendix G: Peer Review (Submitted)

Status: Complete

Project ID/Title: NE_TEMP2401: Urban Agriculture: Equity, Sustainability, and Community Development

Rate the technical merit of the project:

1. Sound Scientific approach:
Approve/continue project
2. Achievable goals/objectives:
Good
3. Appropriate scope of activity to accomplish objectives:
Good
4. Potential for significant outputs(products) and outcomes and/or impacts:
Excellent
5. Overall technical merit:
Good
Comments
This proposed research seeks to address a wide variety of social and environmental questions around challenges faced by urban agriculture practitioners, and how urban agriculture can contribute to environmental quality, food security, socioeconomic vitality, and community resilience.

A strength of the proposal is its justification for the Northeastern United States as a regional microcosm for studying urban agriculture. The introduction provided a comprehensive overview of relevant literature and identified key knowledge gaps. The study objectives are appropriate and it is likely that this work will provide actionable knowledge in each of these areas (described in project outcomes).

The lack of detail about specific approaches to this research makes it difficult to evaluate the study on technical merit. Each objective included a long list of example studies that could be conducted. Any of these could be informative, but additional details would be required in order to assess the likelihood of success of any of these specific studies, or the ability of this team of researchers (including the resources to which they have access) to successfully complete this work.

The scope of this work, while broad, seems appropriate for a large, collaborative, multi-state research proposal. I am confident that, if funded, this project would generate important new knowlege that would directly benefit urban agriculture practitioners in the Northeast and would benefit the community of researchers working on these issues across the United States and worldwide.
Your Recommendation:
Approve/continue project

Appendix G: Peer Review (Submitted)

Status: Complete

Project ID/Title: NE_TEMP2401: Urban Agriculture: Equity, Sustainability, and Community Development

Rate the technical merit of the project:

1. Sound Scientific approach:
Approve/continue project
2. Achievable goals/objectives:
Good
3. Appropriate scope of activity to accomplish objectives:
Good
4. Potential for significant outputs(products) and outcomes and/or impacts:
Excellent
5. Overall technical merit:
Excellent
Comments
Within objective 2, evaluate municipal irrigation water as an input and implications on pH and electrical conductivity. Insure that nutrient leaching includes direct conveyance into stormwater sewer systems (overlay aspects on combined sewer overflows (CSOs).

Objective 4, include language assessment and preferred delivery of translation services.
Your Recommendation:
Approve/continue project

Project ID/Title: NE_TEMP2401: Urban Agriculture: Equity, Sustainability, and Community Development

Comments:

The team appreciates the encouraging comments from the review panel and hope that indeed our "work will provide actionable knowledge" for urban agriculture practitioners, researchers and support agencies.

The lack of detail about specific approaches to this research makes it difficult to evaluate the study on technical merit...but additional details would be required in order to assess the likelihood of success of any of these specific studies, or the ability of this team of researchers (including the resources to which they have access) to successfully complete this work.

Agreed. The research approaches are intentionally general in this proposal, as the work will be highly site specific to the urban farms and institutions involved in the work. To prioritize the Community Development aspect of the project, research approaches must be informed by urban agriculture practitioners. We have added greater specificity to Objective 2, in response the reviewer comment below.

Within objective 2, evaluate municipal irrigation water as an input and implications on pH and electrical conductivity. Insure that nutrient leaching includes direct conveyance into stormwater sewer systems (overlay aspects on combined sewer overflows (CSOs).

Examples of approaches to be used to accomplish basic or applied research projects:

- On farm research or research in collaboration with urban farms and gardens involving:
    - Soil sample collection
    - Leachate water sample collection using lysimeters buried under productive areas
    - Instrumentation for water use monitoring, soil moisture monitoring, ET and weather monitoring
    - Compost sample collection
    - Collection of produce samples
    - In situ testing of soil and crop produce with XRF technology
- Controlled experiments on research farms involving using relevant urban agricultural production practices:
    - Soil sample collection
    - Leachate water sample collection using lysimeters buried under productive areas
    - Instrumentation for water use monitoring, soil moisture monitoring, ET and weather monitoring

- Soil and compost testing including but not limited to:
    - Extraction and spectrographic analysis for nitrate, ammonia, and phosphate
    - Acid digestion and analysis using ICP-OES or ICP-MS for mineral nutrients and heavy metals
    - XRF testing in laboratory conditions to assist in the validation of in situ test results
- Leachate, municipal, and gray water analysis including but not limited to:
    - Volume measurements in the field
    - pH and conductivity measurements
    - Spectrographic analysis for nitrate, ammonia, and phosphate
    - Analysis using ICP-OES or ICP-MS for mineral nutrients and heavy metals.
- Produce analysis including but not limited to:
    - Total and marketable yield measurements
    - Spectrographic analysis for nitrate
    - Acid digestion and analysis using ICP-OES or ICP-MS for mineral nutrients and heavy metals
    - Plant stress indicators including but not limited to:
    - Canopy temperature measurements by thermal imaging
    - Leaf water potential
    - Leaf chlorophyll fluorescence
    - Stomatal conductance

Objective 4, include language assessment and preferred delivery of translation services.

Yes, an important consideration as many engaged in urban agriculture speak languages other than English. We have added to Objective 4 “Prioritize accessibility of project research processes and educational outputs for diverse audiences by conducting language and preferred delivery assessment of translation services at cooperating urban farms. Language preference will be assessed via in-person interviews and written materials translated into appropriate languages and where possible contract interpreters for verbal research and education events.”

Title: Urban Agriculture: Equity, Sustainability, and Community Development

Issues and Justification:

Urban agriculture has the potential to contribute solutions to multiple contemporary issues, including food security, sustainable development, and climate change mitigation. The Northeast United States is an excellent region to serve as a research testbed to examine the dimensions of urban agriculture and the potential that urban agriculture poses. The region is a microcosm of urban agricultural issues found across the country: dense population, small land area, large cities, and diverse peoples. Further, the Northeast has a significant concentration of Land-grant Universities and Experiment Stations. Institutional proximity (to each other and to urban areas) constitutes a powerful, accessible intellectual framework. Leveraging the research capabilities and outreach expertise of the regional Land-grant Universities and Experiment Stations is a powerful approach to addressing the challenges of urban agriculture.

While the challenges faced by urban agriculture in the Northeast are multidimensional, they are not intractable. The challenges include: equality and equity surrounding information access and understanding on the part of growers, access to growing space (ownership of space and long-term use), soil suitability, natural resource management, economic viability, agricultural sustainability, and access to growing resources. We propose to examine these challenges, and in doing so, lead research efforts that seek to expand urban agriculture and explore strategies to increase community engagement, promote equitable development of urban agriculture sites, ensure food sovereignty, and provide sustainability of urban agri-food systems.

Our project has four objectives dedicated to: examining how the regulatory environment impacts urban ag; assessing the natural resource inputs for urban ag; identifying the challenges and opportunities for urban ag, farm to table; and determining the human impact of urban ag on community diversity, equity, inclusion, and One Health. The overarching goal of this multistate project is to **assess impact and improve outcomes of urban ag on environmental quality, socioeconomic vitality, food security, and community resilience, and equity**.

Related Current and Previous Work:

Introduction

Urban agriculture provides a wide range of ecosystem services on a variety of spatial and temporal scales. Depending on the design of the green space these ecosystem services can include stormwater management (Almaaitah and Joksimovic, 2022; Fassman-Beck et al, 2013; Gong et al., 2019; Karczmarczyk et al., 2000; Rowe, 2011; Whittinghill et al., 2014a), reduction of the urban heat island effect (UHI) (Jadaa et al., 2019; Saadatian et al., 2013), increased biodiversity and habitat (Baumann, 2006; Benvenitu, 2024; Cook-Patton and Bauerle, 2012; Tonietto et al., 2011; Madre et al., 2013), reduced noise and air pollution (Speak et al., 2012; Van Renterghem and Botteldooren, 2011; Yang and Gong, 2008), and carbon sequestration (Getter et al., 2009; Whittinghill et al., 2014b))

Urban agriculture has been studied from a variety of perspectives, particularly through social lenses pertaining to:

- food access (Metcalf and Widener, 2011; Saha and Eckelman, 2017);
- fresh produce intake (Alaimo et al 2008, McCormack et 2010);
- food justice (Alkon, 2014; Billings and Cabbil, 2011; Horst et al, 2017; Myers and Sbicca, 2015 ; Ramírez, 2015; White, 2011);
- food sovereignty (Jarosz, 2014),
- health benefits (McCormack, 2010; Clatworthy et al, 2013; Kingsley, 2009; Subica, 2015; Van Den Berg and Custers, 2011); and
- politics of land development and access to land (Lindemann, 2022)

- community wellbeing (Hung, 2004; Kingsley et al, 2006; Okvat and Zautra, 2011; Saldivar-Tanaka and Krasny, 2004; Teig, et al 2009).

While research on the horticultural aspects of urban agriculture is growing, and current agronomic knowledge is applicable, urban agriculture specific research is still limited when compared to rural or truck-crop type agricultural production. This especially applies to forms of urban agriculture that do not integrate well with large-scale mechanized farming or emerging forms of urban agriculture, such as the use of green roof technology to produce food.

Soils

These above areas of research have produced a significant body of work examining the possibilities and challenges of urban agriculture, but research on urban soils is not as abundant. Research examining soil quality in urban spaces investigates the effects on biodiversity and ecosystem services (Lin et al, 2015), the significance in terms of reclaiming vacant land (Beniston and Lal, 2012; Carlet et al, 2017; Kremer et al, 2013), sustainable land use planning (Lovell, 2010), and the potential to exist as novel agroecosystems (Pearson et al 2010; Egerer et al, 2018). The most common attention given to urban soils, however, pertains to the presence of ongoing and legacy inorganic and organic contaminants such as a lead and other heavy metals (Brown et al, 2016; Kessler, 2013; Marquez-Bravo et al, 2016; McBride et al, 2014; Mielke et al, 1983; Mitchell et al, 2014; Sipter et al, 2008; Spliethoff et al, 2016).

While understanding potential contaminant sources and fluxes in urban agriculture is an important issue, these areas of inquiry are often conducted without consideration of other soil biological, chemical, and physical properties, and rarely consider the soil parent materials therein. Though there may be cases in which urban farmers are growing in soils formed from native, undisturbed soil, most urban farmers deliberately avoid such practices in order to mitigate potential contaminant exposure. As such, most urban agriculturalists grow in soil mixtures that they have constructed over time and are therefore generating a wide range of previously unclassified constructed soils (called Technosols in the World Reference Base for Soils (IUSS, 2022). Research in NYC demonstrates that community growing spaces are less contaminated than home gardens or yards (Cheng et al, 2015). If contaminants are present in soil, it is often physically and logistically challenging to remove or extract them without removing the entire substrate, which may also be quite costly (Mielke, 2015). Additionally, given that urban agriculture is a form of agriculture that is often highly motivated by a social or community-based vision, research on urban soils has not often integrated attention to socio-ecological relationships to the soil, or soil relationality, in understanding how urban farmers relate to and understand their interactions with the soil (Krzywoszynska, 2019; Krzywoszynska and Marchesi, 2020).

Nutrient Leaching

Efficient nutrient and irrigation management are two of the horticultural issues that need to be addressed in urban agriculture. Under application of nutrients or irrigation water can lead to plant stress, increases in pest and disease pressure, a reduction in crop quality, and yield losses. Overapplication of nutrients and irrigation water can lead to nutrient leaching, a known issue in agricultural settings. This is of particular concern in urban areas because of the higher percentage of impermeable surfaces and the impact that stormwater runoff can have in exacerbating nutrient leaching into urban watersheds. Overapplication of irrigation can also lead to plant health and soil quality issues that also impact yield. A growing number of research studies demonstrate the inefficient use of nutrients in urban agriculture, which is sometimes linked with observable increases in soil nutrient content or runoff water measurements or records of fertilizer applications and crop yields (Abdulkdir et al, 2013; Arrobas et al, 2017; Cameira et al, 2014; Dewaelheyns et al, 2013; Huang et al, 2006; Salomon et al, 2020; Small et al, 2019; Weilemaker et al, 2019; Witzling et al, 2011). Fewer studies have examined the issue of irrigation water use in urban agriculture. Numerous barriers to efficient nutrient and irrigation management exist for urban growers, which could be addressed through a combination of research and extension efforts.

Several of these barriers relate to the ability of small-scale urban farmers to access and interpret soil test results and use nutrient recommendations. Soil testing is uncommon in urban agriculture (D. Medina, personal communication, November 3, 2021; Small et al, 2019; Whittinghill and Sarr, 2021; Witzling et al, 2011). There may be a variety of reasons for this including uncertainty about how to collect samples, where to obtain testing, and what tests should be requested. Without soil test results, the use of nutrient recommendations may be difficult as most for phosphorus and potassium, including those available for New England, recommend application rates based on soil test results for those nutrients (Sideman et al., 2023). Even if soil tests have been performed, nutrient recommendations are commonly given in pounds of nutrient per acre for a single crop or crop group (e.g., Sideman et al., 2023) while urban farms grow a high diversity of crops in a small area (McDougall et al, 2019; Salomon et al, 2020; Wielemaker et al, 2019). Converting the pounds per acre measurements down to the smaller scale, in square feet or feet of row, can be a challenge, especially for beginning farmers, and these farms have a greater tendency to over apply nutrients (Wielemaker et al, 2019). Nutrient recommendations are also easier to follow when farmers use commercial or synthetic fertilizers with clear nutrient analyses and release times. Urban growers tend to prefer the use of compost (Cameira et al, 2014; Dewaelheyns et al, 2013; Small et al, 2019; Wielemaker et al, 2019), which have lower fertilizer nutrient equivalencies (Maltris-Landry et al, 2016; Mikkelsen and Hartz, 2008; Wielemaker et al, 2019), and release nitrogen depending on variable climatic and soil factors affecting mineralization, which makes following nutrient recommendations using compost much more complicated.

Considering these issues, a need has been expressed for research to better understand the nutrient management practices may affect nutrient export (Cameira et al, 2014; Dewaelheyns et al, 2013; Huang et al, 2006; McDougall et al, 2019; Shrestha et al, 2020; Wielemaker et al, 2019; Witzling et al, 2011). Urban farm irrigation practices may further influence nutrient export from urban agriculture, and as with nutrient management, record keeping for irrigation is generally non-existent or incomplete (Small et al, 2019; Whittinghill et al, 2016; Whittinghill and Sarr; 2021; Wielemaker et. al, 2019). Although annual precipitation is expected to increase in the Eastern United States, this increase may not take place during the growing seasons (USGCRP, 2018), thus, implementation of efficient irrigation management will become more important under a changing climate. This coupled with increases in temperatures, consecutive dry days, and water costs, stresses the importance of irrigation management for urban growers.

Alternative Growing Methods for Urban Agriculture

A lack of land area for production in urban centers is one of the major barriers to urban agriculture. This has resulted in numerous production methods that make use of space in and on buildings. The use of container gardens, vertical gardens, and green roof technology to produce food on rooftops is not a new concept but is growing in practice in modern urban agriculture (Appolloni et al, 2021; Buehler and Junge, 2016). Green roof technology makes use of light weight growing media and other layers such as filter fabric, water retention fabric and drainage layers, to enable plant growth on rooftops while minimizing added weight to the underlying building structure (Whittinghill and Rowe, 2012). Modern green roofs offer many of the same ecosystem services as urban green space, many of which are well studies including stormwater retention and quality improvement (Almaaitah and Joksimovic, 2022; Fassman-Beck et al, 2013; Karczmarczyk et al, 2020; Rowe, 2011), noise and air pollution reduction (Rowe, 2011; Van Renterghem and Botteldoren, 2011; Yang et al, 2008), mitigation of the urban heat island and energy savings to the underlying building (Jadaa et al, 2019; Saadatian et al, 2013), and increased biodiversity and habitat (Baumann 2006; Benvenuti, 2014; Colla et al 2009; Cook-Patton and Bauerle, 2012; Madre et al 2013; Tonietto et al, 2011) . The extent to which green roofs provide these ecosystem services depends on a variety of factors including media depth and composition, water holding capacity, and the plant community that it supports.

Ornamental green roofs installed on existing buildings are shallow with a limited plant pallet (typically mixes of sedum species) because of roof-load restrictions (Dvorak and Volder, 2010). These green roofs are often designed to require little maintenance after the plant community is established and are often composed of drought resistant plants with limited nutrient requirements. Switching from these ornamental plant communities to an agricultural crop system requires changes in management. First, green roof media is designed to hold water but drain quicky, and even deeper media depths are recommended for ornamental herbaceous perennials and crop plants. Regardless of media depth, if deeper media is possible, crop plants will likely require the use of irrigation. The use of irrigation on a green roof changes its capacity to retain stormwater (Almaaitah and Joksimovic, 2022; Harada et al, 2018a; Harada et al, 2020; Whittinghill et al, 2014a; Whittinghill et al, 2015). The few studies that have examined this issue have found that agricultural green roofs retain less storm water than their ornamental counterparts. This can be linked to reduced media dry down between storms because of irrigation and therefore lowered capacity to hold water in following storms, with cropping cycles, and with media composition. Second, greater nutrient inputs will be required for the rooftop to support crop plant growth and production. This can be supplied in the form of fertilizers, composts, and other amendments (Grard et al, 2015; Harada et al, 2018a; Whittinghill et al, 2016). Currently, there are no nutrient application recommendations for growing crops in green roof media, so recommendations for soil-based agriculture are likely used. Green roof media does, however, differ from agricultural soils in several ways, including having a low cation exchange capacity (Whittinghill et al, 2016). This suggests that nutrient applications may need to differ from typical agriculture. The use of fertilizers and composts has been examined in ornamental green roofs, and both are linked with increased nutrient leaching (Buffam et al, 2016; Clark and Zheng, 2013, 2014; Czemiel Berndtsson, 2010; Hathaway et al, 2008; Ntoulas et al, 2015; Rowe, 2011). There are many fewer studies examining the effects of nutrient applications to agricultural rooftops are fewer, demonstrate high nutrient leaching with some differences among nutrient sources for the extent to which they contribute to leaching (Elstien et al, 2008; Harada et al, 2017; Harada et al, 2018b; Harada et al, 2020; Kong et al, 2015; Matlock and Rowe, 2017; Whittinghill et al, 2015; Whittinghill et al, 2016; Whittinghill et al, 2024). Few of these studies examine nutrient cycling withing the green roof media or the potential dynamics that microbial communities or other media factors could play in nutrient leaching on agricultural green roofs (Harada et al, 2018b; Harada et al, 2020).

Few studies have examined the impacts of switching from ornamental to agricultural plant communities have on ecosystem services typically provided by green roofs beyond stormwater management. No studies have been found that examine air and noise pollution reduction by agricultural green roofs; although three monitored atmospheric deposition (Harada et al, 2018b; Harada et al, 2019; Tong et al, 2016). The first study (Harada et al, 2018b) focused on atmospheric deposition of nitrogen, the second (Harada et al, 2019) focused on heavy metal atmospheric deposition and media content. The third compared particulate matter on the roof to street level but did not make comparisons to a nearby conventional roof. Another study measured heavy metals in green roof media, and vegetables grown on that roof, but did not monitor atmospheric deposition (Grard et al, 2015). They did test the media three times a year over a two-year experiment but saw no changes over time. It is unclear how the results from any of these studies could be generalized to discuss the system's ability to reduce air pollution. Two studies have explored carbon sequestration (Begam et al, 2021; Whittinghill et al, 2014b). Of these, only the study by Whittinghill et al. (2014b) compared carbon sequestration on agricultural green roofs with ornamental green roofs. Three other studies investigated how green roofs can mitigate urban heat islands and reduce building energy use (Almaaitah and Joksimovic, 2022; Begum et al, 2021; Elstein et al, 2008). These observed that the growth stage of the vegetation affects the extent of cooling but that agricultural green roofs do provide a cooling benefit when compared to a bare roof (Almaaitah and Joksimovic, 2022; Begum et al, 2021). One of those studies also identified differences in cooling among different crop plants (Almaaitah and Joksimovic, 2022).

Very little work has examined the impacts of agricultural green roofs on urban wildlife habitat and biodiversity, especially as compared to ornamental green roofs or ground level systems. More, but still limited work has been done on how the green roof environment affects agricultural production, including aspects like crop variety selection, yields, crop quality and food safety. In this work the focus has been predominantly on yield (Aloisio et al. , 2016; Buckley et al., 2022, Butts, 2017; Eksi et al., 2015; Eksi et al., 2016; Lacarne et al., 2021; Martini et al., 2017, Matlock and Rowe, 2017, Mower e tal., 2019, Olsezewski and Eisenman, 2017; Orsini et al., 2014; Oullette et al., 2013; Varela et al., 20221, Walters et al., 2022, Walters et al., 2023, Whittinghill et al., 2013; Whittinghill et al., 2016b; Whittinghill and Poudel 2020) and not crop quality (Ahmed et al., 2017; Eksi et al., 2015; Lacarne et al., 2021; Whittinghill et al. 2013; Whittinghill et al., 2016b) or food safety (Grard et al., 2015). However, only a few of these include comparisons with more traditional agricultural yields (Aloisio et al., 2016; Whittinghill et al., 2016b; Whittinghill and Poudel, 2020) or include ground level soil-based plots in the experiment for comparison (Eksi et al., 2015; Whittinghill et al., 2013; Whittinghill et al., 2016b; Whittinghill and Poudel, 2020), making it difficult to determine the effects of the green roof systems on crop production. This indicates a need for more research to develop best management practices for green roof crop production. Such practices would help optimize the tradeoffs between crop production and the provisioning of ecosystem services.

