Just and Resilient Landscapes: Green Infrastructure, Community, and Climate in Austin, TX

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As the climate changes, we are witnessing an increase in the frequency, duration, and intensity of extreme weather events. As we begin to appreciate the role ecological systems can play in increasing our resilience in the face of these events, we are also confronted with the difficulty of distributing climate adaptations equitably across communities. In this panel we tap into the ecosystem service value of green infrastructure, offering examples from academic, municipal, community, and private sector perspectives concerning how, where, when, and by whom green infrastructure is implemented to address climate resilience.

Katherine Lieberknecht shares two ongoing research projects that focus on better incorporating residents' local knowledge into the design of climate adaptation strategies, introducing an inclusive model of data and metrics generation to co-develop strategies to address climate and environmental challenges.

Marc Coudert presents on practical, community-centered approaches to building climate resilience, sharing how municipalities across Texas are implementing innovative strategies to identify vulnerable populations and combat extreme weather in communities of color by partnering with community members, designers and researchers.

Frances Acuna provides a community perspective on what is needed to create resilience in the face of climate related natural disasters, addressing the unintended consequences of green strategies meant to make a neighborhood more resilient by making it more safe, livable, and attractive, but not more affordable. She asks: when we green things up, what is the impact on low-income communities of color?

Jana McCann tells the story of the urgent need to plant street trees to create shade and protection along Austin's streets, especially along transit corridors and in areas serving vulnerable community members. She describes the many barriers to planting trees in these constrained locations, where utility protection standards and lack of leadership have conspired to result in dangerous conditions for those walking, biking and/or taking transit.

All of these individuals are working to bring inclusivity and collaboration to decision making in the effort to address climate stressors through ecosystem services. In this session they lay out their diverse perspectives on tying green infrastructure, as an urban climate adaptation strategy, to practices and policies, and share their lived experiences with equity and implementation.

Panelist Biographies

Pamela Abee-Taulli implements and designs municipal landscape regulations, with a focus on biological function & ecosystem services of landscape.

Katherine Lieberknecht is an assistant professor in Community & Regional Planning at UT Austin, researching environmental planning centered around equity, with specific focus areas on climate, green infrastructure, and water resources planning.

Marc Coudert plans and implements municipal climate adaptation strategies, supporting community organizers to increase climate resilience in the Eastern Crescent.

Frances Acuña is a Climate Resilience Community Lead Organizer, focusing on empowering communities impacted by systemic inequities and climate shocks and stressors in low income communities of color.

Jana McCann is an architect, planner, and urban designer of transit facilities, parks and trails, multi-modal streetscapes and public spaces and master plans.

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Rewilding the Shoreline: Biodiverse Infrastructure on Lake Erie's Waterfront

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Lake Erie, the most biologically diverse and southernmost of the Great Lakes, is particularly vulnerable to climate change. Climate-resilient shoreline infrastructure presents opportunities to combat biodiversity loss and increase public access. This session will highlight three Lake Erie waterfront projects where built infrastructure enhances natural systems to build climate resilience. We will explore soft engineering techniques, from design to construction, and discuss installation, operations, and lessons learned. Additionally, we'll provide context by examining the history of Lake Erie's waterfront urbanization, the harmful effects of habitat fragmentation, and the accelerating impacts of climate change. We'll also examine public-private partnerships, policies, and funding strategies for reconnecting fragmented shorelines.

Panelist Biographies

Daniel Affleck is a licensed landscape architect with over 15 years of experience from projects ranging from mixed use development to public parks and memorials.

Jennifer Grieser is Director of Natural Resources for Cleveland Metroparks, where she manages and natural resources throughout Northeast Ohio, specializing in stream and wetland restoration, stormwater retrofit projects and watershed volunteerism.

Benjamin Hartman, PE, PMP, CFM, is a skilled engineer with extensive experience in coastal and ecological engineering. He specializes in projects at the land-water interface. Previous roles include significant positions at the Coastal Protection and Restoration Authority of Louisiana, where responsibilities encompassed coastal protection planning and implementation, as well as experience at Delta Coast Consultants focusing on flood protection and coastal restoration

Kevin Grieser is a Senior Landscape Ecologist for Biohabitats, Inc. out of their Great Lakes Bioregion office where his focus includes ecological restoration, conservation planning and regenerative design.

Using Values-Informed Mental Models to Understand Farmer, Policy Actor, and Scientist Use and Perceptions of Hydrologic Models

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Decision-support systems using environmental data and models are increasingly common, but not always adopted by intended end-users. One reason for this disconnect between information production and use for water decisions may be epistemic or relating to the way different people understand the world, because estimating outputs such as groundwater availability with models involves numerous uncertainties that can affect trust in and use of information. Another reason may be related to people's values in the resource itself, or values of nature, including instrumental or intrinsic value types. In this study, identified the decisions that policy makers, scientists and farmers make using hydrologic models and how epistemic values (e.g., testability or usability) and values of nature are considered in these decisions. We conducted and analyzed semi-structured interviews of 10 water policy actors, 5 hydrological model creators (scientists), and 7 irrigators working in a Groundwater Management District in Kansas, part of the High Plains aquifer region in the United States. We then constructed values-informed mental models related to those decisions. We found multiple types of decisions made using hydrological model outputs, including establishing safe yield levels for the aquifer, predicting future water supply for irrigation and municipal use, and allocating or complying with water rights. Our mental models reveal the influence of both epistemic and nature values in decision processes, with differences by type of stakeholder and type of decision. For example, concern about both accuracy (epistemic value) and sustainable livelihoods (nature value) influence some policy actors when using model outputs to establish safe yield levels. These results are relevant for scientists and other data producers to improve the relevance and usability of their work. Furthermore, our results highlight the importance of acknowledging the role values play in environmental policy decisions.