Urban Grower Changing Demographics

A national urban agriculture needs assessment was conducted by the National Center for Appropriate Technology (NCAT) in 2013 and received a total of 315 responses (Oberholtzer et al., 2016). The assessment found most urban farmers are generally younger (average 44 years) and have been farming for 10 years on average. This aligns with findings in a needs assessment conducted by the Cornell Vegetable Program in 2019 for urban growers in the City of Buffalo, where 14/15 (93%) of growers have been growing for 10 years or less. The USDA defines "beginning farmers" as those that have been farming for 10 years or less. These farmers are often targeted for special funding and research opportunities as it is likely they have less production experience, limited access to capital, and are less likely to be tied into service provider networks. Across the United States, only 908,274 producers (27%) have been farming for 10 years or less out of a total of 3,399,834 producers. (USDA 2017). In Buffalo, NY, not only are many urban farmers classified as "beginner" they are also predominantly located in USDA designated "food deserts", neighborhoods that are low-income and have limited access to healthy and affordable foods (Van Ploeg, 2011).

Oberholtzer et al. (2016) also found that 37.3% of growers farm on multiple production sites and approximately 71.3% of growers do not own land that was purchased. The bulk of respondents are either borrowing land through an informal agreement, are on a short term (year to year) lease, or a long-term lease. The lack of secure tenancy and number of production sites adds another layer of challenges for pest management in urban settings. Urban growers may be less likely to invest in long-term crop rotation plans, infrastructure, or IPM controls like developing beneficial habitat for natural enemies if they do not know how long they will have access to a property. When asked to rank production risks and challenges, managing pests and managing weeds ranked as the second and third most challenging below production costs.

Urban communities are more demographically diverse than rural areas and urban farms often strive to grow culturally relevant foods for their neighborhoods. This may mean growing crops that are not typical for that climate and very little may be known about managing pests or diseases of these new crops (Parket, 2018). Distinct from most rural agriculture, urban farmers are often nested within not-for-profits that prioritize social issues. (Anderson and Gonzalez, 2018).

Summary
Numerous sources offer evidence of social benefits of urban agriculture. The context of production methods and their risks and benefits reveals opportunities for further research on urban soils, green roofs, nutrient and irrigation management, and effective outreach methods to these audiences.

Objectives:

1. Investigate the regulatory, policy, and economic environment on the establishment and sustainability of urban agriculture enterprises.
    a. Comment: This objective is dedicated to the examination of the impact of the regulatory environment which could include federal, state, municipal, financial, environmental, and other policies on urban agriculture. This objective also includes economic feasibility as it relates to access to financial resources.
2. Assess the availability, use, and sustainability of natural resources in urban agriculture.
    a. Comment: This objective examines resource inputs associated with urban agriculture and the potential contributions of urban agriculture to biodiversity, climate change adaptation, and mitigation.
3. Identify and examine the challenges and opportunities for improving the equitable development and promotion of urban agri-food systems.
    a. Comment: This objective focuses on urban agricultural endeavors, from farm to plate, and assesses the impact that urban agriculture has on agricultural sustainability and food security.
4. Identify and examine the factors that contribute to advancing human diversity, inclusion, and community engagement in urban agriculture.
    a. Comment: This objective also examines issues of food sovereignty and promotion of One Health.

Methods:

Objective 1. Investigate the impact of the regulatory policy, and economic environment on the establishment and sustainability of urban agriculture initiatives.

We propose to comprehensively investigate the multifaceted impact of the regulatory environment on urban agriculture. This entails a thorough analysis of federal, state, municipal, financial, environmental, and other pertinent policies that shape the landscape of urban agriculture. Our focus will also explore the economic feasibility of urban agriculture, with a particular emphasis on the accessibility of financial resources for prospective urban farmers. By integrating a holistic approach, this research aims to provide a comprehensive understanding of the challenges and opportunities inherent in urban agriculture, with the ultimate goal of facilitating informed policy decisions and promoting sustainable urban agricultural practices.

Examples of studies to be undertaken include policy-oriented, community-based, or applied research projects that:

- Analyze urban zoning policy across different geographies, including assessment of zoning tools and implementation of such tools.
- Perform quantitative and/or qualitative analyses of scope of urban agriculture as it relates to different zoning or urban planning contexts.
- Assess how different zoning tools are used to promote or exclude urban agriculture; assessment of innovative zoning policies and/or tools (including different types of land banks).
- Map (including participant/resident mapping) of different urban land uses across cities.

- Interview focus groups, city planners, and other relevant officials (e.g., CDC staff, departments of sustainability or community development) about the tools they use to support urban ag and their perception of success of these tools.
- Investigate knowledge of or experience with local zoning ordinances, food policy, urban policy, or others that might present barriers to or opportunities for urban food production.
- Perform interviews with focus groups or individual participants related to knowledge, perspectives, and advocacy of participants in urban agriculture.
- Engage in qualitative and comparative analyses of key stakeholders (e.g., people, organizations, land banks, local officials, municipalities, counties, etc.) involved in creating and implementing land policy, as well as the extent of resident involvement in such endeavors.
- Analyze how urban producers access land in cities across the U.S. (e.g., private vs. public land, leased or purchased land).
- Undertake qualitative or mixed methods case studies (e.g., focus groups, surveys, semi-structured or structured interviews, policy review, archival methods, document analysis) focused on residents, and other key stakeholders, as well as past and present urban agriculture in a place. Analyze zoning records, land and deed transfer records.
- Assess the criteria groups/organizers/people use to select land for urban agriculture and how do they differ from recommended criteria.
- Perform quantitative assessment, mapping, of health indicators of community members in places (e.g., census defined places, census tracts) with differing percentages of urban land under agricultural production.
- Perform time lag regression or spatial analysis to investigate impacts of urban food production across time and space.

Objective 2. Assess the availability, use, and sustainability of natural resources in urban agriculture.

We propose to conduct a thorough examination of the reciprocal relationship between resource inputs and urban agriculture activities, with a specific emphasis on the potential contributions of urban agriculture to biodiversity, climate change adaptation, and mitigation. Our research will entail a comprehensive analysis of the diverse inputs available in urban areas, ranging from brownfields, waste streams, and urban infrastructure to local labor forces, and the potential roles these inputs have on shaping the dynamics of urban agriculture. Concurrently, we will investigate the impact of urban agriculture on biodiversity, climate change adaptation, and mitigation, considering factors such as green infrastructure, carbon sequestration, and the promotion of sustainable ecosystems. This multifaceted approach aims to shed light on the intricate interplay between urban settings and agriculture, with the ultimate goal of identifying strategies that enhance urban agriculture's role in fostering biodiversity, climate resilience, and mitigating the effects of climate change in urban environments.

Examples of studies to be undertaken include basic or applied research projects that:

- Analyze how urban farm irrigation and nutrient management practices impact plant stress and nutrient leaching.
- Evaluate instrumentation on urban farms that monitor water use, soil moisture at several depths, and local environmental conditions.
- Monitor water and nutrient losses from the root zone including the impact that changes in farm management practices have on nutrient leaching.
- Soil test for nutrient content.
- Create strategies for nutrient applications by farm management.
- Analyze nutrient budgets and create nutrient best management application recommendations.
- Monitor how soil health or compost use changes agronomic outcomes (e.g., soil moisture, nutrient leaching, and plant stress).

- Assess contamination in urban soils.
- Examine the development of XRF calibrations for local soils to test for heavy metal contamination
- Link to the effectiveness of heavy metal contamination mitigation measures on urban farms and assess the effectiveness of organic amendments, such as compost and biochar, on contaminant retention and immobilization in a time study.
- Evaluate the impact of heavy metal contamination on food safety from urban agriculture by developing portable XRF method on testing on plant and fruit tissues. ~~on on~~
- Analyze the types of materials that are reused, recycled, or utilized as an input/advantage on urban farms or community gardens and quantify economic and environmental value of use of the materials.
- Consider grey water capture and storm water management as a means for irrigation.
- Examine the quality of municipal water for irrigation and its possible effects on soil properties.
- Assess the quality of locally sourced composts used by urban agriculture practitioners.
- Determine micro- and macro-plastic contamination in the urban environment.

Examples of approaches to be used to accomplish basic or applied research projects:

- On farm research or research in collaboration with urban farms and gardens involving:
  - Soil sample collection
  - Leachate water sample collection using lysimeters buried under productive areas
  - Instrumentation for water use monitoring, soil moisture monitoring, ET and weather monitoring
  - Compost sample collection
  - Collection of produce samples
  - In situ testing of soil and crop produce with XRF technology
- Controlled experiments on research farms involving using relevant urban agricultural production practices:
  - Soil sample collection
  - Leachate water sample collection using lysimeters buried under productive areas
  - Instrumentation for water use monitoring, soil moisture monitoring, ET and weather monitoring
- Soil and compost testing including but not limited to:
  - Extraction and spectrographic analysis for nitrate, ammonia, and phosphate
  - Acid digestion and analysis using ICP-OES or ICP-MS for mineral nutrients and heavy metals
  - XRF testing in laboratory conditions to assist in the validation of in situ test results
- Leachate, municipal, and gray water analysis including but not limited to:
  - Volume measurements in the field
  - pH and conductivity measurements
  - Spectrographic analysis for nitrate, ammonia, and phosphate
  - Analysis using ICP-OES or ICP-MS for mineral nutrients and heavy metals.
- Produce analysis including but not limited to:
  - Total and marketable yield measurements
  - Spectrographic analysis for nitrate
  - Acid digestion and analysis using ICP-OES or ICP-MS for mineral nutrients and heavy metals
- Plant stress indicators including but not limited to:
  - Canopy temperature measurements by thermal imaging
  - Leaf water potential
  - Leaf chlorophyll fluorescence
  - Stomatal conductance

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Objective 3. Identify and examine the challenges and opportunities for improving the equitable development and promotion of urban agri-food systems.

The focus of this objective is to rigorously examine urban agricultural practices, processes, and endeavors along the entire supply chain, from farm to plate, and to evaluate the broader impacts of urban agriculture on urban agricultural sustainability and food security. Our research approach will encompass a comprehensive investigation into various facets of urban agricultural systems, including cultivation techniques, distribution networks, and consumption patterns, and the role of NGOs and/or community-based organizations (CBOs) community residents in hyper-local agrifood systems. This analysis will enable an understanding of how urban agriculture affects not only the ecological and economic dimensions of urban food production but also its role in enhancing food security within urban areas. We will investigate the complex dynamics and potential synergies between urban agriculture and sustainable food systems, with an aim to provide valuable insights for urban planners, policymakers, and practitioners to foster resilient and secure food production in urban environments.

Examples of studies to be undertaken include basic or applied research projects that:

- Monitor plant stress indicators during the growing season and drought.
- Classify farm practices for comparisons between farms.
- Evaluate innovative agronomic strategies that are easily implemented and consider scale of implementation.
- Determine the extent the built environment can be and is being used to develop urban agriculture (e.g., rooftop urban agriculture).
- Evaluate vegetable production in open air, media-based rooftop systems and determine how such systems might provide environmental benefits by green roof agriculture.
- Determine how growing in green roof media affects crop management (e.g., irrigation, nutrient management recommendations, crop variety selection) and how growth in the rooftop environment affects plant yield and nutrient content.
- Assess the impact of nutrient management/compost additions to such roofs on nutrient leaching.
- Evaluate the opportunities and challenges of urban areas serving as heat sinks.
- Determine and categorize underutilized resources that urban farmers could incorporate into their operation that could have an economic or environmental benefit.
- Identify criteria for siting urban agricultural enterprises.
- Develop nutrient management recommendations that increase yields and crop nutrient quality.
- Develop or assess the impact and improve outcomes of urban agriculture on environmental and equitable socioeconomic sustainability.
- Examine and evaluate the landscape of NGOs or CBOs and their role in education or promotion of urban ag-related practices.
- Research with urban growers that identifies challenges and barriers in growing, access to markets, assessing market demand, and/or aggregating product for marketability.

Examples of approaches to be used to accomplish basic or applied research projects:

- On farm research or research in collaboration with urban farms and gardens involving:
  - Testing and monitoring methods as in objective 2
  - Surveys of farm and garden practices
- Controlled experiments on green roof experimental platforms that would be monitored for:
  - Media properties over time
  - Leachate water volume and quality over time
  - Crop yields, USDA quality standards, and nutrient content (using methods described in objective 2)

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- Soil and growing media testing as in objective 2
- Leachate water analysis as in objective 2
- Plant stress indicators as in objective 2
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Objective 4. Identify and examine the factors that contribute to human diversity, inclusion, and community engagement in urban agriculture.

We plan to identify and comprehensively examine the multifaceted factors that underpin human diversity, equity, inclusion, and community engagement within the urban agriculture domain. This research will provide a nuanced understanding of how urban agriculture not only addresses food security but also serves as a catalyst for fostering diversity, inclusivity, and community cohesion. This objective also includes consideration of food sovereignty and the promotion of One Health, the nexus between human and environmental health. Ultimately, we expect to offer valuable insights for policy development and implementation that can promote equitable and sustainable urban agricultural practices, thereby contributing to the broader well-being of urban populations.

Examples of studies to be undertaken include basic or applied research projects that:

- Directly utilize longitudinal, cross-sectional, causal, or correlational study design to inventory, survey, and analyze programs and projects involved in urban agriculture for DEI measures.
- Analyze spatial relationships between social determinants of health, presence of urban agriculture operations, resources (financial and otherwise) dedicated to such operations, location of other food retail infrastructure, and vacant land and/or green space availability for urban food production.
- Perform urban agriculture-focused primary and meta-analyses of participant and production data, engaging in action research, or executing experimental research related to measures of race and ethnicity, gender/gender identity and sexual orientation, socioeconomic composition, neurodiversity, and disability status.
- Undertake qualitative, quantitative, mixed method, interpretive research or ethnographies related to participants attitudes, beliefs, group dynamics, life experiences, sense of community, cultural norms, and talents of those engaged in urban agriculture projects and programs.
- Collect data, analyze, and interpret expressions of ideas, perspectives, and abilities of participants in urban agriculture.
- Employ case studies, focus groups, structured interviews, or implementation of methods in programs that are thought to elevate equity, activate diversity, lead with inclusivity, or promote relevant activities in socially, culturally, and economically disadvantaged populations.
- Implement and analyze informal and formal educational opportunities or mentorship/sponsorship outcomes related to urban agriculture and their effectiveness toward DEI goals, including career outcomes; educational matriculation, retention, and recruitment; and measurements of participant well-being.
- Map, inventory, and assess local and regional food supply chain engagement by participants of urban agriculture.
- Implement and analyze projects that promote community engagement or provide mutual aid in the context of regional food systems and agriculture-centered activities.
- Develop, implement, and analyze talent and culture practices, mentorship, or education strategies within urban agriculture, community food program development, or regional food system development, with special focus on outcomes.
- Identify and engage in professional development opportunities for DEI-focus participants.
- Prioritize accessibility of project research processes and educational outputs for diverse audiences by conducting language and preferred delivery assessment of translation services at cooperating urban farms. Language preference will be assessed via in-person interviews and

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written materials translated into appropriate languages and where possible contract interpreters for verbal research and education events.

Measurement of Progress and Results:
Project Outputs:
The multistate research team will **train undergraduate and graduate students** in qualitative research (e.g., conducting focus groups, qualitative data collection and analysis, participant observation, collaborative and engaged research methodologies analyzing focus group transcripts), quantitative research (e.g., data collection, data analysis), professional and scientific writing, and laboratory skills.

The multistate research team will **submit collaborative grant applications** to external funding agencies and organizations.

The multistate research team will **publish research findings** in refereed journal publications.

The multistate research team will **present research findings** at scientific meetings and other public presentation events.

The multistate research team will **work closely with colleagues in Extension to create and disseminate relevant findings** to stakeholders per the Outreach plan.

The multistate research team will **work closely with communications experts to craft compelling, accessible, and relevant messaging** to all constituencies.

Project Outcomes:
Clearly identify the regulatory, policy, and economic environment on the establishment and sustainability of urban agriculture enterprises.

Create models for economic feasibility of urban agricultural enterprises.

Identify the availability, use, and sustainability of natural resources in urban agriculture.

Improve the equitable development and promotion of urban agri-food systems.

Identify and examine the factors that contribute to advancing human diversity, inclusion, and community engagement in urban agriculture.

Outreach Plan:
This multistate research project focuses on the impact of urban agriculture on environmental quality, socioeconomic vitality, food security, community resilience, and equity. While there are many stakeholder groups to interact with, our Multistate project team is well positioned to provide broad dissemination of the results of this project. To that end, project participants include individuals with Extension appointments and station scientists closely linked to Cooperative Extension faculty, educators, and staff at their Land-grant university. Hence, research findings will be disseminated to urban farmers, agricultural businesses, urban stakeholders, decision makers, scientists, and other clientele through a variety of outreach strategies. The technical team also plans to seek input from all stakeholder groups to ensure that the research is meeting the needs of stakeholders. To move information in a two-way fashion, we expect to use the following strategies:

- **Traditional Extension Outputs:**
    - Develop concise and informative fact sheets summarizing key research findings.

    - Utilize Extension networks and channels to distribute fact sheets to urban farmers and stakeholders.
    - Host informational workshops at urban and peri-urban Extension offices to engage directly with local communities.
- **Digital Tools and Platforms:**
    - Create user-friendly digital tools (e.g., decision making tools, interactive maps, etc.) to enhance accessibility to research outcomes.
    - Employ the project website on NIMSS to aggregate a list of resources generated by project participants.
    - Leverage social media platforms for regular updates and engagement.
- **Workshops and Field Days:**
    - Organize hands-on workshops and field days to provide practical insights and demonstrations.
    - Deploy Extension educators to coordinate regional events that cater to diverse urban agricultural communities.
- **Peer-Reviewed Publications:**
    - Produce peer-reviewed publications for professionals in the field.
    - Collaborate with academic journals and Extension publications to disseminate in-depth research findings.
- **Professional Conferences, Groups, and Organizations:**
    - Present research results at relevant national and regional professional conferences.
    - Foster partnerships with other multistate research projects, especially those with urban ag dimensions.
- **Reaching Underrepresented Communities:**
    - Develop tailored outreach materials addressing the specific needs and challenges of underrepresented communities.
    - Collaborate with community leaders and organizations to ensure effective communication and engagement.
- **Engage With Urban Agriculture Networks:**
    - Engage with existing urban agriculture networks and projects (e.g., NE2206: Green Stormwater Infrastructure and Agriculture.)
    - Attend and present at conferences focused on urban agriculture to expand the project's reach.
- **Recruitment and Participation:**
    - Implement inclusive recruitment strategies to ensure a diverse and representative participant pool.
    - Establish mentorship programs to support underrepresented participants throughout the project.
- **Stakeholder Interaction:**
    - Incorporate diversity, equity, and inclusion principles in all interactions with stakeholders.
    - Solicit feedback from diverse stakeholders to inform project direction and priorities.
- **Cultural Sensitivity:**
    - Ensure that all outreach materials and events are culturally sensitive and accessible.
    - Collaborate with community organizations to facilitate the dissemination of research in a manner that respects and aligns with diverse cultural perspectives.

Last, the Technical Team will implement feedback mechanisms, such as surveys and focus groups, to assess the effectiveness of outreach strategies and use feedback to adapt and refine outreach efforts throughout the project.

Organization/Governance:
The technical committee will organize itself by annually appointing an incoming secretary, who will then serve as the secretary for the following year. The secretary will complete a one-year term and then serve as the committee chair the following year. Therefore, officers serve two-year terms. This limits the time commitment requested from incoming officers yet provides sufficient institutional memory about the project. Annual meetings will be organized on a rotating basis after the technical committee membership has been polled for availability and interest. If a face-to-face meeting is not feasible, a virtual annual meeting will be held. For decision making, all Appendix E participants may vote. A quorum for technical committee deliberations will be 51% of the Appendix E participants. Motions pass by simple majority.

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Prospective Participation

Project Writing Workshop Participants:
Nikki Byrne-Hoffman, WVU, cbyrne1@mail.wvu.edu
Fransesco Di Gioia, PSU, fxd92@psu.edu
Dwane Jones, UDC, dwane.jones@udc.edu
Jacqueline Kowalski, UCONN, jacqueline.kowalski@uconn.edu
David Leibovitz, NERA, david_leibovitz@uri.edu
Justine Lindemann, PSU, jlindemann@psu.edu
Judson Reid, Cornell, jer11@cornell.edu
Rick Rhodes, NERA, rcrhodes@uri.edu
Subharajit (Jeet) Saha, UMASS, subhrajitsah@umass.edu
John Taylor, URI, jr_taylor@uri.edu
Matt Wilson, WVU, Matt.Wilson@mail.wvu.edu

Other Interested Northeasterners:
Jenny Kao-Kniffin, Cornell, jtk57@cornell.edu
Ali Mitchell, NEED, Amitchell@northeastextension.org
Anu Rangarajan, Cornell, ar47@cornell.edu
Leigh Whittinghill, CT AES (New Haven), Leigh.Whittinghill@ct.gov
Patrick Drohan, Penn State, pjd7@psu.edu
Ekaterina Bazilevskaya, Penn State, eab204@psu.edu

NE_TEMP2438: Carbon Dynamics and Hydromorphology in Depressional Wetland Systems

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Admin Advisors:	[Puneet Srivastava]
NIFA Reps:	

Non-Technical Summary

Wetland soils are one of the largest reservoirs of soil organic carbon storing up to 20-30% of the planet's terrestrial carbon pool. Hydrology is a primary factor controlling wetland carbon storage since wet soils have less oxygen causing slow rates of decomposition of plant tissues (leaves, roots, etc.). Depressional wetlands occur in landscape positions where water collects, resulting in wet conditions that promote soil carbon accumulation. Our goal is to study depressional wetlands across 11 different states with varying climates from Northeast Region across the Midwest and into the Mountain West in order to document soil carbon storage. Our primary objectives are to quantify the carbon pools in depressional wetlands and the range in characteristics that occur within these 11 sites. Our target audiences for the results from this research include the soil science and ecology scientific communities, students, policy makers, conservationists, and others interested in soils and carbon. Our activities in this collaborative project will facilitate research that is difficult to perform alone or in small research teams. Further, the results from this work will inform the management and conservation of depressional wetlands as well as greenhouse gas models used to predict soil carbon dynamics.

Statement of Issues and Justification

The complexity of the carbon (C) cycle, and the potential for soil to act as both a C source and sink, have made projections of terrestrial C dynamics in light of global change difficult to determine with high confidence (Jaffe et al., 2013). The debate on whether soil is a net source or sink of C is ongoing because soil organic matter is a fundamental dynamic soil property that is capable of varying on human-time scales with changes in climate (Six et al., 2002; Janzen, 2006; West and Six, 2007; Ågren et al., 2008). If the United States is to manage and/or diminish future C emissions, scientists and policy makers must have dependable and accurate information on C stocks and fluxes (NOAA, 2013).

Of the landscapes that exist around the globe, wetland soils are one of the largest reservoirs of soil organic C (Chmura et al., 2003). Mitsch et al. (2012) estimated that wetlands store 20-30% of the earth's terrestrial C pool; which makes them one of the landscape types under scrutiny in an attempt to mitigate the impacts of global climate change (IPCC, 2007). The primary factor controlling the quantity of C in the wetland soil reservoir is the hydrology that promotes saturation and anaerobic conditions. In soils that are saturated to the surface or inundated, (i.e. hydromorphic soils), the soil environment is anaerobic for much or all of the year. In such cases, soil organic matter (SOM) decomposition is a function of microbial activity (Borken et al., 2006). Fewer microbes are involved, and they are much less efficient at decomposing SOM into organic C compounds under anaerobic conditions than under aerobic conditions, and thus C stocks are typically greater in hydromorphic soils (Mausbach and Richardson, 2000). Carbon dioxide (CO_2) is a byproduct of SOM breakdown via aerobic and anaerobic respiration, while methane (CH_4) is produced via fermentation of SOM under anaerobic conditions. A secondary but important factor in SOM decomposition is soil temperature; with an increase in temperature typically leading to an increase in decomposition (Davidson and Janssens, 2006). Significant increases in temperature have been recorded over the last couple decades and are expected to continue to increase (Rohde et al., 2013). Recent models suggest global temperature increases of 15% (approximately 3.9℃) by the next century (Brown and Caldeira, 2017), which should accelerate microbial activity and the rate of SOM breakdown in soils. The question is: How such an increase in temperature will affect C stocks in wetlands (Davidson and Janssens, 2006). One way to answer this question is to find wetlands to study with similar soils, hydrologies, and geomorphic settings but a range in temperatures.

Depressional wetlands occur worldwide. In the United States there are a range of depressional wetlands including prairie potholes, kettle holes, and Carolina Bays (Brinson, 1993). Over a short distance depressional wetlands have areas that are inundated, saturated, and unsaturated (Gala et al., 2005). The areas that are inundated and saturated change over the seasons resulting in a full range of hydrologic conditions every year. Thus, the unique hydrologic characteristics of depressional wetlands allow for a diagnostic investigation of how hydrology influences the magnitude of the biological and chemical interactions that take place in the soil such as C fluxes in all types of wetlands. Over the last nine years members of the NE-1438 multistate project and subsequent NE-1938 multistate project have been studying the hydrology, redox processes, and carbon dynamics occurring in vernal pool wetlands (seasonally wet depressional wetlands). These studies have mostly occurred across the northeast region from Massachusetts to Virginia, with three study sites in the west (Wyoming, Kansas, and Nebraska). These depressional wetlands represent a suite of wetlands with similar hydrologies, yet vary in temperatures, parent materials, vegetation, and other soil forming factors which leads to variation in wetland C stocks. Further, notable amounts of recalcitrant carbon, sometimes known as "black carbon", have been observed in some of the sites. Goldberg (1985) stated that black carbon is formed through the incomplete combustion of wood, vegetation, and fossil fuels as well as certain industrial processes. Kuhlbusch (1998) describes black carbon as a potential sink for atmospheric carbon. Black carbon is a mechanism of long-term carbon storage that was not explored in NE-1438 or NE-1938.

Our goal is to determine the range in C stocks across a set of 11 depressional wetlands. In concert with accounting the labile, recalcitrant, and mineral C stored in these systems, we will measure inputs of C through litter and dead fall, rates of decomposition of these C sources, and the fluxes of C via carbon dioxide (CO_2) and methane (CH_4) that occur in these soils. We will make these measurements in, or adjacent to, each of the two zones of these wetlands (seasonally inundated, seasonally saturated), and the adjacent uplands. Our working hypothesis is that these multistate project sites, while exhibiting similar hydrologic conditions, will have varied carbon storage, and differing rates of soil C additions, decomposition, and losses. By quantifying C dynamics of these understudied wetland ecosystems we will gain a better understanding of the vulnerability of stored C to losses due to increasing temperatures as well as the potential for C sequestration over the next century.

Related, Current and Previous Work

Because soil is the of Earth's large terrestrial C pool, the topic of soil C budgets for different landscapes is being increasingly debated within the scientific community (Smith et al., 1995; Huntington, 1995; Bridgham et al., 2006; Mitsch et al., 2012; Ricker et al., 2014). In soils, C sequestration (a net gain in C over time), is a function of a larger contribution of C primarily from plant inputs relative to a smaller amount of losses primarily through microbial decomposition. Over long periods of time (100's to 1000's of years) C builds up in soils if the balance is positive. This is particularly true in wetlands because they develop anaerobic conditions due to saturation for extended periods compared to adjacent upland soils. The anaerobic conditions that develop in saturated soils slow the rates of SOM decomposition (Whiting and Chanton, 2001; Altor and Mitsch, 2008). These relatively high soil C stocks (200-600 Mg ha-1) are often cited as evidence of the effectiveness of wetlands to serve as a C sink.

With increasing global temperatures, the question becomes: has the net positive balance between C inputs and losses shifted so that now (or in the near future) the C stored in these wetlands will serve as a net source of C to the atmosphere in response to rising temperatures?

Studies on the variation in organic matter decomposition rates across hydrologic gradients of depressional wetlands have produced conflicting results (McClain et al., 2003; Capps et al., 2014). In C sequestration studies, sources of C are typically associated with leaf litter, deadfall, and roots. Decomposition rates of these sources have been studied in a number of different ways. Mesh litter bags filled with leaves or tea bags may be used to represent leaf litter deposited in the field, while wooden dowel rods placed at the soil surface may represent deadfall, and wooden dowel rods inserted into the soil may represent coarse roots (O'Lear et al., 1995; Austin and Vitousek, 2000; Bontti et al., 2009; Capps et al., 2014). Fibrous root decomposition could also be studied by inserting dead roots into mesh bags buried in the soil. One study by Capps et al. (2014) examined differences in leaf litter decomposition across a hydrologic gradient in a forested depressional wetland. This study reported that the percentage of leaf litter lost over approximately three months was significantly higher in the vernal pool basin (~38%) and transitional edge zone (~45%) than in the upland area (~28%). These results are counter-intuitive; we expect decreased SOM decomposition in wetlands rather than uplands. The 1-cm mesh bags used in the study were very large and the losses in the wetlands may have been due to increased scavenging of leaf tissue by macroinvertebrates such as aquatic larvae of winged insects, other insects, earthworms, and arachnids, rather than decomposition by microbes. Benthic macroinvertebrates are estimated to consume 20-73% of leaf litter inputs to riparian wetlands (Covich et al., 1999), which could explain higher losses in wetlands with standing water. Replication of this study using a finer (closer to 1 mm) mesh size to exclude large macroinvertebrates is necessary to refute or accept the Capps study results as representative in wetland systems.

Studies have also simulated deadfall and woody root decomposition through the examination of above-ground and below-ground dowel rod decomposition in a variety of different environments. These studies focused on precipitation, temperature, and landscape disturbance as the variables relative to dowel decomposition. After a span of approximately three months, several studies found that dowel decomposition did not exceed 10% (O'Lear et al., 1995; Austin and Vitousek, 2000; Bontti et al., 2009). Parts of these results both match and also are in conflict with data from our studies as part of the NE-1438 multistate project. In our present study, we found significant site, zone, and year effects on dowel rod decomposition in the soil. Annual decomposition ranged from 0.2% to 18% mass loss in zone 1, 0.3% to 27% in zone 2, and from 0.6% to 48% in zone 3. We are still analyzing the data, and expect most of these differences to be a function of temperature, especially when the soil wasn't saturated. Other effects, however, could be related to the characteristics of the soils in which the decomposition sticks were placed. This could include presence of easily soluble C that the microbes could use instead of the C in sticks, soil pH affecting the microbial community, and soil texture which controls factors such as moisture content during unsaturated conditions and how much direct contact occurs between the soil and the sticks (finer textures will have greater contact).

We previously studied decomposition at the soil surface in NE-1938, and will continue that research and methodology going forward. We will minimize the soil effects by studying decomposition at the soil surface with both leaves and sticks. Deadfall and litter fall are by far the largest source of C to the wetland soils making up approximately 80% of the contributions (Davis et al., 2010; Richardson and Stolt, 2012; Ricker et al., 2014) and were not measured in the previous study. Within sites temperature is controlled, thus decomposition of leaves and sticks at the surface is a function of duration of inundation (water over the soil surface). Zones 2 and 3 are not inundated, thus, we can test temperature effects among sites by focusing on these two zones. In addition, we will deploy a second set of sticks and litter bags in early summer after ponding in Zone 1 has ceased. These sticks and leaves will be left for the 3 summer months (before fall inundation in Zone 1) which is the warmest time of year where most decomposition is expected. Lastly, we will include Zone 1 in a multiple regression analysis of yearly decomposition to explain the contributions of both temperature and inundation.

Decomposition of organic matter is primarily the result of heterotrophic respiration from microbial mineralization of organic matter. Soil microbes decompose SOM in order to utilize it as an energy source. Through respiration, C is released into the atmosphere as CO2. Depending on environmental conditions, microorganisms will respire either aerobically (via the tricarboxylic acid cycle) or anaerobically (via fermentation). Wetland soils play a key role in the global C cycle not only by contributing CO2, but also through the process of methanogenesis to produce CH4. Both CO2 and CH4 are important greenhouse gasses (GHG). Thus, understanding how differences in organic matter sources, losses, degree of soil saturation, and temperature control decomposition processes and the production of greenhouse gasses is of the utmost importance.

Methanogenesis is an anaerobic process in which microorganisms first degrade organic matter present in the soil. Methanogenic microorganisms utilize the acetate or hydrogen produced by this decomposition in order respire, thus producing CH4 which can then be emitted into the atmosphere (Segers, 1998; Altor and Mitsch, 2008). Although fluxes of CH4 are much lower than CO2, CH4 is 25-times more effective as a GHG. There is a positive correlation between the amount of C fixed in wetlands to the amount of CH4 emitted into the atmosphere (Whiting and Chanton, 2001). Although depressional wetlands tend to be small, CH4 concentrations tend to be high in these wetlands as aerobic soil becomes inundated, reducing the soil's ability to oxidize CH4. When CH4 oxidation exceeds CH4 production through methanogenesis, the area is considered to be a sink of CH4 rather than a source (Kuhn, 2015; Holgerson, 2015). Thus, this absorption of CH4 is typical in aerobic soil environments (Kagotani et al., 2001). Considering how potent a greenhouse gas CH4 is, the release or sorption of CH4 in wetlands under different temperatures and degrees of saturation/inundation needs further study.

During the preceding multistate project, NE-1938, several collaborators noted the presence of black carbon at their sites. At the site in West Virginia the source of black carbon is coal in residual soils. At the site in Pennsylvania the black carbon is attributed to charcoal hearths used for making charcoal for making iron in the late 1700s. Further, two new tallgrass prairie sites from the Great Plains were added to the project – bison wallows in the Flint Hills of Kansas and depressional wetlands in southeast Nebraska. Prairie ecosystems are fire-dependent and are likely to have significant pools of black carbon present. Black carbon included in total carbon measurements. However, the recalcitrance of this pool of carbon complicates carbon dynamics of these depressional wetlands. Thus, we propose to quantify the presence of black carbon at all of our sites using the temperature ramp dry combustion method, a novel analytical method that quantifies soil organic carbon (SOC), soil inorganic carbon (SIC), and black carbon.

Previous multistate projects, NE-1021, NE-1038, and NE-1438 helped establish a framework for the systematic study of hydromorphic, hydric, and subaqueous soils. These efforts pointed to the need to establish studies focused on wetlands with similar hydrologic conditions of national importance and debate (vernal pools). In multistate project NE-1938 (2015-2019), we instrumented 8 depressional wetlands (vernal pools) and studied their hydrology and redox status, soil morphology, and simulated rates of root decomposition with dowel rods. Although we are still analyzing these data sets, several things became clear. In particular, our understanding of carbon dynamics in these soil systems was incomplete. We focused on root decomposition, but roots only make up about 20% of the carbon additions to the systems. We had no measures of other carbon inputs (litter and dead fall), nor actual measures of carbon losses as either CO_2 or methane. Although our studies pointed to the importance of temperature in decomposition, since our studies were of below-ground decomposition there were several confounding soil factors that clouded our interpretations of the results. Considering the role of wetlands in carbon storage and cycling, and the possible effects of rising temperatures on carbon pools and cycles, we need a much better understanding of wetland C-budgets in a changing climate.

For ecologists, understanding the duration of inundation (hydroperiod) is critical to determining whether a depressional wetland will serve as an effective wetland breeding habitat for important amphibians. One of our goals was to understand the range in hydroperiods in the depressional wetlands across these 11 sites. Likewise, one of our interests was to relate inundation and saturation, relative to the criteria used for identifying hydric soil conditions, to test hydric soil morphologic indicators. Although we now have several years of hydrologic data for our range of depressional wetlands, considering the recent large variability in precipitation, additional hydrology data for these sites would be valuable. A continuation of this project will provide a forum to advance our knowledge of these systems and the associated soils and provide an outlet for the dissemination of our knowledge to stakeholders that are seeking answers to their use, management, and restoration questions.

The depressional wetland systems identified across the 11 multistate project sites are distributed across climatic gradients, across parent material types (coastal plain, residual, and glacial), and among different geomorphological settings. This multi-state project will permit the documentation of ranges in depressional wetland properties in a way that is not possible for a single investigator working within a single state. This information is critical for providing baseline data to document if and how these systems are changing with increased temperatures as well as comparisons with depressional wetlands in other regions of the world. Achieving this within a multi-state framework is also critical because the major agencies that use the soil information that pedologists collect, such as USDA-NRCS, USACE, and USEPA, all work across state and regional boundaries. In addition, working groups such as the New England Hydric Soil Technical Committee and Mid-Atlantic Hydric Soils Committee, who offer guidance to regional regulatory bodies like the New England Interstate Water Pollution Control Commission (http://www.neiwpcc.org/), need soils information that is not restricted by state boundaries. Recent focus of the USACE and other federal agencies to develop amendments to the 1987 Wetlands Delineation Manual (Environmental Laboratory, 1987) provide additional incentive to work region-wide in applied research. This project will enhance current collaborations and will foster and facilitate new collaborations.

Through multistate projects NE-1021, NE-1038, NE-1438, and NE-1938 the original members of our team established eight depressional wetland study sites that span different temperature regimes across the Northeast with one site in Wyoming. Since NE-1938 began, we have added two collaborators with respective sites in Kansas and Nebraska. Those collaborators are in the process of characterizing their sites and implementing protocols established in NE-1938. In addition, one new collaborator will be joining the project in 2024 and will need to implement a newly established study site in Michigan. These additional sites expand the range of depressional wetland characteristics observed, thus expanding the applicability of our results to other regions. Disruptions of research caused by the Covid-19 pandemic limited certain aspects of the NE-1938 research, especially the measurement of greenhouse gasses. In addition, observations of black carbon at some sites during the NE-1938 project helped identify the need for quantifying black carbon and documenting that carbon pool as an important component of the carbon dynamics story of these depressional wetlands. Due to the differences in time of establishment across our 11 sites, the disturbances caused by the Covid-19 pandemic, and the observation of black carbon at multiple sites, we propose a continuation of the research initially proposed for NE-1938 with the addition of an assessment of black carbon pools at all sites.

Objectives

1. To better understand the hydrological, biogeochemical and pedological properties and processes that affect SOM decomposition, CO_2 and CH_4 greenhouse gas fluxes, and C sequestration in depressional wetland ecosystems.
2. To document the range in accumulated soil C stocks and fluxes across these 11 depressional wetland systems.
3. To determine the relationship between hydroperiod (i.e. duration of saturation and inundation) and accumulated soil C stocks and fluxes in depressional wetlands.
4. To quantify black carbon in depressional wetland systems.

Methods

Site Selection

Eleven sites will be used in this study (Figure 1). Those sites include eight that were previously selected across the Northeast region for study by the PIs and generally characterized, and three new sites in Kansas, Michigan, and Nebraska. Each site includes a depressional wetland having three clearly-identifiable hydrological zones (ponded, saturated, and unsaturated) with gradual boundaries between the zones (Figure 2).

Plot Layout and Experimental Design

In each wetland study site, three hydrological zones were identified, corresponding to the predominant soil, plant, and water characteristics at each location (Figure 2). Zone 1 is seasonally ponded, and typically contains hydrophytic vegetation (emergent, shrub or woody). Zone 1 usually becomes ponded in the Winter and early Spring and then dries out sometime before or during the Summer season. Zone 2 is a wetland zone marked by saturation, but not significant ponding. It contains hydrophytic vegetation and hydric soils. Zone 3 is the upland area beyond the wetland boundary. Hydric soils are not present in zone 3, although in some cases hydrophytic vegetation can be observed adjacent to, and outside the boundary of, the wetland zones.

Within each site, nine research plots have been identified along three transects as illustrated in Figure 3. Each of the transects extends radially outwards from the center of the vernal pool (zone 1) through zone 2 and into the upland. Along each transect, a single plot was centrally located within each of the hydrological zones. Locations of the transects were randomized based upon compass orientation. Elevations along each transect will be measured using appropriate tools such as a level or total station. Microtopographic differences will be documented by recording elevations at 1 m intervals along the transects.

Hydrology

The depth of ponded water or the depth to the water table (below the surface) will continue to be recorded at each site. Depth of ponded water is measured using a staff gauge. Monitoring ports consisting of a well screen installed to a depth of 100 cm have been placed at each plot and water tables will continue to be measured periodically (Figure 3). Along a single transect at each site, water table recording devices have been installed and programmed to record water table levels daily. The detailed (daily) data set from the recording devices will be extended to the other transects based on the periodic observations in the monitoring ports.

Soil Morphology

In the vicinity of each plot, a soil profile description has been made to a depth of 1 to 2 m according to standard protocols (Schoeneberger et al., 2012). Samples collected from each horizon have been stored for laboratory analysis. Morphological descriptions will be compared with approved field indicators of hydric soils to determine whether there is any need for additional hydric soil indicators for use in depressional wetlands (USDA-NRCS, 2017).

Vegetation Analysis

Plant communities in each of the three zones will be assessed by methods outlined in the 1987 USACE Wetland Delineation Manual (Environmental Laboratory, 1987) and the appropriate regional supplement (USACE, 2010a; USACE, 2010b; USACE, 2010c; USACE, 2012a; USACE, 2012b).

Weather and Climate Data

In order to generalize and extend hydrological observations from the period of this study to the broader context, weather data will be obtained from the nearest weather station that maintains a long term (30+ years) record of daily precipitation and air temperatures. Daily records of precipitation and of minimum and maximum temperatures will be collected for the period of this study and will also be obtained for a minimum of the previous 30 years.