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Microsites Matter: Small-scale Environmental Variation Plays a Role in Community Assembly and Consequential Rangeland Services

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There is strong evidence for the benefits of managing for multiple ecosystem services in rangelands, but this is often challenging if there are trade-offs in the conditions that support different services. Here, in a semi-arid grassland restoration, we investigate whether actions to increase microsite heterogeneity (e.g., the small-scale biotic and abiotic variation in a plot, from centimeters to a meter) can combine with high functional plant diversity seeding to maximize both forage production and native grass cover, or whether there are tradeoffs where homogenous conditions (in this case, high soil moisture pits) maximize production while heterogeneity in soil moisture (a mixture of pits and surface) maximize native cover. We draw on results from an ongoing rangeland restoration experiment that test for the effect of plot level microsite heterogeneity on the assembly of forage grass communities with different resource use strategies. We measured community composition using grided line-point intercept (LPI) and production using the non-differentiated vegetation index (NDVI). Our $1m^2$ plot treatments included unaltered surface plots, pit plots that were 10cm deep, and mixed plots composed of mixed surface and pit subplots. Our seeded forage grass communities were combinations of native grasses to reflect conservative drought tolerant growth strategies, acquisitive fast-growing growth strategies, or diverse growth strategies. After the first year of growth, we did not find evidence that microsite heterogeneity had a synergistic interactive effect when combined with seeding with species that span diverse growth strategies. Instead, native cover was greatest in plots seeded with conservative grass species as well as in the pit microsites. Despite these positive effects on the presence of native species (more native hits in the LPI), the NDVI, a proxy for aboveground biomass, was lower on the surface compared to other plot types where aboveground growth remains less due to lower soil moisture. However, we detected no difference in NDVI for the different community types. These preliminary findings suggest that pit microsites can boost native cover but that diversity in either microsites or seeding might not have the tradeoffs expected to affect forage production.

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Enhancing Soil Health and Ecosystem Services Through Pasture Cropping

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Adoption of low-cost management strategies that facilitate crop production while promoting restoration of perennial grasses can be an economically viable approach to regenerate degraded land. Pasture cropping integrates direct seeding of annual crops into dormant perennial grasses and has successfully regenerated soil function in Australia. However, the feasibility of pasture cropping for the Southern Great Plains (SGP) region is not well-studied. The goal of this study is to evaluate soil-dependent ecosystem services where pasture cropping is implemented on grasslands of the SGP region.

Pasture-cropping field experiments were initiated in 2021 summer at the Pittman Ranch near Muenster, TX and at the Nance Ranch near Canyon, TX. Adaptive multi-paddock grazing was implemented at both sites with short grazing periods followed by adequate recovery. The experimental design at the Pittman Ranch consisted of control plots (no-wheat), plots planted with wheat each year, and plots planted with wheat once in four years. At the Nance Ranch, wheat was planted into a different strip each year in each of 8 field-scale replicates to allow grass recovery following the disturbance associated with planting of wheat and simultaneous grazing of grasslands with and without interseeded wheat. Each strip encompassed 20% of the total research area. Two densities of cattle grazing at the same stocking rate were also imposed to determine if there were differences in rates of recovery of soil parameters associated with differences in grazing management.

Observations over three years suggested that weather conditions in winter months largely influenced the success of pasture cropping. Wheat germinated well in all years at the Pittman Ranch, but its establishment was poor, especially in the first season, due to unfavorable soil moisture or low-temperature conditions. Successive development of wheat in the second and third seasons was outcompeted by annual and perennial grasses later in the season. At the Nance Ranch, dry winters resulted in no wheat stand the first season, a stand that failed in the second, and a marginally successful wheat crop in the third season when late winter rains facilitated germination and production. In addition, the grass stand has increased in productivity and cover in the third season. A watershed-scale assessment of ecosystem service benefits of adopting pasture cropping in the Clear Creek Watershed in north central Texas is in progress.

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Application of a Use Estimating Model in Reservoir Recreation Benefits Estimation

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In an economic feasibility study to evaluate corrective action alternatives of a reservoir or dam, recreation benefits constitute part of the total reservoir benefits that are quantified. To estimate reservoir recreation benefits, visitation to the reservoir can be estimated using different methods including the ratio, interpolation, carrying capacity, facility availability, and use estimating modeling. While some of these methods are determined to be simple to use (e.g., ratio), others are moderate in complexity (e.g., carrying capacity) or more complex (e.g., use estimating models). This study estimated recreation benefits of two adjacent reservoirs in the Western United States through the application of the Use Estimating Method (UEM). The UEM model was used to predict day and overnight visitation to the reservoirs based on historical day visitation and camping data recorded at monthly time step. The model also evaluated impacts of reservoir surface area on monthly day visitation and camping. The results revealed that surface area of a reservoir positively correlates with day visitation and camping. The results also showed that visitation and camping are higher during summer months (June, July, and August) than during other months and this may be due to recreation activities that are available at the reservoir during different seasons. Part of the benefits of the UEM is that it can be used to evaluate change in visitation between two reservoirs in deciding reallocation of resources including safety of dams modifications to maximize reservoir recreation benefits.