Quantification of Carbon and Nitrogen Stocks

Carbon and nitrogen stocks will be determined at plots along each transect (Vasilas et al., 2013). A soil core will be collected from the upper 50 cm in a way that permits simultaneous calculation of horizon thickness and soil bulk density. While most approaches to calculating carbon stocks generate independent errors associated with determining bulk density and measuring horizon thickness, this approach decreases sampling error by combining these two components. Within each plot, a section of aluminum tubing (sharpened on the leading edge) (60 cm long and 5 cm diameter) will be driven 50 cm into the soil. The tube will then be excavated and capped. Upon return to the lab, cores will be frozen to assist in extrusion (alternatively, cores will be opened with sheet metal shears). Once opened, the cores will be divided into vertical sections based on observed soil horizons, and the thickness of each horizon will be carefully measured. All soil material from each horizon will then be homogenized and weighed. The bulk density of each horizon will then be calculated as the weight of the horizon divided by the horizon volume (calculated from the thickness of the horizon multiplied by the cross-sectional area of the tube). The soil organic C percentage will be determined using a homogenized subsample of each horizon. Total carbon will be determined in duplicate by dry combustion (Nelson and Sommers, 1996) using a high temperature CNH Analyzer with an IR detector. These data will be used in conjunction with measurements of horizon thickness and bulk density to calculate the total C stocks in the soil to a depth of 50 cm based on the equivalent soil mass calculation by Ellert and Bettany (1995)

Further, pools of soil carbon can be thermodynamically subdivided into easily oxidized organic carbon (SOC), inorganic carbon (SIC), and less easily oxidized organic carbon (presumably “black carbon”) via the process of temperature ramp dry combustion. This will be performed in collaboration with Tiffany Carter at the National Soil Survey Center in Lincoln, Nebraska using the “soli TOC® cube”, a commercially available combustion analyzer by Elementar Americas which has been used across various studies for the speciation and quantification of SOC and SIC (Zethof et al., 2019; Natali et al, 2020; Wenzel et al., 2023). The commercial analyzer is equipped with an analytical method that utilizes both temperature ramping and carrier gas alteration to separate carbon pools. During the analysis the initial instrument temperature rises from 150°C to 400°C where it plateaus for 2 minutes utilizing O_2 as the initial carrier gas. After the 2-minute plateau at 400°C, the O_2 is switched off and replaced with nitrogen (N_2). The temperature then rises and plateaus at 900 °C for 4 minutes under N_2. At the conclusion of the 4-minute plateau at 900°C, the O_2 is switched back on and the temperature remains at 900°C for an additional 2 minutes. In principle, easily oxidized soil organic carbon, soil inorganic carbon, and less easily oxidized soil organic carbon (presumably “black carbon”) are respectively quantified during the ramps to 400°C (under O_2), to 900°C (under N_2), and then at 900°C (under O_2) (Zethof et al., 2019; Natali et al, 2020; Wenzel et al., 2023).

Soil Inorganic Nitrogen

Soil nitrate and ammonium will be measured on samples collected from each plot in the middle to end of the aerobic phase (August -September). Four to six replicate cores will be collected using a 30 cm push probe, and will be aggregated into a single composite homogenized sample for analysis. Samples will be analyzed using the HACH 8171 method, similar to that used by Spokas et al. (2010). These data will be used to provide insight into OM decomposition data.

Soil Redox Assessment

IRIS (indication of reduction in soil) films will be used to assess the reducing soil conditions within each plot (Rabenhorst, 2008, 2018; Rabenhorst and Burch, 2006; Rabenhorst et al., 2008; Vasilas et al., 2013). Both traditional Fe-coated and newly developed Mn-coated devices will be utilized (Rabenhorst and Persing, 2017; Rabenhorst and Post, 2018). Five replicate IRIS films of each type (Fe and Mn) will be deployed at each plot to a depth of 50 cm. IRIS films will be deployed for one month periods in the Spring when water tables are expected to be high. Deployment dates at the various sites will be scheduled to follow local weather conditions and will target the beginning of the growing season as determined by US Army Corps of Engineers guidance (USACE, 2010a; USACE, 2010b; USACE, 2010c; USACE, 2012a; USACE, 2012b). The extent of reduction on IRIS films will be assessed using digital image analysis (Rabenhorst, 2012). Mn- coated IRIS devices may also be deployed prior to the normal growing season in an attempt to document biogeochemical conditions during colder, but saturated, periods.

Carbon Inputs

Replicate measurements of litterfall will be made within each plot along the central transect at each site. Leaf litter deposition will be measured over a 12 month period with focused collection between the months of September to November using plastic devices to collect litter. This focused sampling period was chosen to align with the period of major leaf fall in the forested wetlands of the eastern United States (September to November) (Ricker et al., 2014). Three randomly placed C input plots for deadfall will be determined in each zone. Deadfall will be considered as any woody debris greater than 1 cm in diameter. Existing deadfall and leaf litter will be cleared from the forest floor upon delineation of each plot. Flags, placed at the corners of each plot, will be left in place throughout the study. Over the course of a year deadfall that has accumulated in the plots will be collected. Leaves and deadfall will be dried to a constant weight at 60oC, in order to determine carbon contributions at the various hydrologic zones throughout the sites. Carbon inputs will be estimated assuming a concentration of 0.50 g C g^{-1} leaf litter (Davis et al., 2010).

Organic Matter Decomposition

During the previous study northern white birch (*Betula papyrifera*) sticks (9.5 mm dowels, 30 cm long) were inserted into the soil and then extracted following one year of burial in order to assess the relative rates of organic matter decomposition. This approach was based upon other studies showing that wooden sticks can be used to indicate organic matter decomposition rates in several different types of settings (Baker et al., 2001; Gulis et al., 2004; Ostertag et al., 2008). To complement these data already collected, metrics of leaf litter and woody deadfall decomposition will be examined at each study plot. Five replicate nylon mesh leaf-litter bags will be filled with dried, pre-weighed leaves of species native to each site (such as White Oak (*Quercus alba),* Black Oak (*Quercus velutina),* or Red Maple (*Acer rubrum)*) and secured at the soil surface in each zone. After retrieval, the bags will be rinsed and dried to a constant weight (60^{o}C) and mass loss will be calculated by comparing with initial weights. Two sets of five replicate pre-weighed northern white birch (*Betula papyrifera*) dowels (30 cm in length and either 9.5 mm in diameter) will be secured at the soil surface at each research plot at the same time as the leaf litter bags. The bags and dowel rods will be left on the soil surface for one year (May to May), dried in the oven, and the difference in weight before and after will be calculated as a measure of degree of decomposition. Corrections for soil contamination within the litterbags will be made using the standard methods for ashing and the recommended correction equation (Harmon et al., 1999). We will use the number of growing degree days for each year, and among the study sites, to identify any difference in energy in the soil system between the sites and years and relate those differences to decomposition rates. Growing degree days are an index of solar energy a given site receives each day and is based on air temperature. It is strongly correlated with soil heat which in turn is an index related to soil microbial activity (Douglas and Rickman, 1992). We will compare the decomposition rates to organic inputs from leaf and woody deadfall studies to understand net carbon fluxes from the primary sources of SOC to each system and how temperature, inundation, and soil surface saturation control carbon fluxes in wetlands.

Greenhouse Gas Flux

Flux rates of major greenhouse gasses will be measured at each research plot on each of the three transects at each site, using a closed chamber approach, thus providing data for each of the three hydrologic zones. Two cylindrical plastic chambers (16 cm in height, 20 cm in diameter) will be placed at each site and pushed approximately 2.5 cm into the soil. Using a 20 ml gas-tight syringe, an initial gas sample will be collected after securing the chamber's lid, which contains a rubber septum to allow for sampling, followed by samples taken 15 and 30 minutes after the initial sample. The headspace of the chamber will be mixed prior to sampling. After sample collection, syringe contents are immediately transferred into a 15 ml evacuated tube (Amador and Azivinis, 2013). In each sample, CO_2, CH_4, and N_2O will be determined.

Sampling date will be based on growing degree days in the spring, summer, and fall. In the field, internal chamber temperatures are measured when each gas sample is collected and averaged in order to obtain the average chamber temperature during the sampling period. Soil temperature and moisture content at a depth of 10 cm, and specific chamber volume (m3) will be recorded at each sample period (Ricker et al., 2014; Waggoner, 2016). Greenhouse gas sampling will occur at least once per season for the spring, summer, and fall.

Gas concentrations (CO_2, CH_4, and N_2O) will be measured with a Shimadzu gas chromatograph and recorded in units of ppm (Altor and Mitsch, 2008). Concentrations are plotted against time and fitted with a linear regression in order to calculate the CO_2 flux rates. The mass of each gas present in the sampling chamber, or n (mol), is calculated using the Ideal Gas Law, n=PV/RT, where n=mol CO_2 per mol air, R=universal gas constant (0.0821 L atm/mol K), T= chamber internal temperature (K), P=atmospheric pressure (atm), and V= chamber volume (L). The rate of GHG production per unit area is calculated using the slope of the best- fit line, cross-sectional area of the chamber, and volume of air in the chamber (Waggoner, 2016).

Site History

We will investigate site history for each of the 11 sites. This will be done through several means. First, we will explore the recent history of each site using available aerial imagery. Second, we will identify the current state within the Ecological Site Description (ESD) state and transition model using the respective ESD key for each Major Land Resource Area, soil data collected as part of this study, and plant survey data from this study. This will allow inferences to be made on historic land use. Lastly, for sites where it is available, records associated with each property will be reviewed and used to supplement ESD and aerial imagery information.

Data Analysis

The project design has three plots for each of three hydrologic zones at each depressional wetland: basin (zone 1), transition (zone 2), and upland (zone 3). Total areas represented by the three zones will be determined based on Goldman et al. (2020). Temperature and hydrology will be continuously measured. Gas fluxes will be measured from two chambers from each plot for three seasons (18 data points/zone/year). Total annual CO_2-C flux from the soil surface will be estimated by developing CO_2vs. temperature regressions for each chamber. This approach will allow us to calculate standard errors and make comparisons across sites for each season and year. Daily average soil temperature for each site will be used to extrapolate annual CO_2emissions from each chamber (Davis et al., 2010; Ricker et al., 2014). Mean comparisons for the point-in-time values will be assessed using repeated measures analysis of variance. We will use multiple regression to test the effects of soil temperature and moisture on CO_2, CH_4, and N_2O fluxes. Leaves and deadfall additions will be collected within specified areas at each plot and averaged across zones and years. Five decomposition litter bags and coarse woody debris sticks will be placed at each plot each year and loss of C determined after averaging within plots and within zones. Analysis of variance will be used to test for differences in decomposition in leaves and deadfall among zones within sites and by zone among sites. Effects of temperature on decomposition across sites will be assessed using regression analysis, with total degree days as the independent variable and average decomposition at zones 2 and 3 (zones that are not inundated) within sites as the dependent variable. Decomposition rates per year will be applied to leaves and dead fall additions to estimate annual CO_2 additions (g m-2 yr-1) to the atmosphere from each zone and site. Our previous in-the-soil decomposition rates (simulated root decomposition) can be applied to estimated root additions (i.e. 20% of the mass of leaves plus deadfall) to roughly estimate total yearly addition of CO_2 to the atmosphere. Total yearly CO_2 loss will be compared to our yearly CO_2 efflux measures as a ballpark check on our analysis. Carbon additions from litter, deadfall, and roots (estimated) will be compared with C losses as CO_2. Zones with net gains in carbon will serve as a sink while zones with a net C-loss will serve as a source of CO_2 to the atmosphere.

Current Site Status

As shown in Table 1, original sites that participated in NE-1021, NE-1038, NE-1438, and NE-1938 are ahead of recently established (KS and NE) and to-be-established (MI) sites. Thus, for the original sites, efforts during the proposed research will be focused on measurement of greenhouse gas fluxes and assessment of soil black carbon concentrations. For recently- and newly-established sites, research efforts will include completing all aspects of the project originally proposed for NE-1938 as well as assessing black carbon pools.

Measurement of Progress and Results

Outputs

- An annual project report highlighting the results for the previous year will be made available on the project website, and forwarded to participants in the related project focus areas.
- Participants will submit appropriate research findings for publication in peer reviewed journals and make presentations at local, regional, and national meetings.
- Any amendments related to Field Indicators of Hydric Soils in the United States, or related documents, will be composed and submitted for consideration and final approval.
- Research sites will be incorporated into bi-annual Soil Survey Work Planning Conference fieldtrips and Northeast Graduate Student Pedology Field Tours. These field trips and tours rotate throughout the region and run on opposite years.
- A summary of Outputs from NE1438 and NE1938 are included below. Comments: Peer-reviewed Publications (1) Rabenhorst, M.C., P.J. Drohan, J.M. Galbraith, C. Moorberg, L. Spokas, M.H. Stolt, J.A. Thompson, J. Turk, B.L. Vasilas, and K.L. Vaughan. 2021. Mn-Coated IRIS to document reducing soil conditions. Soil Science Society of America Journal, 85(6):2201-2209. https://doi.org/10.1002/saj2.20301. Conference Oral and Poster Presentations (4) Rabenhorst, M.C., P.J. Drohan, J.M. Galbraith, B.A. Needelman, L. Spokas, M. Stolt, J.A. Thompson, B.L. Vasilas, and K.L. Vaughan. 2017. Comparing Performance of Mn-Coated and Fe-Coated IRIS Devices. Poster presentation at the 2017 American Society of Agronomy-Crop Science Society of America-Soil Science Society of America International Annual Meeting, Tampa, FL, October 22-25, 2017. Rabenhorst, M.C., P.J. Drohan, J.M. Galbraith, L. Spokas, M. Stolt, J.A. Thompson, B.L. Vasilas, and K.L. Vaughan. 2019. Biogeochemistry of Vernal Pools Assessed Using IRIS Film Technology. Poster presentation at the 2019 Soil Science Society of America International Soils Meeting, San Diego, CA, January 6-9, 2019. Rabenhorst, M.C., P.J. Drohan, J.M. Galbraith, L. Spokas, M. Stolt, J.A. Thompson, B.L. Vasilas, and K.L. Vaughan. 2019. Using Mn IRIS (Indicator of Reduction In Soils) for early growing season redox assessment. Oral presentation at the 2021 National Cooperative Soil Survey (NCSS) National Conference, Virtual, June 8-10, 2021. Vaughan, K.L., P.J. Drohan, J.M. Galbraith M.C. Rabenhorst,, L. Spokas, M. Stolt, J.A. Thompson, and B.L. Vasilas. 2019. Redoximorphic Feature Expression in Seasonally Inundated Soils Reveals Belowground Climatic Influence on Development. Poster presentation at the 2019 Soil Science Society of America International Soils Meeting, San Diego, CA, January 6-9, 2019.

Outcomes or Projected Impacts

- This research will result in improved region-wide understanding of the soils, hydrology, and carbon accounting of depressional wetlands. We will use the depressional wetlands as surrogates for a range of wetlands that have both inundation and saturation and that these conditions vary seasonally. This research will be a continuation of our region-wide focus on hydric soils and hydric indicators to determine if there is a need for additional hydric soil indicators. If needed, new hydric soil indicators may be proposed and submitted for inclusion as part of the National Indicators of Hydric Soils for the Northeast Supplement or the Field Indicators of the United States.
- External funding for proposals drafted by members of the multistate project. With the NE-1438 project we leveraged funds ($100,000) from USDA-NRCS to complete some of our current work. We plan to approach USDA-NRCS in their next call for soils related research to seek additional funding.
- Our previous research showed that there is significant variation in soil climate within depressional wetlands over a 4-year period. Considering that variability, the additional data from our region-wide approach (temperature gradient) to measure reducing conditions with IRIS tubes may have significant impact on how (when and for how long) reducing conditions within wetlands are measured and evaluated.
- Carbon accounting requires measures of inputs and losses of carbon. Our studies will provide metrics of main sources of carbon to the soil (litterfall and deadfall) and the rates that these soil carbon sources decompose. We can assume that decomposition results in an equivalent amount of CO2 being lost to the atmosphere. We will measure GHG fluxes at the same time as a check of the release of carbon from these systems. These inputs and losses will provide an estimate of the amount of C that is sequestered in these soils yearly and how inundation and saturation affect the C balance toward sequestration.
- Our previous soil morphology and soil carbon investigations revealed sites in West Virginia and Pennsylvania contained measurable amounts of black carbon that resulted in abnormally high total carbon concentrations. We have also added two prairie sites that are expected to have some black carbon due to prairie fires. By incorporating a novel method for quantifying black carbon, we will attribute carbon storage to biologic and pyrogenic processes and provide much needed context for wetland carbon processes.
- One of the main advantages to studying carbon accounting in similar soil conditions on a regional scale is differences in temperature. The differences in temperature among our sites represents the projected change in temperature in the next century. Thus, our study will provide an estimate of how wetland soils will react to an increase in temperature as a result of global warming.

Milestones

(**2025**):Collect climate and hydrological data for newly-established sites. Organize research so that all participants are on the same page. Develop training materials (video) for measuring GHG. Purchase and prepare materials for experiments in future years. Organize a meeting for all participants to attend. Collect soil carbon cores for carbon and nitrogen stock and black carbon analysis for recently established sites or for original sites where archived soil samples are not available. Submit all soil carbon samples to Tiffany Carter at the USDA NRCS Kellogg National Laboratory for analysis.

(**2026**):Initiate decomposition for newly-established sites. Initiate GHG studies for all sites. Visit selected sites during biannual Northeast Pedology Fieldtrip. Meet to further discuss coordination and strategies for instrumentation, mapping, and sampling. Update web page to include site information and discussions during the regional field trip to selected sites.

(**2027**):Maintain monitoring, decomposition, and GHG experiments. Describe and sample soils within various hydropedological entities (i.e. upland, wetland, inundated) for newly and recently-established sites. Meet to discuss greenhouse gas flux and black carbon data from the first two years of project and initial results from the recently-established sites. Visit selected sites during region soil survey work planning conference tours. Update web page to include site and monitoring information and discussions during the field trip to selected sites.

(**2028**):Complete monitoring, decomposition, and GHG experiments. Complete the soil characterization efforts. Continue to analyze the morphologic data from the inundated, hydric, and seasonally saturated soils relative to inundation, saturation, temperature, redox potential, data. Continue to collect and analyze GHG and decomposition data. Meet to discuss the initial three years of the project and to begin to develop and construct research proposals and peer- reviewed papers based on the project. Visit selected sites during biannual Northeast Pedology Fieldtrip. Update web site to include new monitoring and analytical information and discussions during the regional field trip to selected sites.

(**2029**):Complete analysis, synthesize results across all study sites, and write final report and other output works.

Outreach Plan

Results from the proposed multistate project activities will be published as project reports, on the project web site, and as peer-reviewed publications. Participating members involved in undergraduate teaching and research, graduate student advising, and extension activities associated with Land Grant Universities will promote the general dissemination of knowledge developed from the proposed project activities. Research sites will be visited on local, regional, and national pedology, hydric soil, and soil-environmental science field trips and workshops.

Northeast Pedology Field trips have been run at least every two years since 1985. Participants include National Cooperative Soil Survey personnel from the NE region and graduate students from participating schools. Field trips are run every other year during the region soil survey work planning conferences. Annual field trips are also run by the New England Hydric Soils Technical Committee and the Mid-Atlantic Hydric Soils Committee. These committees are made up of university faculty, consulting soil scientists, NRCS soil scientists, and state and regional regulators.

Organization/Governance

The core membership in the multi-state project will likely come from the current NE-1938 Multistate project including: Patrick Drohan (Penn State University), John Galbraith (Virginia Tech), Martin Rabenhorst (University of Maryland), Mark Stolt (University of Rhode Island), James Thompson (West Virginia University), Bruce Vasilas (University of Delaware), Mickey Spokas (University of Massachusetts), and Karen Vaughan (University of Wyoming). Vasilas and Spokas have since retired and will not be directly participating in the project organization or governance, but we have access to their respective study sites for resampling for black carbon. New members since the start of NE-1938 include Colby Moorberg (Kansas State University), Judy Turk (University of Nebraska - Lincoln), and Barret Wessel (Michigan State University).

A Chair, a Chair-elect, and a Secretary will be selected from the above participants. Representatives from the member institutions will meet at least annually to assign tasks and review progress on the current research project. Additional participants with expertise in pedology, mineralogy, soil ecology, hydrology, soil-environmental science, and other related disciplines will be invited to join the project.

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Land Grant Participating States/Institutions

NE,MD,KS,VA,WV,PA,RI

Non Land Grant Participating States/Institutions

Participation

Participant	Is Head	Station	Objective	Research						Extension	
				KA	SOI	FOS	SY	PY	TY	FTE	KA

Combined Participation

Combination of KA, SOI and FOS	Total SY	Total PY	Total TY
Grand Total:	**1.61**	**10.00**	**0.00**
102	1	10	10
102	0.1	0	0
101	0.05	0	0
101	0.05	0	0
101	0.11	0	0
102	0.05	0	0
102	0.05	0	0
101	0.05	0	0
101	0.05	0	0
101	0.5	10	0
101	0.5	10	0
101	0.1	0	0

Program/KA	Total FTE
Grand FTE Total:	**0.05**
102	0.33
101	0.02
0	0

Appendix G: Peer Review (Submitted)

Status: Complete

Project ID/Title: NE_TEMP2438: Carbon Dynamics and Hydromorphology in Depressional Wetland Systems

Rate the technical merit of the project:

1. Sound Scientific approach:
Approve/continue project
2. Achievable goals/objectives:
Excellent
3. Appropriate scope of activity to accomplish objectives:
Excellent
4. Potential for significant outputs(products) and outcomes and/or impacts:
Good
5. Overall technical merit:
Excellent
Comments
More work could be done on identifying/verifying the source of new black carbon sites and tying them to specific anthropogenic activities.
Make sure all your members actually sign up for the project, so far only Dr Turk and Dr Rabenhorst are listed. Which is likely below the minimum threshold.
Your Recommendation:
Approve/continue project

Appendix G: Peer Review (Submitted)

Status: Complete

Project ID/Title: NE_TEMP2438: Carbon Dynamics and Hydromorphology in Depressional Wetland Systems

Rate the technical merit of the project:

1. Sound Scientific approach:
Approve/continue project
2. Achievable goals/objectives:
Good
3. Appropriate scope of activity to accomplish objectives:
Good
4. Potential for significant outputs(products) and outcomes and/or impacts:
Excellent
5. Overall technical merit:
Excellent
Comments
This is a very timely and technically sound multistate proposal which has shown previous research success. I would make a few minor suggestions listed below, but overall I approve the project as the proposal is written.

In the project overview/abstract is says "Our goal is to study depressional wetlands across 11 different states with varying climates from Northeast Region across the Midwest and into the Mountain West in order to assess the impacts of temperature, hydrology, and soil properties on soil carbon storage." This statement really limits the project in that later on under the organization/governance section it is stated "Additional participants with expertise in pedology, mineralogy, soil ecology, hydrology, soil-environmental science, and other related disciplines will be invited to join the project."
Perhaps amend the initial statement to indicate the study will include the Northeast Region as well as additional participants from across the United States. One major missing area is the southern USA, which has many famous examples of depressional wetlands (cypress domes, Carolina bays, etc.) that are in the thermic/hyperthermic soil temperature regimes. As stated in the proposal, it seems like this project will be held in focus to the initial 11 states.

Under the section of Organic Matter Decomposition:
The methods as outlined are generally acceptable, however the participants will need to determine mean ash weight of litter samples initially and compare to each collection due to seasonal ponding/flooding that can introduce sediment weight to the sample bags. In methods it mentions rinsing bags upon collection, this can lead to loss of litter from bags. Careful hand sorting and ash weights (mean before versus after field incubation) are typically used to correct for possible mineral/organic additions to the litter bags. Handling loss can also occur during transport (unless samples are fully sealed in containers), triplicate mesh bags can be weighed before and after transport to field locations to estimate this minor source of loss (Baker et al., 2001 cited in the references outlines this procedure). In areas with large destructive fauna (bears, hogs, bison) exclosures may need to be constructed to obtain viable data from the decay bags. Five sets of bags can easily be destroyed by large animals before 1 year, if not protected.
Your Recommendation:
Approve/continue project

Appendix G: Peer Review (Submitted)

Status: Complete

Project ID/Title: NE_TEMP2438: Carbon Dynamics and Hydromorphology in Depressional Wetland Systems

Rate the technical merit of the project:

1. Sound Scientific approach:
Disapprove/terminate project
2. Achievable goals/objectives:
Fair
3. Appropriate scope of activity to accomplish objectives:
Fair
4. Potential for significant outputs(products) and outcomes and/or impacts:
Fair
5. Overall technical merit:
Fair
Comments
The proposal builds on previous work in the northeastern U.S. to evaluate carbon (C) storage in depressional wetlands. It seeks to understand how hydrology, temperature and soil properties affect C storage. In addition to the NE sites, new sites in MI, NE, KS and WY are added.

My concerns with the proposed work include (1) the addition of the four sites in the Midwest (1 site), Plains (2) and western mountains (1) are not sufficient to really develop a climate gradient, (2) Methods to measure decomposition and greenhouse greenhouse gases are inadequate to characterize fluxes. For example, red maple and oak will be used to measure decomposition across all sites? Seasonal (3 seasons) measurements of greenhouse gases? It is not clear whether these will be done every year for 5 years or not. (3) Understanding the recent and long-term history of the sites is essential for C storage and fluxes. The proposal does not address this at all. I would be more positive about this proposal if it included some products (publications, etc) from the 5 year study in the NE

Overall, it seems that the proposal is an easy extension of the work done in the NE over the past 5 years. While the proposed black carbon measurements are new, I do not expect black C to account for a significant amount of C stored. It might help though with fire history (see comments below). It would make more sense to add more climatically diverse sites, focus on C storage (and drop the decomposition and greenhouse gas work) and factors (hydrology, climate variables - temperature and precipitation, plant productivity) that affect it, and a thorough understanding of the history (agricultural, grazing, forestry, fire and associated drainage activities and ditches) of the sites.
Your Recommendation:
Disapprove/terminate project

Appendix G: Peer Review (Submitted)

Status: Complete

Project ID/Title: NE_TEMP2438: Carbon Dynamics and Hydromorphology in Depressional Wetland Systems

Rate the technical merit of the project:

1. Sound Scientific approach:
Approve/continue project
2. Achievable goals/objectives:
Excellent
3. Appropriate scope of activity to accomplish objectives:
Good
4. Potential for significant outputs(products) and outcomes and/or impacts:
Excellent
5. Overall technical merit:
Excellent
Comments
This is an exciting project that will have considerable impacts for understanding of wetland soil carbon that can support environmental sustainability. For the soil organic carbon measurements consider using the equivalent soil mass calculation (Ellert & Bettany, 1995) to appropriately compare between wetlands were bulk density is likely to differ. Consider reported soil carbon to 0-30 cm as well to align with historical studies of other depressional wetlands in North America, although the 0-50 cm sampling depth is preferrable and important. Consider methods for how the soil organic carbon or nitrogen at sampling points within the wetland will be used to calculate soil carbon stocks for the entire wetlands (ie. measure the area for each of the three zones within the wetland or alternative methods?). For the greenhouse gas measurements the frequency of the sampling is not indicated (ie. every X days or weeks). It is important to consider temporal and spatial hotspots of greenhouse gas emissions, especially for N_2O.
Your Recommendation:
Approve/continue project

Appendix G: Peer Review (Submitted)

Status: Complete

Project ID/Title: NE_TEMP2438: Carbon Dynamics and Hydromorphology in Depressional Wetland Systems

Rate the technical merit of the project:

1. Sound Scientific approach:
Approve/continue project
2. Achievable goals/objectives:
Excellent
3. Appropriate scope of activity to accomplish objectives:
Excellent
4. Potential for significant outputs(products) and outcomes and/or impacts:
Excellent
5. Overall technical merit:
Excellent
Comments
Sites will vary in hydrology as temperature and rainfall amounts gradually decrease from east to west. This may make comparisons among sites more difficult.

Suggest rainfall be measured onsite to compare with nearest available weather data.

Redox measurements from IRIS tubes may not be able to say much about potential formation of methane. Methane production may also be retarded by sulfates.

Bulk density may be useful for expressing C levels on a volume basis.
Your Recommendation:
Approve/continue project

Appendix G: Peer Review (Submitted)

Status: Complete

Project ID/Title: NE_TEMP2438: Carbon Dynamics and Hydromorphology in Depressional Wetland Systems

Rate the technical merit of the project:

1. Sound Scientific approach:
Approve/continue project with revision
2. Achievable goals/objectives:
Fair
3. Appropriate scope of activity to accomplish objectives:
Fair
4. Potential for significant outputs(products) and outcomes and/or impacts:
Good
5. Overall technical merit:
Fair
Comments
I selected Approve/continue project with revision. If the authors are willing to make adjustments to correct the issues I saw, and get rid of the idea that they are evaluating carbon balance from a temperature persective, then the project will provide good information. But with the purpose as currently stated, the project will not be successful. My full comments for the review criteria are below.

Rate the technical merit of the project:
1. Sound Scientific approach:
The main question presented is “how such an increase in temperature will affect carbon stocks in wetlands?” With the suggested route to answering the question being “find wetland with similar soils, hydrologies, and geomorphic settings but in a range of temperatures.” The idea, then, it seems is to utilize sites that behave similarly with respect to all the soil forming factors other than the temperature component of climate. Intuitively, this makes sense – hold everything but temperature constant and try to see what the variation in carbon dynamics is.

To this end, the researchers have identified 11 different sites to instrument and measure in closed-drainage systems. These include, based on Figure 1:
• Wyoming, 8000’ elevation and either granitic residuum or Pinedale-aged till of mixed mineralogy, and a conifer-dominant ecosystem
• Nebraska, 1000’ elevation, in likely Illinoian-aged glacial deposits (or reworked alluvial?), and likely a native prairie ecosystem that has been modified by landuse
• Kansas, ~1000’, in pre-Illinoisian glacial landscape, likely native prairie with major modifications
• Michigan, ~800’, in Wisconsinan-aged till, likely native hardwood forest
• Pennsylvania, ~1000’, in ridge and valley province, likely hardwood forest as native community, with at least 2 clear cut histories, if not fully converted to agriculture
• Delaware and Maryland, <500’ on either the piedmont or coastal plain, hardwood forest with modifications
• WV and VA, ~200-2500’, in ridge and valley province, native hardwoods with strong potential for modifications
• RI, >500’, in coastal plain or glacial outwash? With a hardwood native vegetation that has seen modification
• And MA, ~500-1000’, in glaciated landscape, also native hardwood, with unclear landuse history

The researchers intent seems to be to say that these spatially spread sites have similar soil forming conditions and therefore can be compared against each other to use temperature as a controlling factor of carbon dynamics.

To this reviewer, the locations, site histories, and variables of CLORT are not held constant to the exception of temperature. There is strong variation in pedogenic processes and controls. And while there may be a distinct variation in soil temperature, the differences in local climate do not make these sites a temperature-sequence.

Hydrology: the researchers are targeting hydric to non-hydric hillslopes. Yet, all hydric soils are not alike – if they were we would not have and be constantly updating and revising the hydric soils indicators – we would have one indicator. We have regionality to the indicators as well as texture-dependent indicators. The researchers will be monitoring with wells (Figure 4 mentions piezometers and wells, but piezometers are not mentioned in the methods), which can help elucidate water flow patterns – which is important. Surface and subsurface hydrology can have significant impacts on distribution of dissolved and particulate organic carbon. I am not convinced (based on my experiences observing landscape hydrology at similar systems around the US and elsewhere) that the hydrologies of these systems are likely to be similar enough to discount hydrology as a modifier of OC distribution in the landscape – meaning that temperature is not the primary driver of the carbon dynamics.

Parent Materials: there are at least three different parent material types I would expect to see for these various sites based on their approximate geographic locations – glacial till, residuum, and outwash. Without full knowledge of the sites, I might also include colluvium and alluvium. Additionally, the geochemistry of the parent materials represented by the sites looks to have high potential variation. That chemistry, and the resultant soil chemistry (e.g. pH, carbonates, …) can have a strong influence on the carbon decomposition dynamics.

Organisms: The variations in precipitation, temperature, and evapotranspiration mechanics at these sites have resulted in distinct vegetative communities. The conifer and prairie systems are different than the hardwood systems. The chemical makeup of the vegetative litter is different and, combined with the chemistries, hydrologies (e.g. precipitation (amounts and seasonalities), vapor pressure deficits), and fine-earth differences make me think that decomposition will not be controlled by temperature alone. The described methods of measuring decomposition and carbon inputs may not be appropriate for the given geographies. Herbaceous plant senescence in the western sites begins much earlier than the eastern sites. And this is markedly so in a western vernal pool system in an ustic or xeric region. Focusing on fall litter collection at 8000' is a bit late. No mention of adjusting sampling protocol to fit regional plant cycling is mentioned.

Black Carbon: The authors are intrigued by the pyrogenic carbon that has been observed at some of these sites. This carbon is a definite long-term storage type for carbon in soils as it is slow to react and decompose. In western forests pyrogenic carbon has been shown to have a strong influence on nutrient cycling. What I find interesting is the lack of discussion as to the genesis of this carbon. In fire-adapted landscapes, this carbon can be added repetitively over 100's to 1000's of years. But only if the systems are burning. In the sites west of the Mississippi, the pyrogenic carbon addition is still a strong possibility unless landuse has eliminated the vegetation that carries fire. In the eastern sites, what is the source of the carbon? Is it from periodic burning of the wetlands? Or is was it contributed by slopewash in the past after sites were logged and burned. Or cyclic wildfire. I would have liked to have been provided some more site-specific details to evaluate whether black carbon is something to pursue in this study.

Impact of historic landuse: Each of these sites has been managed differently and exposed to different degrees of erosion, accumulation, fire, native vegetation conversion, altered hydrology, etc. A full accounting of those potential impacts are required to assess how they can be compared and how historic landuse may have impacted current carbon levels. In an undisturbed system, the carbon balance is likely a 100-1000 year dynamic that reflects long-term trends in hydrology, vegetation, and climate. In the last 100 years, in almost all the proposed systems, we have set the cycle out of balance in drastic ways. The current carbon cycling may not reflect the actual influence of climate any more as the system may still be finding a new equilibrium post disturbance. We could compare this to the idea of isostatic rebound – the glaciers have been gone for ~10,000 years and the land masses are still adjusting. Carbon in a wetland-upland system could be in the same scenario, adjusting to the violent plowing or timber harvests that occurred and drastically upset the balance. No indication of that was provided to help assess the historic landuse changes and potential influence on the carbon cycle..

In summary, with respect to the idea that these sites can help isolate temperature as a control on carbon dynamics (a main thesis from the introduction) and then be used to model carbon storage with climate change, there is not enough information provided to support that the project can achieve this. And based on my knowledge/experience, there will be too much environmental noise to achieve that expected outcome. That said, much like the wetland soils project of the 1990's, a longitudinal study across these ecosystems to help elucidate the dynamics of carbon in wetland-upland systems across these highly varied systems will provide valuable scientific knowledge to aid in our management on a regional basis. It just won't do what is being proposed as the main thesis.

2. Achievable goals/objectives:
The researchers propose the below objectives. I give an impression with each one.

• To better understand the hydrological, biogeochemical and pedological properties and processes that affect SOM decomposition, CO_2 and CH_4 greenhouse gas fluxes, and C sequestration in depressional wetland ecosystems, as expressed across geographical and climatic gradients.
• Certainly, can be done for each site and compared between sites. This objective hints that differences other than control by temperature are expected. That doesn't jive with that thesis that differences will be related to temperature alone, and therefore using these sites as a way to develop a standardized model how SOC stocks will change as temperature increases due to climate change. And that was suggested as the premise for the research.

• To determine the relationship between soil and air temperature and accumulated soil C stocks and fluxes in depressional wetland systems.
• About the same response as to the previous objective

• To determine the relationship between hydroperiod (i.e. duration of saturation and inundation) and accumulated soil C stocks and fluxes in depressional wetlands.
• Good for developing regional concepts, but not for applying as a blanket across all the ecoregions represented in the study

• To seek to develop morphological indices of the hydroperiod within depressional wetlands in order to estimate or predict C stocks.
• This will be a challenge. If we take indicator A12, thick dark surface – that is a morphological property. Can we estimate carbon from that? Not likely. We can infer that SOC is high (relative to the surrounding soils) but the SOC content can be highly variable across different regions in soils that have the A12 indicator applied. That would be a fun NASIS exercise, if only indicators were consistently included in NASIS data population in pedons that got lab analyses.

• To quantify black carbon in depressional wetland systems.
• With this limited selection of sites, are the researchers proposing to assign relative black carbon content to depressional wetlands? The black carbon is a reflection of local fire history and may or may not be applicable across all systems. And…to what end? How does specifically identifying black carbon help in the climate change projections – unless it is as a proposed management scenario. Interesting information, but limited in scope and applicability.

3. Appropriate scope of activity to accomplish objectives:

The activities suggested for this project can get at the proposed objectives. But I don't see that the objectives get at the proposed thesis of how temperature increases due to climate change will impact carbon stocks in wetlands.

4. Potential for significant outputs(products) and outcomes and/or impacts:

This research can provide further wetland dynamic information that is needed as these systems are managed and threatened. Wetlands are storage systems for carbon and understanding the dynamics across different ecotones adds to the database already built by previous projects. Information gained in this project can help further quantify the role of wetlands in providing ecosystem services and can be used to refine landuse policy at state, regional, and national levels. Given the recent judicial decisions that decreased the scope of what wetlands fall under CWA jurisdiction, adding to the quantification of wetland types, ecosystem processes and services is highly valuable.

5. Overall technical merit:

As a general scientific knowledge pursuit, this proposed project has strong technical merit. With respect to answering the question about how future temperature changes will impact carbon storage, the project proposal falls short.

Comments
Comments are interspersed above

Your Recommendation:
If there is a desire to better quantify wetland soil carbon dynamics, this project should be funded. If the desire is to answer whether changing temperature due to climate change will impact carbon stocks, then this project does seem to meet that desire and should not be funded.
Your Recommendation:
Approve/continue project with revision

Review Comments	Response(s) to Comments
Reviewer 1 Comments	
More work could be done on identifying/verifying the source of new black carbon sites and tying them to specific anthropogenic activities.	Our current goal is to quantify black carbon. We hope to elucidate the source of black carbon in follow-up studies. We will be exploring site history where historic aerial photos are available. A new methods section titled "Site History" was added to the project outline.
Make sure all your members actually sign up for the project, so far only Dr Turk and Dr Rabenhorst are listed. Which is likely below the minimum threshold.	We are working on getting everyone signed up.
Reviewer 2 Comments	
In the project overview/abstract is says "Our goal is to study depressional wetlands across 11 different states with varying climates from Northeast Region across the Midwest and into the Mountain West in order to assess the impacts of temperature, hydrology, and soil properties on soil carbon storage." This statement really limits the project in that later on under the organization/governance section it is stated "Additional participants with expertise in pedology, mineralogy, soil ecology, hydrology, soil-environmental science, and other related disciplines will be invited to join the project." Perhaps amend the initial statement to indicate the study will include the Northeast Region as well as additional participants from across the United States. One major missing area is the southern USA, which has many famous examples of depressional wetlands (cypress domes, Carolina bays, etc.) that are in the thermic/hyperthermic soil temperature regimes. As stated in the proposal, it seems like this project will be held in focus to the initial 11 states.	We have reframed the project to emphasize the goal of determining the range of soil C storage and C fluxes across the 11 study sites, and de-emphasized quantifying temperature as the main factor under investigation. This is primarily to address comments from Reviewer 6. It also leaves the door open to additional participants from other regions, which would expand the potential ranges of characteristics that we will document. Unfortunately, multistate projects can be a bit limited in what types of sites (in this case, type of depressional wetland) based on what individuals sign on to the project from different states. We would warmly welcome additional participants - especially from the famous examples mentioned by Reviewer 2.
Under the section of Organic Matter Decomposition: The methods as outlined are generally	We will adopt the ashing method for the sites that are still conducting or are repeating litter bag studies. Our methods have been revised

acceptable, however the participants will need to determine mean ash weight of litter samples initially and compare to each collection due to seasonal ponding/flooding that can introduce sediment weight to the sample bags. In methods it mentions rinsing bags upon collection, this can lead to loss of litter from bags. Careful hand sorting and ash weights (mean before versus after field incubation) are typically used to correct for possible mineral/organic additions to the litter bags. Handling loss can also occur during transport (unless samples are fully sealed in containers), triplicate mesh bags can be weighed before and after transport to field locations to estimate this minor source of loss (Baker et al., 2001 cited in the references outlines this procedure). In areas with large destructive fauna (bears, hogs, bison) exclosures may need to be constructed to obtain viable data from the decay bags. Five sets of bags can easily be destroyed by large animals before 1 year, if not protected.	accordingly.
<u>*Reviewer 3 Comments*</u>	
My concerns with the proposed work include (1) the addition of the four sites in the Midwest (1 site), Plains (2) and western mountains (1) are not sufficient to really develop a climate gradient, (2) Methods to measure decomposition and greenhouse greenhouse gases are inadequate to characterize fluxes. For example, red maple and oak will be used to measure decomposition across all sites? Seasonal (3 seasons) measurements of greenhouse gases? It is not clear whether these will be done every year for 5 years or not. (3) Understanding the recent and long-term history of the sites is essential for C storage and fluxes. The proposal does not address this at all. I would be more positive about this proposal if it included some products (publications, etc) from the 5 year study in the NE	Regarding concerns about the climate gradient, please see our response to comments from reviewer 6. Greenhouse gas sampling will be performed for at least one field season with “normal rainfall”. We now note this in the project outline. We will also add the ashing method in response to comments from Reviewer 2. The recent history of most of these sites is known. Long-term history will be summarized to the extent possible by the time of publication based on aerial imagery. We will also identify the ESD state based on current vegetation to understand previous land use, assuming ESDs are available for each wetland in the respective 11 MLRAs. Products resulting from previous funding cycles are now noted in the project outline. See the new section titled “Summary of Outputs and Impacts from Previous Funding Cycles”

Overall, it seems that the proposal is an easy extension of the work done in the NE over the past 5 years. While the proposed black carbon measurements are new, I do not expect black C to account for a significant amount of C stored. It might help though with fire history (see comments below). It would make more sense to add more climatically diverse sites, focus on C storage (and drop the decomposition and greenhouse gas work) and factors (hydrology, climate variables - temperature and precipitation, plant productivity) that affect it, and a thorough understanding of the history (agricultural, grazing, forestry, fire and associated drainage activities and ditches) of the sites.	We will try to include site history regarding fire, coal mining, etc. in the final report and subsequent publication(s). Unfortunately, site selection for multistate projects is limited by the recruitment of additional collaborators from states not currently represented on the project. Our current data reveals a significant amount of black carbon in the West Virginia and Pennsylvania sites. We also expect significant amounts of black carbon in the Nebraska and Kansas sites due to prairie fires, and in the case of the Kansas site documented prescribed fires approximately every 2 to 3 years.
<u>*Reviewer 4 Comments:*</u>	
This is an exciting project that will have considerable impacts for understanding of wetland soil carbon that can support environmental sustainability. For the soil organic carbon measurements consider using the equivalent soil mass calculation (Ellert & Bettany, 1995) to appropriately compare between wetlands were bulk density is likely to differ. Consider reported soil carbon to 0-30 cm as well to align with historical studies of other depressional wetlands in North America, although the 0-50 cm sampling depth is preferrable and important. Consider methods for how the soil organic carbon or nitrogen at sampling points within the wetland will be used to calculate soil carbon stocks for the entire wetlands (ie. measure the area for each of the three zones within the wetland or alternative methods?). For the greenhouse gas measurements the frequency of the sampling is not indicated (ie. every X days or weeks). It is important to consider temporal and spatial hotspots of greenhouse gas emissions, especially for N2O.	The Ellert and Bettany (1995) manuscript was added to our method. We are analyzing carbon by genetic horizon to a depth of at least 50 cm. Distinct horizons will be described and characterized discreetly. Other researchers are welcome to use our data to quantify C down to 30 cm, if desired. Calculating areas represented by the three zones is a good idea. We will estimate areas represented within each of our sites based on Goldman et al. (2020). This was added to the outline. Gas sampling will be done on at least a quarterly basis, weather and site access permitting. Sampling will be performed while the soil in zone two is at or near saturation during the wet season and sampled in the week following a rain event during the dry season. This was clarified in the outline.
<u>*Reviewer 5 Comments:*</u>	
Sites will vary in hydrology as temperature and rainfall amounts gradually decrease from east to west. This may make comparisons among sites more difficult.	Following a reframing of the project to address comments from Reviewer 6, the project now focuses on capturing the range of properties exhibited across the sampled sites.