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Valuing the Monetary and Non-Monetary Ecosystem Services of U.S. Coral Reefs

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Coral reefs benefit society through various ecosystem goods and services, including seafood, coastal protection, cultural heritage, artistic inspiration, social connectedness through a sense of place, recreation opportunities, and tourism attractions. However, coral reefs are experiencing unprecedented pressure and destruction from increasing population, coastal development, land-based pollution, climate change, coral bleaching, and coral disease. These complex issues can be addressed through evidence-based policies, which aim to conserve and restore coral reefs, and merit answers to critical questions such as: How much are coral reefs worth to society? What ecosystem goods and services are provided by U.S. coral reefs, and who benefits from them? What are their quantitative or qualitative values, and what are the most appropriate ways to express these values?

The NOAA Coral Reef Conservation Program, with support from the NOAA Office for Coastal Management and Eastern Research Group, seeks to answer these questions through a five-year comprehensive valuation of the ecosystem goods and services provided by U.S. coral reefs in American Samoa, the Commonwealth of the Northern Mariana Islands, Florida, Guam, Hawai`i, Puerto Rico, U.S. Virgin Islands, Pacific Remote Island Areas, and Flower Garden Banks. This project also engages local stakeholders to ensure the inclusion and representation of diverse local values, including cultural values. While many cultural values have not been historically included in these types of studies, this project is exploring new ways to incorporate them for a more complete understanding of the value of coral reef ecosystems.

This presentation will discuss the results from Florida and Hawai'i. It will also include lessons learned from the project thus far. Discussion will highlight the integration of economic, social, and cultural dimensions of ecosystem goods and services, and connections to ecosystem conditions and a changing climate.

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Understanding and Supporting Cultural Ecosystem Services for Positive and Enduring Wildlife Conservation and Community Outcomes

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This chapter of the proposes a transformative shift in wildlife conservation emphasizing the cultural and spiritual ties between communities and nature and particularly between people and wildlife for conservation. It introduces a conceptual framework drawn from diverse case studies worldwide spanning India, Central Asia, and the Democratic Republic of Congo, and demonstrates how ancestral, spiritual, and cultural connections with key species as forms of CES can foster inclusive community ownership of conservation efforts. This conceptual framework advocates embracing various knowledge systems beyond conservation biology, identifying cultural keystone species, understanding their ancestral significance, and nurturing spiritual bonds with them. These elements cultivate stronger community ownership, which is essential for sustainable conservation outcomes. The chapter offers tangible recommendations for practitioners, including considering cultural contexts, actively listening, respecting diverse viewpoints, and using storytelling to enrich existing knowledge systems.

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National Accounting for Wild Pollination in the United States

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National environmental-economic accounts can provide regularly updated information to public and private-sector decisionmakers that is accurate and persistent through time. The U.S. has produced pilot natural capital accounts for land, water, urban, forests, and ecosystems to advance our understanding of how biophysical and socioeconomic systems interact with one another, as called for in the *National Strategy to Develop Statistics for Environmental-Economic Decisions*. Pollination accounts, which quantify the value that wild pollinators and their habitat provide to commercial crops, fill a gap in the Nation's natural capital accounts, which we present here for the years 2008 to 2020 in 3-year increments.

We used data from the National Land Cover Database, Cropland Data Layer, and National Agricultural Statistics Service on price and yield for pollination-dependent crops as inputs to a widely applied model of crop pollination. The model's logarithmic decline function calculated the values of habitat sustainability and floral resources. We summarized results into supply and use tables compliant with the System of Environmental Economic Accounting for states, counties, and protected areas in the coterminous U.S. Our work shows a substantial increase in pollination value from 2008 to 2020, from $6.7 to $10.3 billion per year. Nationally, for the year 2020, around 78% of value is provided by agriculture, 17% by forests, grasslands, shrublands, and wetlands, and 5% by developed lands, though these vary substantially at the state level. Soybeans, almonds, and apples accounted for about two-thirds of the total value of crops benefitting from wild pollination. The top five states benefitting from wild pollination included California, Washington, Michigan, Texas, and Illinois. The model code and data for the pollination accounts are planned for public release upon their completion, further facilitating their reuse.

These pollination accounts provide a unique opportunity in the natural capital accounting space by reporting results at multiple scales – national, state, county, and protected areas. Like all accounts they disaggregate results by ecosystems supplying the service and economic industries benefitting from them. Results highlight the importance of pollinator services to the national economy and allow for various users to benefit from data specific to their region of interest, building our understanding of how pollinators benefit our economy and society.

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Training Culturally Responsive Leaders for Managing Resilient Forests

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Managing resilient natural and agroecosystems with a diverse and adaptable workforce is the major focus of the USDA's strategic goals. However, minority representation in forestry remains the lowest among the disciplines within Targeted Expertise Shortage Area (TESA) areas. We have developed pathways and programs to support, produce and retain the next generation of science leaders who can bring diverse cultural perspectives to improve quality of decisions in public land management agencies, as well as diversity, equity, inclusion, and justice in TESA areas. We are doing this by building culturally responsive undergraduate and graduate training programs to expand representation in forestry graduate education and the workforce. At the undergraduate level we are helping students identify careers in forestry through career panels, pathway talks and field trips. We are providing relevant paid internships and recruiting into graduate programs with funding through USDA and the Sloan Foundation. In these programs, we focus on helping fellows develop dual cultural and scientific identities that align personal and professional values and offer experiential learning in the process of developing research projects and collaborations. Fellows meet weekly with each other and mentors to create trust and community and to work towards these goals while keeping on track in their graduate programs. Fellows develop a graduate career development plan with their academic and professional mentors and check in regularly to reassess. Fellows listen to pathway talks from people in various forestry related careers and read and discuss issues around equity in science and management. We also involve families in the program, inviting them to participate in relevant class discussions and or an annual symposium and round table. Building culturally responsive, funded programs to train and support students in forestry related fields at different levels has the potential to improve equity and representation in the workforce, leadership and higher education.