	Because these are all depressional, closed-basin wetlands the hydrology should be similar across all sites. The biggest differences in hydrology will occur between zones within a given site. The rainfall amounts do decrease from east to west. However, this has more of an impact on the soil moisture of upland areas which would transition from Udic to Ustic soil moisture regimes across this gradient. However, the center and edge zones of our experimental design should exhibit an Aquic soil moisture regime, and this should be consistent across all sites.
Suggest rainfall be measured on site to compare with nearest available weather data.	This is not practical for many of the study sites, especially the more remote ones like Wyoming and Virginia, and is problematic for forested sites since a clearing is required.
Redox measurements from IRIS tubes may not be able to say much about potential formation of methane. Methane production may also be retarded by sulfates.	Sulfates are expected to be minimal based on these being inland, freshwater, depressional wetlands. Budget constraints limit other methods of documenting reduction (eg. redox electrodes with data loggers).
Bulk density may be useful for expressing C levels on a volume basis.	We are measuring bulk density. See “Quantification of Carbon and Nitrogen Stocks” in our methods.
Reviewer 6 Comments:	
The main question presented is “how such an increase in temperature will affect carbon stocks in wetlands?” With the suggested route to answering the question being “find wetland with similar soils, hydrologies, and geomorphic settings but in a range of temperatures.” The idea, then, it seems is to utilize sites that behave similarly with respect to all the soil forming factors other than the temperature component of climate. Intuitively, this makes sense – hold everything but temperature constant and try to see what the variation in carbon dynamics is. To this end, the researchers have identified 11 different sites to instrument and measure in closed-drainage systems.	The project outline was revised to address these very useful critiques from Reviewer 6. We reframed the project by changing research objectives 1 and 2. This refocuses the project on documenting the range of characteristics of depressional wetlands across the 11 study sites. Edits were made throughout the outline to reflect this reframing.

These include, based on Figure 1: • Wyoming, 8000’ elevation and either granitic residuum or Pinedale-aged till of mixed mineralogy, and a conifer-dominant ecosystem • Nebraska, 1000’ elevation, in Peorian loess, and likely a native prairie ecosystem that has been modified by landuse • Kansas, ~1000’, in pre-Illinoisian glacial landscape, likely native prairie with major modifications • Michigan, ~800’, in Wisconsinan-aged till, likely native hardwood forest • Pennsylvania, ~1000’, in ridge and valley province, likely hardwood forest as native community, with at least 2 clear cut histories, if not fully converted to agriculture • Delaware and Maryland, <500’ on either the piedmont or coastal plain, hardwood forest with modifications • WV and VA, ~200-2500’, in ridge and valley province, native hardwoods with strong potential for modifications • RI, >500’, in coastal plain or glacial outwash? With a hardwood native vegetation that has seen modification • And MA, ~500-1000’, in glaciated landscape, also native hardwood, with unclear landuse history The researchers intent seems to be to say that these spatially spread sites have similar soil forming conditions and therefore can be compared against each other to use temperature as a controlling factor of carbon dynamics. To this reviewer, the locations, site histories, and variables of CLORT are not held constant to the exception of temperature. There is strong variation in pedogenic processes and controls. And while there may be a distinct variation in soil temperature, the differences in local climate do not make these sites a temperature-sequence. Hydrology: the researchers are targeting hydric to non-hydric hillslopes. Yet, all hydric	

soils are not alike – if they were we would not have and be constantly updating and revising the hydric soils indicators – we would have one indicator. We have regionality to the indicators as well as texture-dependent indicators. The researchers will be monitoring with wells (Figure 4 mentions piezometers and wells, but piezometers are not mentioned in the methods), which can help elucidate water flow patterns – which is important. Surface and subsurface hydrology can have significant impacts on distribution of dissolved and particulate organic carbon. I am not convinced (based on my experiences observing landscape hydrology at similar systems around the US and elsewhere) that the hydrologies of these systems are likely to be similar enough to discount hydrology as a modifier of OC distribution in the landscape – meaning that temperature is not the primary driver of the carbon dynamics. Parent Materials: there are at least three different parent material types I would expect to see for these various sites based on their approximate geographic locations – glacial till, residuum, and outwash. Without full knowledge of the sites, I might also include colluvium and alluvium. Additionally, the geochemistry of the parent materials represented by the sites looks to have high potential variation. That chemistry, and the resultant soil chemistry (e.g. pH, carbonates, …) can have a strong influence on the carbon decomposition dynamics. Organisms: The variations in precipitation, temperature, and evapotranspiration mechanics at these sites have resulted in distinct vegetative communities. The conifer and prairie systems are different than the hardwood systems. The chemical makeup of the vegetative litter is different and, combined with the chemistries, hydrologies (e.g. precipitation (amounts and seasonalities), vapor pressure deficits), and fine-earth differences make me think that decomposition will not be controlled by temperature alone. The described methods of measuring decomposition and carbon inputs	

may not be appropriate for the given geographies. Herbaceous plant senescence in the western sites begins much earlier than the eastern sites. And this is markedly so in a western vernal pool system in an ustic or xeric region. Focusing on fall litter collection at 8000' is a bit late. No mention of adjusting sampling protocol to fit regional plant cycling is mentioned. Black Carbon: The authors are intrigued by the pyrogenic carbon that has been observed at some of these sites. This carbon is a definite long-term storage type for carbon in soils as it is slow to react and decompose. In western forests pyrogenic carbon has been shown to have a strong influence on nutrient cycling. What I find interesting is the lack of discussion as to the genesis of this carbon. In fire-adapted landscapes, this carbon can be added repetitively over 100's to 1000's of years. But only if the systems are burning. In the sites west of the Mississippi, the pyrogenic carbon addition is still a strong possibility unless landuse has eliminated the vegetation that carries fire. In the eastern sites, what is the source of the carbon? Is it from periodic burning of the wetlands? Or is was it contributed by slopewash in the past after sites were logged and burned. Or cyclic wildfire. I would have liked to have been provided some more site-specific details to evaluate whether black carbon is something to pursue in this study. Impact of historic landuse: Each of these sites has been managed differently and exposed to different degrees of erosion, accumulation, fire, native vegetation conversion, altered hydrology, etc. A full accounting of those potential impacts are required to assess how they can be compared and how historic landuse may have impacted current carbon levels. In an undisturbed system, the carbon balance is likely a 100-1000 year dynamic that reflects long-term trends in hydrology, vegetation, and climate. In the last 100 years, in almost all the proposed systems, we have set the cycle out of balance in drastic ways. The current carbon cycling may not reflect the actual influence of climate any more as the system	

may still be finding a new equilibrium post disturbance. We could compare this to the idea of isostatic rebound – the glaciers have been gone for ~10,000 years and the land masses are still adjusting. Carbon in a wetland-upland system could be in the same scenario, adjusting to the violent plowing or timber harvests that occurred and drastically upset the balance. No indication of that was provided to help assess the historic landuse changes and potential influence on the carbon cycle.. In summary, with respect to the idea that these sites can help isolate temperature as a control on carbon dynamics (a main thesis from the introduction) and then be used to model carbon storage with climate change, there is not enough information provided to support that the project can achieve this. And based on my knowledge/experience, there will be too much environmental noise to achieve that expected outcome. That said, much like the wetland soils project of the 1990's, a longitudinal study across these ecosystems to help elucidate the dynamics of carbon in wetland-upland systems across these highly varied systems will provide valuable scientific knowledge to aid in our management on a regional basis. It just won't do what is being proposed as the main thesis.	
The researchers propose the below objectives. I give an impression with each one. • To better understand the hydrological, biogeochemical and pedological properties and processes that affect SOM decomposition, CO2 and CH4 greenhouse gas fluxes, and C sequestration in depressional wetland ecosystems, as expressed across geographical and climatic gradients. Certainly, can be done for each site and compared between sites. This objective hints that differences other than control by temperature are expected. That doesn't jive with that thesis that differences will be related	We removed "as expressed across geographical and climatic gradients" from this objective.

to temperature alone, and therefore using these sites as a way to develop a standardized model how SOC stocks will change as temperature increases due to climate change. And that was suggested as the premise for the research.	
• To determine the relationship between soil and air temperature and accumulated soil C stocks and fluxes in depressional wetland systems. About the same response as to the previous objective	We revised this objective to state: "To document the range in accumulated soil C stocks and fluxes across these 11 depressional wetland systems." as part of our reframing of the project to address this reviewer's comments above.
• To determine the relationship between soil and air temperature and accumulated soil C stocks and fluxes in depressional wetland systems. About the same response as to the previous objective	
• To determine the relationship between hydroperiod (i.e. duration of saturation and inundation) and accumulated soil C stocks and fluxes in depressional wetlands. Good for developing regional concepts, but not for applying as a blanket across all the ecoregions represented in the study	
• To seek to develop morphological indices of the hydroperiod within depressional wetlands in order to estimate or predict C stocks. This will be a challenge. If we take indicator A12, thick dark surface – that is a morphological property. Can we estimate carbon from that? Not likely. We can infer that SOC is high (relative to the surrounding soils) but the SOC content can be highly variable across different regions in soils that have the	We removed this objective.

A12 indicator applied. That would be a fun NASIS exercise, if only indicators were consistently included in NASIS data population in pedons that got lab analyses.	
• To quantify black carbon in depressional wetland systems. With this limited selection of sites, are the researchers proposing to assign relative black carbon content to depressional wetlands? The black carbon is a reflection of local fire history and may or may not be applicable across all systems. And…to what end? How does specifically identifying black carbon help in the climate change projections – unless it is as a proposed management scenario. Interesting information, but limited in scope and applicability.	No, this is designed to be an observational study.
3. Appropriate scope of activity to accomplish objectives: The activities suggested for this project can get at the proposed objectives. But I don't see that the objectives get at the proposed thesis of how temperature increases due to climate change will impact carbon stocks in wetlands.	
4. Potential for significant outputs(products) and outcomes and/or impacts: This research can provide further wetland dynamic information that is needed as these systems are managed and threatened. Wetlands are storage systems for carbon and understanding the dynamics across different ecotones adds to the database already built by previous projects. Information gained in this project can help further quantify the role of wetlands in providing ecosystem services and can be used to refine landuse policy at state, regional, and national levels. Given the recent judicial decisions that decreased the scope of what wetlands fall under CWA jurisdiction, adding to the quantification of wetland types, ecosystem processes and services is highly valuable.	
5. Overall technical merit:	

As a general scientific knowledge pursuit, this proposed project has strong technical merit. With respect to answering the question about how future temperature changes will impact carbon storage, the project proposal falls short.	
If there is a desire to better quantify wetland soil carbon dynamics, this project should be funded. If the desire is to answer whether changing temperature due to climate change will impact carbon stocks, then this project does seem to meet that desire and should not be funded.	

Attachments

Table 1. Study site status, including completed components (dark green), in-progress components (light green), and uninitiated components (white).

State	Plot Layout & Exp. Design	Hydrology	Soil Morph.	Veg. Analysis	Weather & Climate	C & N Stocks	Black Carbon Stock	Inorg. N	Soil Redox	Carbon Inputs	O.M. Decomp.	GHG Flux
DE												
KS												
MA												
MD												
MI												
NE												
PA												
RI												
VA												
WV												
WY												

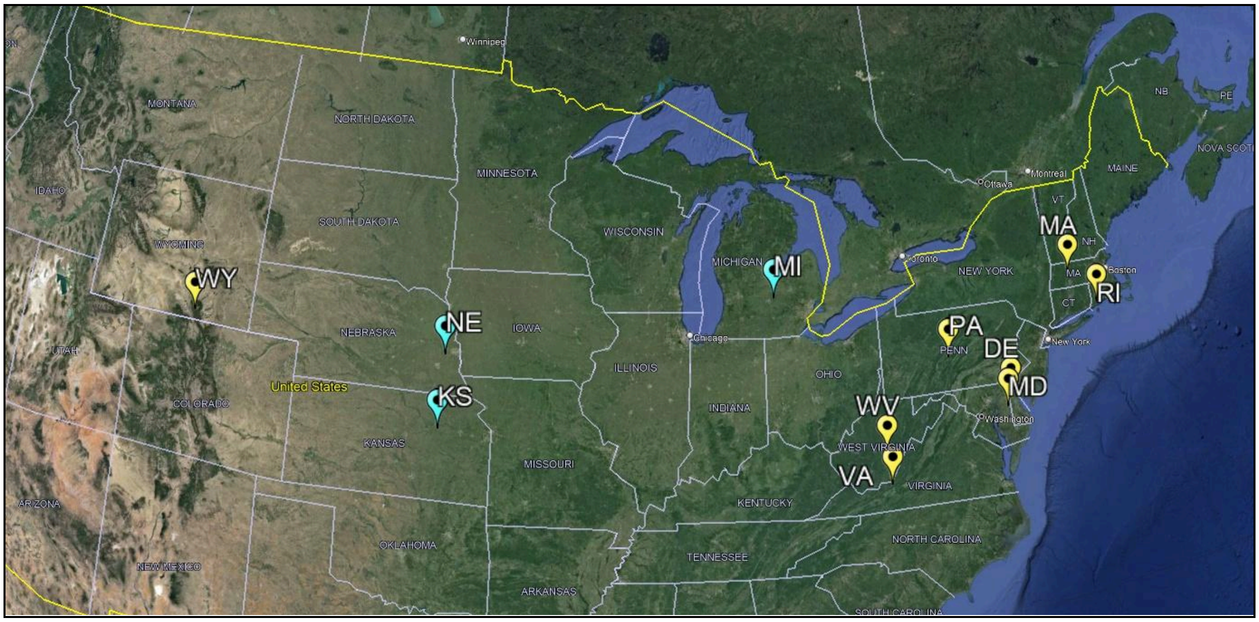
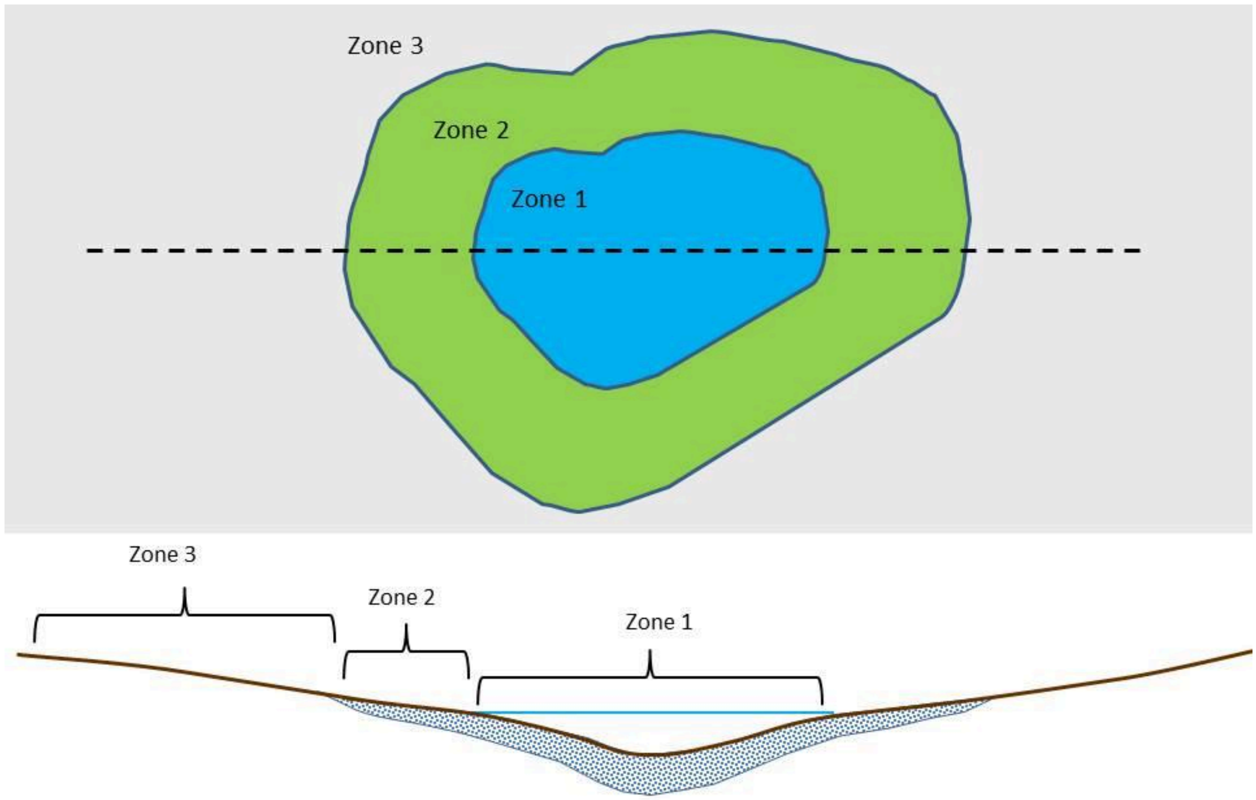


Figure 1. Location of previously established sites (yellow pins) and new sites (cyan pins).



Zone 1 - ponded zone; ponded water likely to recede below the surface during the summer months
Zone 2 - non-ponded wetland zone, containing hydric soils
Zone 3 - non-wetland (upland) zone

Figure 2. A schematic diagram showing the three hydrological zones and a cross section through a typical depressional wetland.

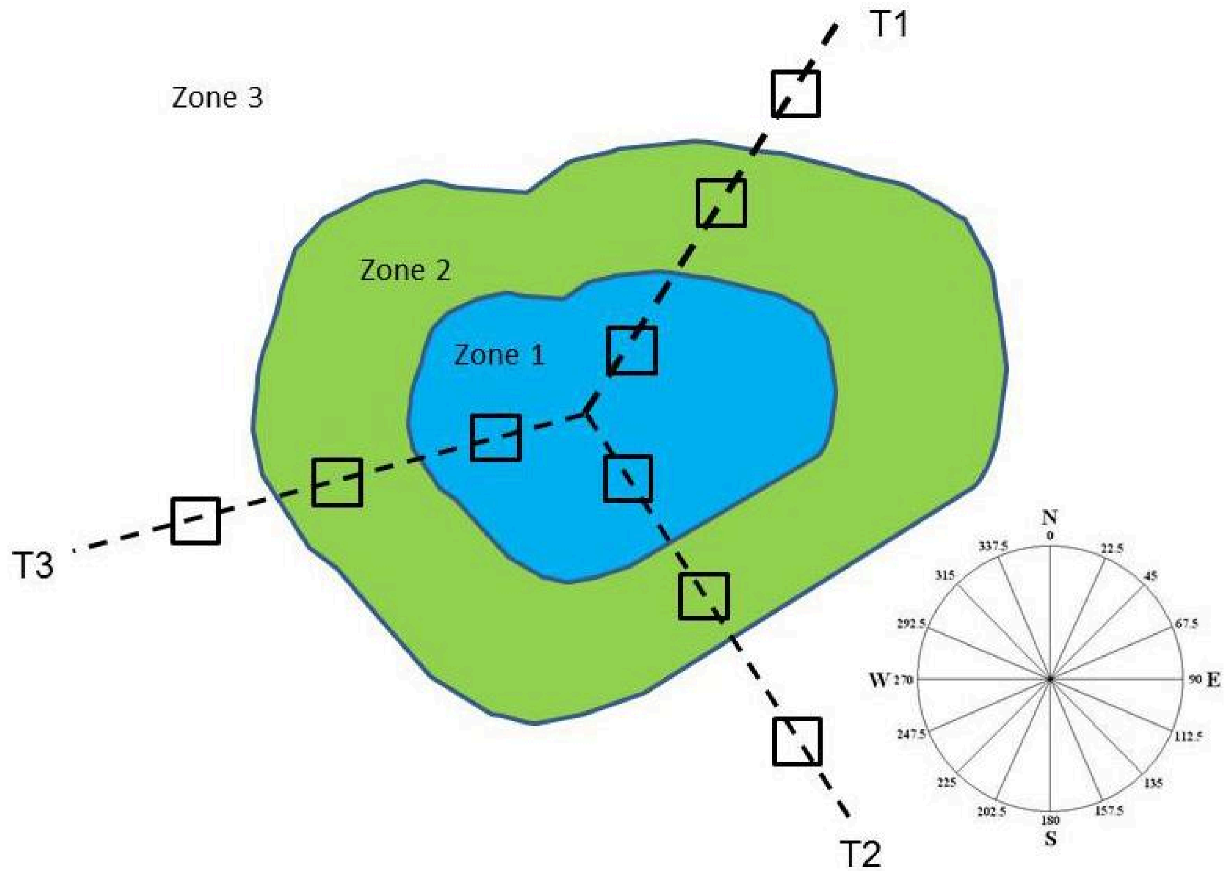


Figure 3. Three radially orientated transects in a depressional wetland, with each containing plots in each of the three hydrological zones.

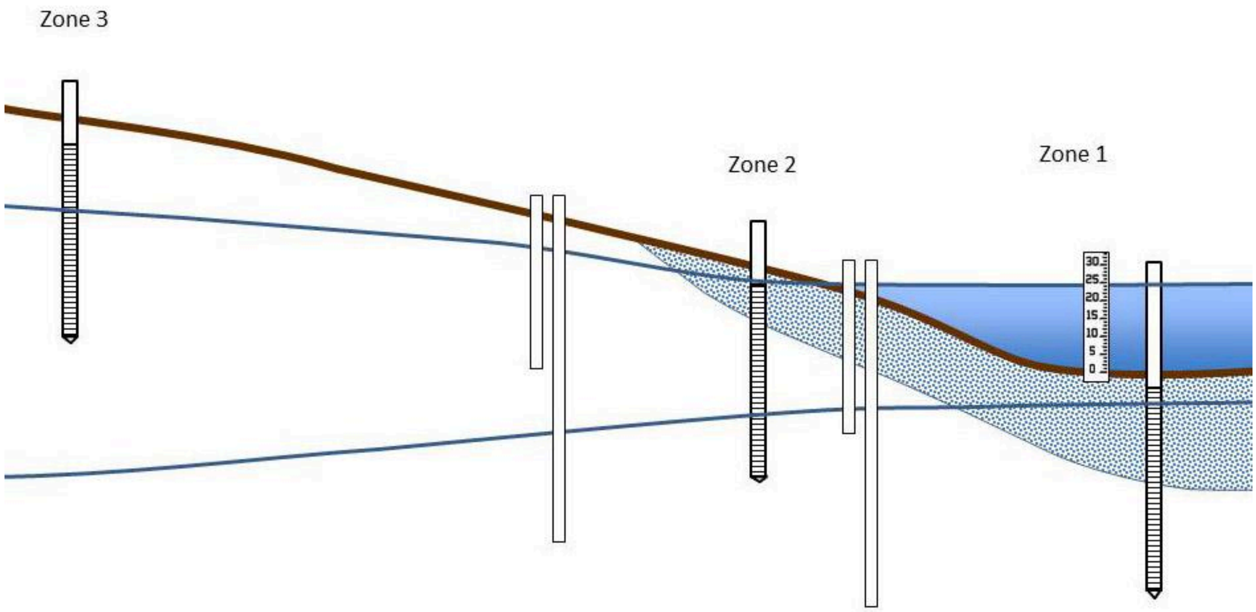


Figure 4. Cross section showing locations of wells, piezometers, and staff gauge.

NE_TEMP1: Northeast Regional Center for Rural Development

Status: Submitted As Final

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Admin Advisors:
NIFA Reps:

Non-Technical Summary

Rural areas in the Northeast and nationally continue to struggle with recovery from Covid-19, which has compounded the long-term adverse impacts of globalization, technological change, job losses and population outmigration. Addressing these impacts is essential to ensure the sustainable growth of rural areas, which in turn are vital to the nation’s food supply and the stewardship of its natural resources. The Northeast Regional Center for Rural Development conducts original research with its partners and connects faculty and Extension educators in the region with one another and to national collaborators and resources, thereby creating synergies and reducing duplication of effort. Our five project goals are approved by the Center’s Board of Directors’ and are to: support rural economic development, innovation, and entrepreneurship; facilitate tourism development, including agritourism; address climate change and carbon levels; measure and promote food and nutrition security; and build regional capacity and facilitate the integration of research and outreach. The target audiences for our work range from farmers and other private businessowners to elected officials at the federal, state, and local levels. These individuals may benefit from this project by receiving research-based information to help guide the recurring decisions they have to make to remain profitable or to ensure sound and efficient uses of public expenditures. The activities proposed here will generate collaborative research findings, and through widespread dissemination of the results through presentations, working groups, factsheets, and other tools, we expect to reach all decisionmakers who may benefit from the project outputs.

Statement of Issues and Justification

The US Northeast’s agricultural and rural areas face challenges ranging from land use conflict to climate change, environmental concerns and lagging economic development, accentuated recently by the lingering effects of the Covid-19 pandemic. These regions also have significant opportunities to contribute to the nation’s prosperity and food supply, sustainability of the environment, and societal equity and justice (Mitchell et al., 2023), but more research is needed to identify specific, place-based feasible and sustainable strategies to realize these opportunities.

The Northeast Regional Center for Rural Development provides research-based information that helps create regional prosperity through entrepreneurial and cluster-based innovation, while assuring balanced uses of natural resources in livable communities in the northeastern United States. We carry out our mission by conducting original research with collaborators, pursuing strategic partnerships with public and private entities, and linking our stakeholders to opportunities and resources; we also compile and disseminate research-based outreach materials through a variety of formats. We serve as a hub that connects researchers and Extension educators across state borders and topic areas. Our work is motivated by the continuing challenges rural areas face both in the region as well as nationally. In essence, supporting NERCRD is an investment in the resilience and prosperity of the Northeast's rural populations, contributing to sustainable economic growth and improved quality of life for residents.

The need for the research proposed here has been indicated by stakeholders ranging from the leadership of the land grant universities in the Northeast to individual campus-based faculty and county-based educators, as well as by government and nonprofit or private sector partners. Specific sources of input include: the Center’s Technical Advisory Committee, which advises the Board of Directors; the results of comprehensive listening sessions on rural economic recovery from Covid-19 conducted by the four Regional Rural Development Centers on behalf of USDA-NIFA (Entsminger et al., 2023); the Northeast Agenda – A Joint Vision for the Future of the Northeast (Mitchell et al., 2023) prepared by the Northeastern Regional Association of State Agricultural Experiment Stations (NERA) and the Northeast Extension Directors (NEED); and other stakeholders including national program leaders at NIFA, the Economic Research and Forest Services, USDA Rural Development, and the NSF’s National Center for Science and Engineering Statistics.

Importance of the work: Providing research-based information to address the problems facing the Northeast is critical if taxpayer funds are to be put to their most cost-effective uses in addressing societal problems. If the work is not carried out communities and individuals will not have the opportunity to develop a complete and research-based understanding of the factors that support or impede growth of minority and female entrepreneurship, or the factors that support or impede tourism and agritourism development with sustainable beneficial impacts for the local communities where they are based; the factors that support decarbonization, innovation and the transition to renewable energy along with their impacts for different kinds of rural communities; historical crop production patterns and their shifts over time in order to predict future production prospects including implications for the spatial distribution of nutrient dense foods, with implications for population health.

Technical feasibility: as documented in the section below on Related, Current and Previous Work, the Northeast Regional Center for Rural Development has a proven track record of successfully completing the kinds of projects proposed here. As such, the feasibility of achieving the objectives is not in question.

Given the region-covering nature of the issues addressed, and limited faculty and educator resources at individual experiment stations in the region, taking a regional approach in a multi-state effort that draws on the expertise of collaborators in the different states represents a critical advantage.

Expected impacts of successful completion of this work include more-informed decision makers at all levels of government as well as individuals, farmers and businessowners throughout the region in different industries who make economic decisions about sustainable and profitable resource allocations every day. In turn, we expect to see more resilient, vibrant, and sustainable businesses, farms, and local economies over time, with more strategic federal and private investments that benefit from higher economic and social returns, including healthier populations and more equitable socioeconomic outcomes across different ethnic groups and across gender.

Related, Current and Previous Work

The Northeast Regional Center has a long history of contributing to the research and outreach needed to address the region's current and emerging challenges. Selected highlights of the work undertaken by the Center include:

NERCRD staff use state-of-the-art research tools: We published the first application of artificial intelligence in the form of natural language processing to big data (Tweets) to predict where food supply chains were breaking down during Covid-19 (Goetz et al., 2023). This interdisciplinary research included faculty from the College of Information Sciences and Technology, and collaborators as far away as Doha, Qatar. Helping to train or support the next generation of scientists, the study also included two Ph.D. students, one postdoc and two junior faculty members.

The Center's research (Tian et al., 2022) on the role of food pantries in reducing food insecurity early in the pandemic won an Outstanding Article Award from the *Journal of Agricultural and Resource Economics* and the 2023 High-Impact Research Publication in Nutritional and Food Security Award from the College of Agricultural Sciences at Penn State University.

NERCRD research has been used at the highest levels of the federal government: The 2019 Economic Report of the President, prepared by the Council of Economic Advisors (CEA), cited three scientific papers written by NERCRD staff and collaborating researchers (Goetz et al., 2018; Rupasingha and Goetz, 2013; and Goetz and Rupasingha, 2009); the older citations underscore the durability of the Center's work. In an email, CEA Chairman K. Hassett wrote: "We found your research to be insightful and critical to the completion of the 2019 Economic Report of the President."

NERCRD's data resources have been used or cited in a variety of socioeconomic academic subdisciplines: The social capital data collection is recognized as the gold standard for measuring county-level social capital in numerous academic fields, with over 1,000 citations (Google Scholar). For example, it was used by economists at Harvard University and UC Berkeley in their groundbreaking study on rural and urban economic mobility (Chetty et al., 2014).

NERCRD's own research on intergenerational mobility has also been impactful. A News story about a NERCRD study of human capital and intergenerational mobility (Swayne, 2018) received more than 3,400 comments on Reddit, and more than 57,000 "upvotes," signaling that the topic resonated with these users.

The Center has been instrumental in supporting the national recreation economy, a critical new engine of rural economic growth. Starting with its support of the National Extension Tourism Network (see, e.g., Extension Foundation, 2022), the Center assisted West Virginia University, Vermont, New Hampshire and Penn State faculty in securing an AFRI competitive grant, and also secured New Technologies in Agricultural Extension funding. This was followed by the establishment of a new regional Hatch project (NE2251, Tourism Resilience and Community Sustainability: Adaptation and Recovery of Rural Businesses and Destinations). Most recently, the Regional Rural Development Centers were charged by NIFA to help implement a Memorandum of Understanding between NIFA, the Forest Service and Rural Development (USDA, 2022).

In addition to training graduate students and postdoctoral students, the Center was instrumental in helping a total of seven faculty members secure six major NIFA grants, to the best of our knowledge, for the first time. The Center's earlier $5mn local food systems grant connected extension educators at Penn State, Cornell and West Virginia State University and other land grants with faculty at Columbia, John Hopkins, and Tufts universities, among others.

As noted above, this proposal draws on a large body of ongoing, related and previous work that is guided by the Center's Technical Advisory Committee and approved annually by a Board of Directors (land grant university administrators), and a large-scale listening session effort that the Center conducted in 2022 along with its three counterpart institutions in the North Central, Southern and Western regions on behalf of NIFA (Entsminger et al., 2023). This proposal also aligns closely with the three Key Priorities set forth in the Northeast Agenda document (Mitchell et al., 2023), as well as USDA-NIFA goals. The Center's Board-approved broad priority areas currently are: 1. Economic development, resilience, and innovation; 2. Food systems, nutrition security, and agriculture; and 3. Capacity building and facilitation. Within these three broad priority areas, the five specific objectives listed in the next section are proposed over the next 5 years.

Objectives

1. Support rural economic development and entrepreneurship, and innovation. We will conduct research and outreach on the success factors, barriers and opportunities for female and minority entrepreneurs in the region, including the roles of access to credit, broadband and market information, as well as child and elder caregiving. We will also examine the barriers facing female and ethnic minority farmers using National Agricultural Statistics Service and related public data sets and seek to evaluate the role of policy levers such as the Community Reinvestment Act in facilitating access to credit among other resources.
2. Facilitate tourism development, including agritourism. We will help to implement the new Memorandum of Understanding signed by NIFA, Rural Development and the U.S. Forest Service, with the goal of helping rural communities take better advantage of their natural resources, while managing them in a sustainable manner. In Northeast states without large forest stands, we will conduct research to help communities understand their tourism possibilities. We will conduct research on the role of clusters and other explanatory factors in supporting tourism expansion and resilience and develop research-based outreach materials to assist farmers seeking to expand their agritourism activities, taking advantage of synergies and proximity to urban consumers. The importance of infrastructure development, including broadband availability and physical accessibility as measured in the Economic Research Service's new ruggedness index, will also be assessed.
3. Address climate change and carbon levels. We will examine the state of greenhouse gas emissions in the Northeast region and contributors to energy intensity, and determine opportunities for decarbonization, including the use of wind turbines (on shore, offshore) and solar panels, combined with agri-voltaics. These opportunities will include assessing regional supply chains for producing green energy, including barriers to their development, such as workforce availability. The more expansive use of land under green energy production has the potential to profoundly impact rural communities, and landowners; suitably targeted research can help to develop guidelines for mitigating adverse impacts.
4. Measure and promote food and nutrition security. We propose to build on the Center's long history of work on local and regional foods systems by documenting the contribution of the region's food system to the nation's nutrient supply (lacking the masses of land needed to grow bulk commodities, the region nevertheless contributes disproportionately to the quality of the nation's diet). This is important given the rise of obesity and malnourishment even in the presence of adequate food production levels. Part of the analysis will seek to document shifts in crop production at the state-level over time, including the roles of population pressure on land as well as shifting climate belts. We will also examine the diet quality of different ethnic groups over time, and during economic shocks, such as Covid-19.
5. Build regional capacity and facilitate the integration of research and outreach. To support the integration of research into practice, in the spirit of the Northeast Agenda 2023, we will support the infusion of DEIJ principles into extension programs wherever possible, and ensure that community development professionals in the region, whether or not they have this responsibility in their formal position title, have access to state-of-the-art research and training materials, including DEIJ and impact measurement tools.

Methods

1. We will estimate state-of-the-art statistical models using confidential data from the Penn State Federal Research Data Center (RDC) on the growth characteristics, survival constraints and opportunities facing female and ethnic minority entrepreneurs in the Northeast region. Collaborating faculty in WV, ME, PA, at 1890 institutions and the Economic Research Service, among others, will be critical to carrying out the objective by providing guidance and model specification, analysis, publication and dissemination of results. The individual level data will be tied to specific counties allowing us to assess how both individual and contextual as well as spatial clustering factors affect entrepreneurial success. Typical regression models will be of the form Y = a + bX + cZ + e where Y is some outcome variable such as profit or employment growth, X is a set of county level characteristics such as the rural-urban continuum score or population density as measures of market access, natural amenities, existing business services and agglomeration factors, among others. Z denotes a set of entrepreneur-specific variables such as gender, age, ethnicity, education, industry sector and others. We will used appropriate statistical techniques such as limited dependent variables models or spatial error and spatial lag specifications as necessary. Also, as necessary we will explore the use of instrumental variables or synthetic control methods. Bayesian methods of analysis will be used in cases of modeling uncertainty (e.g., Gelman et al., 2013, Schmidt et al. 2024). In certain specifications we will also use data collected at different points in time, so that the dependent variable Y can be measured over time as a log or percent change (dY), and the initial or starting value of Y is included as a control variable among the regressors, allowing for explicit tests of convergence. This will allow us to assess the effect of economic and other shocks, such as recessions or the Covid-19 pandemic on food system and other entrepreneurs, including those operating breweries, wineries, distilleries or cideries. We will also explore the measurement and use of entrepreneurial ecosystem-type variables at the county level. This will include both labor force characteristics and the availability of services, such as bank branches, adult and childcare service facilities, or broadband availability. We will use caregiver data collected in collaboration with the North Central Regional Center for Rural Development and also use secondary public data such as that collected in the Household Pulse Survey. Institutional variables such as the Community Reinvestment Act designation will be considered as well in terms of their impact on outcome variables such as access to credit. Policy variables from the USDA's Economic Research Service and natural indicators such as the Amenities Index and the new Ruggedness measure also will be considered.

2. In collaboration with the Outdoor Recreation Group, formed in response to the release of the USDA NIFA-RD-FS MOU, we will model and analyze barriers and constraints facing various tourism destination management organizations (DMOs), and also provide training for lagging regions that have not yet taken advantage of their natural resources, including agritourism opportunities. The primary methods of analysis will include county-level data over time, so that the impact of different shocks on resilience can be evaluated both in the short and long terms. In the initial phase we will conduct spatial analyses to assess overlap in the service areas of NIFA, the Forest Service, and Rural Development, in order to identify priority locations for interventions. Here collaborations with expert faculty in WV, ME, NH and VT among other states will be critically important to the successful implementation of the objective. In addition to using secondary data, we anticipate collecting primary survey data to specifically identify key challenges, priorities, and resource needs of DMOs. We will use appropriate stratifications in order allow comparisons among different tourism destination to facilitate the identification and sharing of best practices across different locations. For example, well-known destinations such as the Acadia National Park in Maine are challenged by over-tourism and need programs to better support tourists while managing visitor numbers in sustainable ways. Other locations, such as PA Wilds and selected individual counties such as Wyoming, PA in rural Pennsylvania (https://www.nicholsonheritage.org) do not yet have the scale needed to attract a large number of diverse tourists; in fact, they often face a chicken and egg situation where the services are not forthcoming because tourists are few in numbers, and the number of tourists is limited by a lack of attractions and leisure and hospitality services. Here the challenge is for individual counties and regions to collaborate and cluster in breaking out of the dilemma. With careful comparisons and models of different communities based on secondary data and custom surveys, we expect to be able to identify best practices to help different types of communities grow to scale. On the agritourism side, we will use secondary data analysis to evaluate the impact of agri-tourism on local community indicators. For example, we will estimate regression models of the form Y = a + bX + cZ + e where Y is some community level outcome such as farm income, local income, poverty or employment growth, X is set of county level economic or farm conditions (such as livestock vs. crop agriculture), broadband availability, ease of access, population density or distance to major metropolitan areas, which control for local context. In this specification, Z is a measure of agritourism, such as the number of farms offering such services, or the income earned from providing the services. Using time series data, it will be possible to assess the impact of different kinds of shocks on tourism revenues and resilience.

3. We plan to use secondary data, including input-output tables to begin to assess the potential for building green energy related supply chains in the northeast states, along with their impacts and the factors contributing to their emergence. Using state-level data on greenhouse gas (GHG) emissions over time available at U.S. Energy Information Administration (EIA, https://www.eia.gov/environment/emissions/state/), we will document how different states are managing the transition to green energy, along with the contributions of different industrial sectors to carbon dioxide emissions. The use of satellite-based carbon emission sites will also be explored, as a means of verifying and complementing the survey-based data. We propose to use existing public data, as well as the new Census Bureau's Annual Business Survey (ABS) (https://www.census.gov/programs-surveys/abs.html), to identify barriers to and opportunities for firms both to adopt and to generate green energy in their production facilities. This modeling will include state, county and firm-level analyses of changing greenhouse gas emissions over time, including the impact on different racial groups and different business types, including farms. We will combine firm level and county level secondary data in the analysis. More specifically, identifying where carbon-intensive industrial activity occurs is critical for understanding possible routes to a low-carbon economy, and for identifying impacts on communities and workers. We propose to use microdata from the 2014, 2018 and 2022 Manufacturing Energy Consumption Survey (MECS) (EIA 2015, 2019 and 2023) to estimate the carbon performance of individual establishments across all manufacturing industries, examine the locational characteristics of these various establishments, and test hypotheses about the locational (community) characteristics most conducive to carbon-intensive activity. The MECS provides comprehensive data on all forms of energy used by manufacturing plants during the reference year. By applying an emissions factor – a coefficient produced by EPA that describes the rate at which a given energy type releases greenhouse gases into the atmosphere – to these data we can accurately estimate emissions from each plant (Boyd and Lee 2020). Normalizing carbon emissions by total revenue or employment allows comparisons of carbon performance across establishments. Employment and payroll data for the MECS firms will be merged with the Longitudinal Business Database (LBD) using firm specific identifiers. Revenue is not available in non-Economic Census years (2014 and 2018) but can be imputed using payroll to revenue ratios by detailed industry in the nearest Economic Census year. An OLS regression of carbon performance provides information on the factors contributing to carbon performance at the mean. However, testing hypotheses of factors associated with high emissions plants requires quantile regression that can examine associations throughout the carbon performance distribution. The hypothesis that disadvantaged areas are more likely to attract more polluting industries has been well researched in the environmental justice literature (Mohai et al. 2009; Goetz and Kemlage 1996) but the evidence with respect to rural areas is much thinner (Cohen 1997). Testing the effects of population density, land values, topography, and socio-economic disadvantage on carbon intensive activities will provide information on where the challenges and opportunities with respect to the low-carbon transition are greatest.