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Model to Mishap: Making a Case for Protection of Water Quality in Southwest Florida

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Southwest Florida's prosperity and allure hinge critically on the health of its water resources, which transcend both geographic and political boundaries. Beyond environmental concerns, pristine waters underpin every facet of life in the region—from tourism and job creation to recreational activities and property values. Despite widespread acknowledgment of water's pivotal role in the economy, its quality continues to deteriorate. In 2011, Florida's legislature made significant changes that resulted in fewer checks and balances over local planning decisions, making it more challenging for citizens to participate in the process. Concurrently, harmful algal blooms such as blue-green algae and red tides persistently ravage local ecosystems, disrupting industries and compromising the area's ecological resilience. Florida has made significant investment in restoration but on the other hand poor land use decisions and wetland loss have had substantial negative impacts.

Harmful Algal Blooms, like blue-green algae and red tides, continue to decimate our waters. Severe events, such as the 2018 bloom, disrupted local industries, marred the natural beauty, and raised alarming concerns about the ecological future of the region. Our region suffers from smaller yet still impactful events on an annual basis. Each occurrence harms our environment, damages our economy and weakens our ecosystem's ability to bounce back. These blooms serve as a stark reminder of the fragile balance between nature and human activities. But what does our economy actually lose when we have severe water quality events?

In response to these challenges, Captains for Clean Water, Conservancy of Southwest Florida, and Sanibel Captiva Conservation Foundation commissioned Greene Economics to quantify the economic toll of degraded water quality. This comprehensive analysis translates ecological degradation into tangible economic terms, highlighting the profound implications for the region's future. This recognition of the ecosystem service value underscores the urgent need for concerted action—both in safeguarding existing water resources and restoring those already compromised. This study serves as a clarion call to the public, elected officials, and community leaders, urging proactive measures to protect and sustain Southwest Florida's economic and ecological well-being.

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Farming for Future: Integrated Interventions to Improve Student Success and Experimental Learning in Controlled Environmental Agriculture

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The collaborative project between two campuses of Inter American University of Puerto Rico in Barranquitas and Aguadilla, in partnership with Purdue University and Corteva Agrisciences, is committed to advancing the goals of the USDA-HSI program. It aims to attract and support undergraduate students from underrepresented groups, preparing them for careers in agricultural sciences and enhancing the quality of university education. Puerto Rico imports over 80% of its food products. The vulnerability of the island's supply chains, which became evident during recent natural disasters, highlights the increased need for food security. In recent years, the field of agriculture has undergone a transformation driven by technological advancements aimed at increasing productivity, sustainability, and efficiency. One such advancement is precision agriculture, a practice that integrates technology and data analytics to optimize agricultural production. Academic offerings and training in the field of precision agriculture in Puerto Rico are still in their infancy. Therefore, our project aims to develop a workforce with expertise in precision agriculture by attracting and supporting undergraduate and graduate students from underrepresented groups. This will be achieved by developing new academic programs in precision agriculture, strengthening the plant biotechnology graduate program, and providing experiential learning experiences in industries for students. Additionally, the project seeks to maximize its outreach potential with an off-campus training facility for local communities in the form of an Agricultural Mobile Laboratory. Thus far, our project has enhanced educational and training opportunities, impacting over 1200 K-12 students, providing experiential learning to 43 students, and creating academic programs in precision agriculture. This initiative has facilitated the development of a potential agricultural workforce with the necessary knowledge and skills, aligned with the core aims of the NIFA-USDA program, and the establishment of agricultural educational programs in rural regions of Puerto Rico.

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Coupling Soil Hydrology and Carbon Process-Models to Transform the Accuracy of Greenhouse Gas and Water Co-Benefits of Applying Nature Based Solutions to AgroEcosystems

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Agricultural systems present both major challenges and opportunities to managing water availability, water quality, and greenhouse gas balance. All of these issues depend on processes within soils, yet most agricultural production models that we routinely use to manage water and carbon have simplistic representation of processes within soils, based on the state of knowledge developed 20-30 years ago. The science has advanced substantially. In particular, in recent decades there has been a paradigm-shift in our understanding of soil carbon stabilization mechanisms. Similar advancements have been made for soil hydrology. Process-based models have been developed that represent our new understanding, and because these models are based on measurable soil parameters, they have consistently out-performed the early generation of models that are still our agricultural production and watershed models. It is time to incorporate our collective understanding into the models we use for management. We lay out a practical roadmap to make such a transformation quickly to meet societies many urgent needs.

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Accounting for Hazards and Natural Capital Within the U.S. Natural Capital Accounting System

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Disasters caused by natural hazards are becoming increasingly costly due to rising exposure of people, property, and infrastructure within hazard-prone regions, exacerbated by climate change. Historically, quantification of hazard impacts has focused on damage to the built environment, with more recent emphasis placed on impacts to human capital. However, hazards—both natural and anthropogenic—also destroy the natural capital on which we depend. Importantly, natural capital can also mitigate some types of hazards; for example, healthy coral reefs and forests can mitigate the effects of storm surges and extreme wildfire, respectively.

Despite the high profile and significant costs of disasters globally, an explicit linkage between hazards, natural capital, and the economy does not appear in official accounting standards such as the System of National Accounts (SNA) nor the System of Environmental-Economic Accounting (SEEA). Recognizing the need to systematically integrate and report on data linking extreme weather, hazards, and the economy, the U.S. *National Strategy to Develop Statistics for Environmental-Economic Decisions* supports the creation of a thematic account for "Natural capital-related hazards, extreme weather and climate events, and resilience."

The Natural Hazards Account will coordinate and broaden existing U.S. government data collection efforts to address: (1) the impact of hazards on natural capital stocks and (2) the hazard-mitigation benefits provided by natural capital. In this presentation, we will describe six recommendations for U.S. Natural Hazards Accounts, the planned content of these accounts, and opportunities for hazards and ecosystem services researchers to contribute to the construction of Natural Hazards Accounts.

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Receptivity to Diverse Cultural Benefits Knowledges in the Glen Canyon Dam Adaptive Management Program

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Adaptive management is envisioned to improve management of complex social-ecological systems through reduction of uncertainty about ecosystem structures and processes. Adaptive management can work particularly well in systems with high controllability, in which managers can engage in experimental management actions and evaluate which actions offer the best outcomes. In this sense, learning in adaptive management has historically focused on single-loop, technical learning to reduce structural uncertainty about how ecosystems function and how ecosystems processes respond to management actions. However, challenges in implementation of adaptive management increasingly call attention to a wider suite of socio-political uncertainties, beyond and intertwined with structural uncertainty, that also need attention to achieve successful (equitable and accurate) management outcomes. These include linguistic, ethical, and institutional uncertainties, as well as deep uncertainty around, for example, multiple valid worldviews and associated values used to define management success.

Traditional approaches to experimentation in adaptive management are not sufficient to reduce these broader socio-political uncertainties. Reduction of these additional uncertainties requires increased emphasize on deliberative (double-loop and triple-loop) learning in adaptive management, alongside technical (single-loop) learning. Adaptive management is inherently a social learning process, with iterative cycles of structured decision-making, learning, and adjustment involving diverse stakeholders and rights-holders over time. This social learning context increases potential for double-loop and triple-loop learning outcomes. However, adaptive management practitioners need tools and processes that can systematically facilitate double-loop and triple-loop learning.

In this presentation, we explore the potential of one social learning tool to help reduce deep uncertainty around the well-being(s) of diverse stakeholder groups: the Cultural Benefits Learning Framework (CBLF). This framework supports systematic recognition of benefits knowledge across groups of stakeholders and rights-holders, and the identification of opportunities for diverse knowledge forms to support double-loop learning at all stages of adaptive management. We introduce overarching steps of the CBLF, including to clarify context, characterize knowledge systems, identify knowledge-forms, and outline opportunities-in-context. In addition, we share examples of what more meaningful consideration of diverse benefits knowledges may mean in practice in environmental management programs, such as the Glen Canyon Dam Adaptive Management Program.

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The Bengal Tiger of the Sundarbans: Conserving Endangered Species to conserve Ecosystem Services threatened by Climate Change and Human Activity

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The Bengal Tiger of the Sundarbans, the mangrove forests between India and Bangladesh, is a globally and regionally endangered species with the 200 individuals remaining managed separately by the two countries. Apart from the challenges of adapting to an island and estuarine habitat, the mangrove tiger faces a variety of threats including habitat destruction, tiger-human conflict, lack of prey species, and climate change. The area is a biodiversity hotspot and includes about 76 species of mangrove plants and several endangered and threatened species such as the tiger, Ganges River dolphin, gharial (fish-eating crocodile), and the fishing cat. It caters to two valuable commercial fisheries, the hilsa and the tiger prawn, contributes substantially to state tourism, and provides many valuable ecosystem services such as fisheries, forest products such as timber and honey, nursery services, pollination, water filtration, recreation, hydroelectric power, and storm barrier for the nearby cities. However, these ecosystem services are characterized by degradation from pollution, impacts of climate change, and unsustainable use, the latter owing to the area's high human density comprising low-income groups featuring income-based exploitation and environmental justice concerns. The tiger is dependent on the landscape for its continued survival but the landscape itself including the mangrove ecosystems, species communities, and services are dependent on the continued survival of tigers. In this paper we analyze the links between the tiger and its landscape showing this interdependence and make the case for tiger conservation as a more cost-effective solution to protecting this landscape compared to strategies targeting individual species. We provide recommendations for conservation strategies that account for tiger-human conflict, and climate change.

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The Water Quality Index: Bringing Water Quality to the Table

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The USEPA uses a water quality index (WQI) as a key part of an integrated modeling approach to evaluate changes in water quality from policy actions. The WQI is a multi-metric index comprised of commonly measured water quality parameters. Estimated changes in these parameters are used to calculate WQIs for policy scenarios, which are compared to baseline WQIs to show the overall change in the average WQI score for waterbodies regionally or nationwide. These WQI score changes are then used to estimate corresponding household willingness-to-pay values, essential for estimating benefits. The WQI has been used in several Clean Water Act rulemakings.