Logistic regression with bias correction for rare events as proposed by King and Zeng (2001) is well suited for estimating the probability of rare events, especially when the sample size is large as is the case here. In addition to 300,000 firm level observations in the 2022 American Business Survey (ABS), multi-unit firms have each of their establishments included in an establishment file with roughly 2.2 million observations. The establishment file contains only rudimentary information such as NAICS industry, location, and employment size. However, these data are sufficient to test the central hypotheses of the associations between location characteristics and reported renewable energy R&D and use at the firm level. We will use the 2022 ABS data to estimate the following logistical regression equation: Prob(Renewables R&D=1) = b0 + bX + e where suppressed index i and j denote firm and county, respectively and the X are the following regressors: establishment age, firm size, publicly held company status, intent to eliminate, replace or reduce carbon emissions, 2030–2050 decarbonization goals, environmental innovation, strategy failure risks, climate shock, FEMA climate shock, republican vote 2020, socio-economic level, population density, land value, natural amenity scale, solar energy potential, average wind speed, ruggedness, transmission access, airports, land cover, decarbonization actions, and industry fixed effects. A similar equation replaces R&D with renewable energy use as the dependent variable. As noted, a simple logistic model using maximum likelihood estimation for rare events is biased, so we use the bias-corrected approximate Bayesian estimator in King and Zeng (2001). We will use firm and county (X) controls to identify factors at each level that are correlated with R&D on renewables and the use of various forms of onsite renewable energy. Firm-level variables of interest include the industry (given by the NAICS code), firm size (question A.8), and revenue (question A.11). County-level controls will include factors that encourage or discourage renewable energy siting, many of which come from previous studies (e.g., Hitaj 2013) and ongoing work from Justin Winikoff at the ERS. Key variables will include transmission access, renewable (solar and wind) potential, land values and existing renewable energy development. Controls will also include key variables measuring rurality in various ways, such as population density and the amount of undeveloped land suitable for renewable energy. Critically important under this objective will be a collaboration with the National Extension Climate Initiative (NECI), currently chaired by Dr. David Kay of Cornell University. Successfully modeling the determinants and impacts of shifting to green energy also requires local, state-level knowledge of communities, preferences, and policies, for example in NY and NH, so that a multi-state approach is required.

4. Using public data, including from the Household Pulse Survey as well as other sources, we will examine how the food security and quality situation of different households stratified by ethnicity and income was affected by Covid and its aftermath, including the effect of public covid support payments. We will use agricultural Census and NASS historical data to document the production of different crops and related products over time and compare the region's contributions to those of the nation. Shift share analysis will be used to identify the contribution of competitive factors in crop acreage growth or decline. We will use proprietary grocery store scanner data (IRI) to calculate household level diet qualities indices and public secondary data to model and assess differences in population health at the county-level.

Following Loveridge and Selting (1998) and Artige and van Neuss (2014) who discussed an assortment of variation in the shift-share formulation, we apply the most basic approach to computing shift-shares for crop production (Dunn Jr., 1960). The shift-share analysis decomposes the total change in crop production into three components: (1) a national growth effects: the amount of all crops of a state would have grown or decline if it had changed at the same rate as the nation; (2) a commodity mix effect: the amount of change attributable to differences in the commodity makeup of a state versus that of the nation (we use the term of commodity mix effect to replace the industry mix component in the original shift-share definition). (3) a competitive effect: the amount of local crop production changes not attributable to national growth or commodity mix effects. A positive competitive effect for a particular crop indicates competitive advantages in its production. With the crop-specific shift-shares, we can examine the comparative advantages in producing specific types of crops, for example, using the four-cell table analysis. To explore economic and natural drivers for the shifts in shares, we regress each component of the shift-share change for individual crops separately on the growth of personal income, population density as a proxy for land costs, precipitation and drought variables, and others.

5. This objective will be achieved though zoom meetings organized around specific topics corresponding to the different objectives, as well as a wide variety of outreach materials for peer reviewed research findings, including factsheets, infographics, bulletins, and short reports. In selected cases and for certain objectives, such as for the results that will be of interest to DMOs, we will prepare data dashboards containing information in as close to real time as possible. For county leaders we will also provide informational materials related to decarbonization and entrepreneurial growth conditions, some of which may be presented in the form of dashboards. Communicating the relevant research results generated both by the Center and collaborators both to the region and beyond, including policymakers, is a priority. A multi-state approach is essential not just for ensuring that state differences in policies and conditions are reflected in the research, but also for widespread distribution of results to where they are most needed.

Measurement of Progress and Results

Outputs

- The most common type of output will be in the form of peer-reviewed scientific publications, the results of which will be shared at conferences, workshops, and Congressional briefings, as appropriate, and once “translated” also serve as the basis of lay audience-friendly information and outreach materials, including webinars, factsheets, data dashboards and press releases. These outputs are expected to be of value to stakeholders or end users in making critical day-to-day decisions, whether they are in the public, nonprofit or private sectors, including on farming operations. Specific metrics include scholarly citation counts, audience members reached or attending webinars, media mentions, and references to the results in media such as newspapers or social networks, and invitations to present findings at conferences and selected audiences.
- In addition to curating and presenting publicly available state- and county-level data sets both in tabular and in mapped formats, we will make the deidentified data from the caregiving survey available on our website for others to use; this may include faculty, educators and graduate students interested in the conditions surrounding caregiving. In addition, we will present basic descriptive statistics from the survey, pending data cleaning and analysis. This and other data sets will benefit end user-stakeholders directly, and other products such as the maps will help end users visualize conditions over rural space and how these are changing over time.
- Another tangible output is the networks of researchers and educators convened around specific pressing problems and issues arising in the rural Northeast. One component of this capital will be the post docs and graduate students trained over the life of this project. Members of the networks will benefit directly from the network effects including the sharing of resources, insights, and information while the students will be better prepared to take on employment in academia or the private sectors. Metrics tracked here will include supplemental grant funds secured and other indicators that the results presented resonate with stakeholders (e.g., “upvotes” on Reddit). We will track emerging collaborations with faculty and educators in the Northeast region, as well as networks formed as a result of this work.

Outcomes or Projected Impacts

- One key set of projected impacts is the improved social and economic outcomes in rural communities, for both businesses and individuals. For example, Destination Management Organizations in congested tourist areas will better manage the influx of tourists, while communities that are unable to attract enough tourists to achieve a minimum efficient scale will collaborate with surrounding communities to develop a more viable tourist economy. Similarly, agritourism communities and related offerings such as beer or winery trails will be more economically vibrant. Areas known for high levels of greenhouse gas emissions will be moving towards a path of decarbonization, using the insights generated in this project from the analyses of secondary public data.
- Decisionmakers in the public and private sectors will have a better understanding of the various constraints facing small entrepreneurs, including across ethnic and gender lines. These are expected to reflect market and credit access, broadband and services such as child or adult daycare. They will be provided with the tools and resources needed to address these barriers.
- Ultimately, better physical and mental health outcomes, and lower poverty and higher, more equitable income growth over time as reflected in secondary, publicly available data, are key expected impacts of this project.

Milestones

(**0**):A first milestone will be reached when the data needed to carry out the statistical work under objectives 1 to 4 have been extracted, verified and compiled into appropriate software, such as Stata or R. In general, we expect this to take no more than one year for the publicly available data, although accessing the highly confidential data in the federal Research Data Center may take longer. In parallel, this first milestone will include the forming of objective-specific groups of multi-state collaborators.

(**0**):The second milestone will be reached once the data have been analyzed, written up in reports, and submitted for peer review to scientific journals. Across the three objectives, we expect this to take from two to four years. In parallel to this milestone, we will have formed networks of researchers and educators around specific objectives and sought additional funding to leverage, extend and deepen the work compiled to this date. We will also have started to disseminate peer-reviewed research results through various media by the time this milestone is reached.

(**0**):The last milestone will be reached after the outreach materials have been prepared, reviewed and distributed through various print and in-person venues through year 5 of the project.

Outreach Plan

As noted above, outreach is a critical objective (no. 5) of the project itself and includes various forms of printed materials as well as webinars providing further detailed information. Given the extensive networks that the Center already has in place, we expect the results to be defused widely, including to the stakeholders in the individual states of the Northeast U.S., for example through faculty and Extension educators. We also expect to share results with our key funders and elected representatives in Congress. The Center also produces an annual report and a quarterly newsletter (appearing with greater frequency, as needed).

Organization/Governance

The Center is funded through multiple sources including a directed or prime grant from NIFA, competitive grants, Hatch Multistate Research Funds (NERA funding), and state funds and, from to time, private foundation funds. This proposal is directly related to the Hatch MRF. The Center is led by a director who works closely with faculty and educators both in the region and, through the other RRDCs, nationally. In addition, The Center is guided by a technical advisory committee and is governed by a Board of Directors, comprised of Northeast land grant university Deans or Directors.

Collaborators

Technical Advisory Committee members (tbd)

David Abler, Ph.D., Prof. of Ag, Env. & Reg. Econ. and Demog., Interim Head, AESE PSU

Andrew Crawley, Ph.D., Assistant Professor, School of Economics, Univ. of Maine
Heather Stephens, Ph.D. (Chair), Assoc. Prof. and Director, RRI, West Virginia Univ.

Doug Arbogast, Ph.D., Rural Tourism Specialist, West Virginia University

Adam Hodges, CED Program Leader, West Virginia State University
David Kay, Senior Extension Assoc., CaRDI and Dept Development Sociology, Cornell U.
Shannon Rogers, Ph.D., Associate Extension Professor, Univ. of New Hampshire

Andy Wetherill, Adjunct Professor and Agribusiness Specialist, Delaware State Univ.

Peter Wulfhorst, ECD Educator, Penn State Extension, Pike County

Zheng Tian, Assistant Research Professor, NERCRD, AESE Penn State

Claudia Schmidt, Assistant Professor and Extension Specialist, AESE Penn State

Other faculty and educators in the region, as well as nationally, tbd.

Counterpart Regional Rural Development Centers and their staff (generally topic-specific)

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Land Grant Participating States/Institutions

Non Land Grant Participating States/Institutions

Participation

Participant	Is Head	Station	Objective	Research						Extension	
				KA	SOI	FOS	SY	PY	TY	FTE	KA

Combined Participation

Combination of KA, SOI and FOS	Total SY	Total PY	Total TY
Grand Total:	**0**	**0**	**0**

Program/KA	Total FTE
Grand FTE Total:	**0**

Appendix G: Peer Review (Submitted)

Status: Complete

Project ID/Title: NE_TEMP1: Northeast Regional Center for Rural Development

Rate the technical merit of the project:

1. Sound Scientific approach:
Approve/continue project with revision
2. Achievable goals/objectives:
Good
3. Appropriate scope of activity to accomplish objectives:
Fair
4. Potential for significant outputs(products) and outcomes and/or impacts:
Fair
5. Overall technical merit:
Fair
Comments
I find the NERCRD proposed project very conventional in issue focus, methodologically narrow, lacking in transdisciplinary and translational research and extension framing, grounded in an epistemic politics aggressively favoring technical expertise relative to practical local knowledge reflected in community member lived experience, and seriously underdeveloped with respect to its extension/engaged scholarship strategy and tactics.
Your Recommendation:
Approve/continue project with revision

Appendix G: Peer Review (Submitted)

Status: Complete

Project ID/Title: NE_TEMP1: Northeast Regional Center for Rural Development

Rate the technical merit of the project:

1. Sound Scientific approach:
Approve/continue project
2. Achievable goals/objectives:
Good
3. Appropriate scope of activity to accomplish objectives:
Excellent
4. Potential for significant outputs(products) and outcomes and/or impacts:
Excellent
5. Overall technical merit:
Excellent
Comments
This is an excellent project. The objectives of the project are: 1) support rural economic development, innovation, and entrepreneurship; 2) facilitate tourism development, including agritourism; 3) address climate change and carbon levels; 4) measure and promote food and nutrition security; and 5) build regional capacity and facilitate the integration of research and outreach. The project may be a bit ambitious with 5 objectives, especially as the topics do not necessarily overlap. However, the topics are important to the NE region.

The Center has extensive experience working in these areas across the NE region with outstanding collaborators.

Technically sound methods for objectives. Particularly important to link national datasets to research issues and provide data-driven policy solutions. Proposed outputs are achievable.
Your Recommendation:
Approve/continue project

Appendix G: Peer Review (Submitted)

Status: Complete

Project ID/Title: NE_TEMP1: Northeast Regional Center for Rural Development

Rate the technical merit of the project:

1. Sound Scientific approach:
Approve/continue project
2. Achievable goals/objectives:
Good
3. Appropriate scope of activity to accomplish objectives:
Excellent
4. Potential for significant outputs(products) and outcomes and/or impacts:
Excellent
5. Overall technical merit:
Excellent
Comments
The Northeast Regional Center for Rural Development (NERCRD) serves as a pivotal hub for the Northeastern states, providing vital research and outreach essential to addressing regional issues. With a focus on rural prosperity and sustainable economic growth, NERCRD engages in regular comprehensive needs assessments that effectively guide its initiatives. The Center's proposal identifies five ambitious objectives, each outlined with a sound methodology.

NERCRD's objectives include their commitment to supporting rural economic development, entrepreneurship and innovation, all critical for the region. In addition, the emphasis on facilitating tourism development, particularly agritourism, aligns with the region's economic landscape and potential. The inclusion of addressing climate change and carbon levels showcases the region's approach towards sustainable development. The center's dedication to measuring and promoting food and nutrition security underscores its holistic approach to rural prosperity. Finally, their plan to build regional capacity and facilitate the integration of research and outreach is noted. The methodology presented for all of these objectives appear thorough and comprehensive.

The proposed outputs, including peer-reviewed publications, workshops, and conference presentations, are appropriate channels for disseminating research findings and engaging stakeholders. Anticipated outcomes such as improved economic growth for rural businesses and individuals, as well as better physical and mental health outcomes, are impactful.

One minor suggestion for enhancement to the proposal would be to incorporate more detailed information on engaging extension personnel for the dissemination of research and resources developed. Extension personnel in the region play a crucial role in bridging the gap between research and practice, and while the proposal indicates this connection will be made, additional details would be helpful.

NERCRD's proposal demonstrates a clear understanding of the region's needs and presents a comprehensive approach to addressing them. I would highly recommend continued funding of their projects
Your Recommendation:
Approve/continue project

NERCRD Hatch 19139: RESPONSE TO THE REVIEWER

Comments
I find the NERCRD proposed project very conventional in issue focus, methodologically narrow, lacking in transdisciplinary and translational research and extension framing, grounded in an epistemic politics aggressively favoring technical expertise relative to practical local knowledge reflected in community member lived experience, and seriously underdeveloped with respect to its extension/engaged scholarship strategy and tactics.

Your Recommendation: Approve/continue project with revision

I appreciate the reviewer taking the time to read the proposal, and to offer comments. The comments are mostly excellent, and with an unlimited budget, we would aspire to implement them. They actually not only make the case for *why* more funding is needed, but also *how* it could be deployed. Moreover, I regret that space constraints for this application prevented me from providing more details, which may have allayed some of the concerns. The reviewer needs also to consider that this request is for $100,000, only about 60% of which is for project personnel. Even so, our NIFA base funds allow us to leverage a larger set of resources, as elaborated below, and to extend our work into the region in impactful ways. Here are responses to each of the major issues raised.

Conventional focus: While the five issues we propose to address are conventional in focus, they are also current priorities that have been identified by NERA, NIFA-funded regional and national RRDC listening sessions, the White House Office of Science and Technology Policy, the Ag Appropriations Committee and/or, perhaps most importantly, the Center's Technical Advisory Committee. In addition, these five issues have been reviewed and approved by the Center's Board of Directors.

Methodologically narrow: While we want to engage in more participatory (or engaged) research with communities, our current core funding level is not sufficient to do this. As an example, a new study at Penn State that engages indigenous communities in climate research is funded at $5 million by the NSF and involves participation and additional funding from three other countries[1]. As it is, we use data and methodologies, and methods, that are accepted (if not expected) by – and allow us to compete successfully for competitive grant funds from – agencies such as the NSF, USDA-AFRI and USDA-ERS. Currently we have funded projects with each of these. In addition to using state of the art econometrics (a field which continues to evolve at a rapid pace), we have successfully used leading edge methods such as machine learning and large language modeling in our research, in collaboration with faculty from a College of Information Sciences and Technology, and from a Computing Research Institute. This approach does favor technical expertise, but it is relatively cost-effective, robust and generalizable, all of which are critical given the resources we have available. It also meets current scientific standards.

Lacking in transdisciplinary and translational research and extension framing: Objectives 2, 3, 4 and 5 involve scientist expertise from tourism and recreation departments, climate science, nutrition, and sociology/extension education, respectively (please also refer to the previous item). I apologize for not spelling these out more clearly, given the space limitations. As for the Extension

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[1] https://www.psu.edu/news/social-science-research-institute/story/5m-grant-engage-indigenous-communities-climate-change/?utm_audience=Faculty&utm_source=newswire&utm_medium=email&utm_campaign=Penn%20State%20Today&utm_content=08-12-2024-20-57&utm_term=TopStories%20-%202

framing, because this is a NERA-funded project, research activities are emphasized to the neglect of Extension and outreach (as noted in the title, this is about regional *research* coordination, not Extension). Further, please be assured that, with a new Associate Director for Extension on board, we will be able to leverage and extend the research farther into the field: Steve Alessi was hired after the original submission; a small amount of funds (4%) is requested for his time.

<u>Aggressively favoring technical expertise relative to practical local knowledge reflected in community member lived experience:</u> This claim is incorrect. Our recent research has extensively drawn on "community member lived experience": to list only four such examples, our work on Community Food Services in alleviating hunger during Covid-19 (Tian et al. 2022), which won a distinguished academic article award and a College research impact award, reflects the practical and local experience of hunger among those who lost their jobs suddenly and unexpectedly; our Artificial Intelligence-based work on Tweets reflects the emotions (such as *fear* or *anger*) about food insecurity experienced during Covid-19 (Goetz et al. 2023); the visitor and resident surveys in the Allegheny National Forest (ANF), and elsewhere, are designed explicitly to gauge the lived experiences of local community members, and of visitors coming from elsewhere related to local recreation (various reports in progress jointly with D. Arbogast); and the field survey work of a graduate student we are supporting reflects the lived experiences of farmers in MD, NJ and PA with adopting agrivoltaics and green energy more generally. These are just four examples of how we consider community members' lived experiences; there are many others. While we would like to do even more community-based, engaged surveys, the current resources available require that we rely primarily on secondary data sources.

<u>Seriously underdeveloped with respect to its extension/engaged scholarship strategy and tactics</u>: Our funding situation limits what we can do strategically and tactically in terms of extension or engaged scholarship. We are doing the best we can with the resources available to build and extend a science-based foundation for outreach materials related to pressing and newly emerging economic and community development concerns. Having an Extension Director at the Center will allow us to do more to address this concern. Having more resources in the future would allow us to have correspondingly even greater impacts.

NERCRD NE19139 Regional Hatch Project; January 11, 2024

Budget Justification

Salaries ($59,436):
Funds are requested to support faculty and staff time to work on research and coordination activities related to the five project objectives. For faculty this will include collection of preliminary data and other research efforts to establish feasibility of specific sub-activities related to the project objectives. For staff time, this will include meeting logistics (including zoom calls) as well as communications and dissemination of research results.

Fringe ($21,338) is calculated at the Penn State rate for FY 2024.

Supplies ($826): for project related efforts, including postage and printing, factsheets and short reports.

Travel ($18,400): to support travel of project participants to meetings at location(s) in the Northeast to be determined in furtherance of project goals (e.g., to work on new grant applications on specific topics). Estimated: 14 individuals at $1,314 travel and lodging expense average per individual.

Total requested: $100,000

NERCD MS HATCH
Proposed budget
9/1/2024-8/31/2025

Salary		
PI-Goetz	$22,400	
Associate Director	$4,000	
Business Manager-Boonie-	$10,400	
Communication Specialist-Devlin-	$13,800	
Assistant Research Professor-Tian	$8,836	$59,436
Fringe		
		$21,338
Supplies		$826
Travel		$18,400
TOTAL		**$100,000**