The WQI is an important tool for helping the agency meet the goals of the Clean Water Act. Clean water is a key ecosystem service fundamental for human well-being, and faces major challenges including climate change, emerging pollutants, and increased human activity, which in turn worsens pressure on aquatic habitats and environmental justice. Assessing these challenges requires a comprehensive, consistent, and quantifiable method for measuring water quality. The current WQI while useful, has limitations in distinguishing changes in water quality and benefits associated with different types of waterbodies and uses, and in being sensitive to the impacts of climate change.

In this paper, we present an overview of the current WQI and note its advantages and limitations. We examine potential improvements to the existing WQI, such as having separate WQIs for (1) different types of waterbodies: rivers and streams versus lakes and reservoirs, (2) different types of uses: use values versus non-use values, and (3) having a WQI responsive to climate change.

We present a new use-based WQI as an approach to resolve some of these limitations. The use-based WQI is comprised of use-specific subindexes (SIs) for recreation, ecological, drinking water, and fish consumptive uses developed by econometric modelling applied to data on state and national water quality monitoring and associated criteria. While the SIs can be aggregated into a single general WQI, individual SIs can also be used to assess potential waterbody impairments or linked to use-specific valuation functions.

Because the SIs represent a use and not a specific parameter, our use-based WQI is highly flexible, with input parameters and criteria tailored to individual state monitoring programs and may improve upon the existing WQI to better inform future policies.

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USDA-NRCS and the Inflation Reduction Act

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The Inflation Reduction Act of 2022 represents the single largest investment in climate and clean energy solutions in American history. It provides $19.5 billion from fiscal years 2023 through 2031 for implementation of climate smart agriculture conservation practices through four popular private lands conservation programs that USDA's Natural Resources Conservation Service (NRCS) administers.

Through this generational investment, NRCS is increasing Climate-Smart Agricultural and Forestry Mitigation Activities eligible for Inflation Reduction Act funding. These in-demand activities are expected to deliver reductions in greenhouse gas emissions or increases in carbon sequestration as well as significant other benefits to natural resources like soil health, water quality, pollinator and wildlife habitat and air quality.

Bringing the Community Capacity into Conversation with Ecosystem Services and Equity in Great Lakes Coastal Communities

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Research and policymakers have engaged the concept of community resilience when planning how to best support communities experiencing environmental or social change, including those related to environmental remediation and habitat restoration in the Great Lakes coastal communities. Community resilience emerges from social ecological systems studies and resilience thinking and has generally been applied to how communities respond to natural disasters. As with many systems approaches, scholars have started to introduce conceptual models integrating more social science with resilience to identify human capacities for adapting and working toward a better quality of life for all members. Frameworks struggle, however, to incorporate the human-environment linkages between ecological health and human well-being and account for the influence of power and equity on communities' capacities, resources, and health.

To bridge these gaps, we review and integrate insights from three literatures with the concept of community resilience: ecosystem services, public health, and environmental justice. As a result, we embrace the concept of community capacity from public health scholarship and leverage ecosystem services benefits as the linkage to social ecological well-being. We integrate environmental justice insights to address issues of power and equity. In our analytical framework of community capacity, we bring ecosystem services into conversation with community resilience, and advance scholarship on social ecological systems generally. Importantly, this paper forms the conceptual foundations for work to better understand community capacity and how to best recognize and support community's priorities for resilience.

We intend this framework to support efforts to coproduce knowledge and research to enhance social and ecological well-being outcomes in Great Lakes coastal communities. We apply community capacity to case studies of Great Lakes Areas of Concern involved in remediation and restoration projects. More narrowly, we discuss how recognizing and engaging community capacity of local groups in the Great Lakes may be facilitated through conversations about desired and current benefits of ecosystem services.

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Enhancing Agri-Education and Diversity Through Multistate Collaborative Approach

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For the past two decades, Florida International University's Agroecology Program has fostered equitable access to affordable agricultural education for underserved students. In this presentation, we highlight our collaborative strategy, institutional commitments, stakeholder participation, and students' success.

Leveraging over 40 competitive grants from various agencies within the US Department of Agriculture, we collaborated with local and regional institutions, farmers, private industries, and foundations. We established two major consortia of Hispanic-Serving Institutions and Historically Black Colleges and Universities across Florida, Puerto Rico, Texas, Louisiana, and New Mexico.

The interdisciplinary curricula cover critical disciplines such as agroecology, environmental sciences, plant protection, horticulture, farm economics, water, soil resources, agroforestry, remote sensing and precision agriculture, and food supply chain. The Program enables pathways from high school to graduate school through mentoring, scholarships, internships, and experiential learning. Students benefit from industry exposure through travel, symposium, conferences, and international field courses, leading to valuable contacts for post-graduation employment.

The Agroecology Program has made remarkable impacts on students and agriculture sector. First, the program has increased diversity and success for minority students. Minority students routinely publish research, secure USDA positions, and excel in national competitions. Agriculture students at our University graduate on average in 4.8 years. Second, many of our students secure positions with the United States Department of Agriculture (USDA). Their training during the program equip them with the skills needed for impactful careers in agriculture. They, in turn, contribute to the USDA's mission, addressing critical issues related to food and agriculture Third, our program actively fosters a pipeline from high school to graduate school. Through mentoring and scholarships, students smoothly transition from one educational level to the next. Fourth, by integrating scientific and analytical skills into our curricula, the program prepares students for advanced studies and research opportunities. In summary, the FIU Agroecology Program not only promotes access for minority students to education and career, but also contributes to scientific workforce that can address the nation's agricultural issues.

Planting Green to Improve Ecosystem Services in Row Crop Production Systems

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Delaying cover crop termination until or after crop planting, known as planting green, could boost cover crop biomass production and ecosystem services relative to the traditional cover crop termination (usually 1-3 weeks before crop planting). Yet, this potential has not been widely discussed. We reviewed literature to compare cover crop biomass production, soil erodibility, soil water, soil C accumulation, nitrate leaching, weed suppression, insect population, disease and pest incidence risks, and crop yields between planting green and traditional cover crop termination. Most planting green studies are from U.S. temperate regions and short term (< 3 yr). Literature indicates cover crop can produce about three times more biomass in planting green than in the traditional cover crop termination. Cover crop biomass under planting green can accumulate at a rate of 0.134 Mg/ha of biomass per day. Planting green does not seem to rapidly sequester large amounts of soil C and improve soil health based on the short-term studies. It is hypothesized that planting green can sequester soil C, promote population of beneficial insects, and improve other ecosystem services in the long term. However, cover crops in planting green can be highly effective at suppressing weeds. Their effect on disease and pest incidence is generally minimal. Crop yields do not always decrease with planting green. While N immobilization under the abundant cover crop residues such as grass cover crops can adversely affect crop production, planting green can increase yields of legume crops (i.e., soybean), in a few cases, by reducing weed population. Long-term (>10 yr) studies are much needed to better understand the implications of planting green on ecosystem services.

Leveraging Virtual Reality for Green Infrastructure Design: Implications for the Cultural Services Aesthetics & Sense of Place

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Urban green infrastructure such as bioretention cells (BRCs) provide nature-based experiences to urban residents who otherwise lack access to nature. These experiences are shown to have positive effects on physical and mental health, making them critical for human well-being. However, current BRC designs often prioritize hydrologic and water quality services over cultural services that foster a deeper connection to nature. Virtual reality (VR) tools can help surmount this design barrier. This project uses VR to evaluate the capacity of BRCs to provide two major cultural services: aesthetics and sense of place and identify key design features that influence their provisioning. Given that vegetation is the most visually obvious feature of BRCs and is easily manipulated during the design phase, our analysis focuses on plant traits, the spatial arrangement of plants within landscapes, and plant biodiversity as putative design features. Participants engaged in virtual walkthroughs of ten BRC models featuring different vegetative elements and were asked to consider either their attractiveness or the degree to which they stimulated place attachment, a key element of sense of place. They then constructed network models illustrating how various plant traits, landscape elements and other design features (e.g., engineered infrastructure such as overflow risers) were perceived to influence aesthetics or sense of place. Here we describe the results of this exercise, focusing not only on how BRCs were perceived (e.g., raw aesthetics and sense of place scores) but on which vegetative design decisions influenced perceptions the most. We draw specific attention to 1) vegetative elements that were variously perceived and the implications of that variability for future BRC design as well as 2) vegetative elements that were broadly influential and how those elements might be leveraged to improve cultural services provisioning for a range of community demographics.

The Value of Conservation: A Stated-Preference Study of Community Values and Priorities for Habitat Restoration Along the Pacific Flyway

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Within the United States, conservation decisions are made by both government and non-government management agencies. In these decisions, community member's voices and values are often left out. Individuals can indirectly influence these outcomes by voting, contributing time or money to relevant organizations, and advocating for change within their own communities. Given that, how can we uplift community voices and values to ensure that they are directly included in the decision-making conversation?

"The Value of Conservation '' examines residents' of the Pacific Flyway's sociological and economic values for conservation and uplifts those values directly into conversations where conservation decisions are being made. To accomplish this, we formed a two-part study to address the following questions:

Part One: How does the relationship dynamic between conservation agencies (such as the Forest Service) and the (human) residents of the Pacific Flyway inform public opinion of restoration? What role does this relationship play in developing community priorities for environmental policy?

Part One is addressed in a series of qualitative focus groups to understand residents' sociological value for conservation. By exploring their relationship to natural systems, value for ecosystem services, and opinions on resource management, we can better understand their perspectives and lived experiences.

These focus groups emphasize questions related to viewing humans as part of ecological communities, decision making in environmental management, and how we handle the inherent economic component of conservation. By including these qualitative conversations we seek to uplift community voices directly to decision makers, increasing inclusivity and collaboration in policy and decision-making. Final results for Part One will be presented.

Part Two: What is the economic value of conserving land along the Pacific Flyway (in the contiguous United States) to help increase migratory bird biodiversity and related ecosystem services?

Part Two is addressed with a stated-preference study of the economic value of habitat restoration along the Pacific Flyway. The survey mechanism values conservation by presenting residents with habitat restoration tradeoffs. This work uses stated preference tools to value a bundle: habitat, the associated biodiversity, and the resulting ecosystem services.

The goal of many habitat management efforts is to enhance the abundance and success of migratory bird populations; however, these habitats provide a bundle of ecosystem services (biodiversity, recreational opportunities, etc.). The survey instrument is designed to be inclusive of the wide range of values. The values from this study may be used to inform local and regional management decisions related to habitat preservation and restoration, wildlife management, and responses to other environmental threats from climate change. Preliminary results for Part Two will be presented.

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The Challenges of Valuing Ecosystem Services: Qualifying the Benefits of Science and Conservation

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Marine protected areas, including national marine sanctuaries, provide a suite of ecosystem services to people. NOAA's Office of National Marine Sanctuaries (ONMS) assesses a subset of these ecosystem services as part of its holistic assessment of sanctuary condition. One of the services assessed by ONMS is "science," defined as the capacity to acquire and contribute information and knowledge. Within the body of literature exploring ecosystem service assessment, there have been few studies related to the evaluation of science as an ecosystem service. ONMS has considered two primary approaches for such assessments. The first approach, which has been the primary method used to date, considers the capacity of the site's infrastructure resources (boats, buildings and lab equipment) and personnel to directly conduct and provide support for scientific research. A more traditional, and sometimes contrasting, approach to evaluating the ecosystem service of science is to assess whether the quality of sanctuary natural and maritime heritage resources provides adequate opportunities to gain information and knowledge. This presentation will focus on the proposed application of both definitions to evaluate the ecosystem service of science. A review of scientific projects and research conducted in the Great Lakes will be presented as a case study for evaluating science using both methods. Additionally, the results of a recent survey of researchers in Gray's Reef National Marine Sanctuary will be provided to show how surveying the beneficiary of the ecosystem service itself may inform the discussion.

Developing a Systematic Approach to Protecting Farmland and Ecosystem Services in the Western United States

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Every day, the U.S. loses 2,000 acres of agricultural lands to development. While it is not possible to protect all farmland from development, there is general agreement that we should try to protect high-priority agricultural lands. Agricultural and developed lands both provide a variety of benefits to humans, but how these competing land uses complement each other to provide a full suite of ecosystem services (ES) is not well-understood. Furthermore, little is known about how diverse stakeholders perceive farmland protection, which restricts our ability to design effective policy. Our research aims to fill these knowledge gaps. We present several years of research in the Snake River Plain region of southern Idaho, an iconic Western working landscape that provides diverse agricultural products and a variety of other highly-valued ES, including recreation and biodiversity habitat. Population growth stimulated by various factors, including urbanization, amenity-seeking, and agricultural industrialization, are leading to rapid rates of farmland loss and rural community change. We use spatial models, qualitative and semi-structured interviews, and policy analysis to measure and assess the various factors influencing farmland loss and protection. Our spatial models indicate that by 2050, 16-32% of the region's agricultural land will be developed. Furthermore, higher quality agricultural land is 15 times more likely to be developed than lower quality agricultural land. Agricultural lands provide a variety of ES in addition to food production, including species habitat, recreational opportunities, and nutrient retention, and optimization models indicate that with strategic planning, agricultural land protection could also further biodiversity and climate mitigation goals. Our social science results indicate that stakeholders involved in farmland protection have diverse views, and that targeted "framing", or messaging, about farmland protection could create opportunities for coordinated action across diverse stakeholder groups. Overall, our results indicate that the loss of farmland is an issue of concern both for continued ES provision and for the diverse stakeholders in the community, but our policy analysis indicates substantial barriers for action for farmland protection, therefore highlighting key areas for policy change. Our results can help guide strategic planning that considers both ecological and social factors around farmland protection.

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Integrating Natural Capital into the Financial Sector: Natural Asset Companies

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This presentation introduces the concept of Natural Asset Companies (NACs) to illustrate how natural capital is being integrated into financial products. As healthy, natural ecosystems become increasingly scarce, while knowledge about their foundational contributions to economic systems becomes more established, NACs are presented as an opportunity to invest directly in nature and recognize the tangible economic value ecosystems hold.

Although there are various mechanisms to fund conservation efforts, including carbon and biodiversity credits, debt-for-nature swaps, and payments for ecosystem services, a larger paradigm shift is needed to integrate natural capital more intentionally into financial decisions to incentivize long-term investments into natural capital. This presentation explores the vision for NACs to translate natural capital into financial capital that can then be leveraged to improve the long-term productive potential of ecosystems while creating new pools of value within a company's equity.

Key considerations addressed in the context of NACs and other existing vehicles seeking to promote natural capital include the durability of incentives, the role of global standards for natural capital accounting, property rights and legal frameworks, and the importance of social safeguards and participatory approaches.

By reviewing the opportunities and challenges faced by NACs, this presentation aims to provide a roadmap for how the financial system can evolve to support these types of initiatives. It will provide insights into the potential of NACs to transform the way natural capital is valued and managed.

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Towards Precision Ecotoxicology: Embracing One Health to Advance the Science and the Practice

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Common protection goals in ecological risk assessments include biodiversity and ecosystem services, but our future ability to meet these goals will rely on systems-based approaches where we leverage the genetics and informatics of species to better understand and manage the risks of global pollution. Though global chemicals production continues to outpace implementation of technologies and environmental management systems aimed at mitigating the impacts of chemicals and waste and realizing sustainable restoration activities, especially in urban regions, unprecedented advancements in comparative genomics and computational toxicology with data science are poised to fuel a new age of ecotoxicology. Developing precision ecotoxicology will decidedly be nontrivial, but will inherently leverage advances in mechanistic, computational and evolutionary ecotoxicology, molecular ecology and systematics, and precision medicine and environmental health science to identify susceptible species and ecosystems. Advances in eco-exposomics and precision exposure science promise to accelerate development of precision ecotoxicology and its translational applications, including intersections with green and sustainable chemistry and engineering, to advance the science and improve the practice of environmental science and technology. Doing so further promises reciprocal benefits to the environment and public health, particularly by embracing One Health.

Environmental Accounting and Measuring Change and Improvement

Susan Burke
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In 2020 Paul Krugman wrote an opinion piece in the New York Times entitled Gross Domestic Misery is Rising. His point was that familiar economic indicators like GDP, stock market indices (DOW, S&P, etc.) and the jobs report do not really measure whether people's lives are getting better and sometimes gloss over the fact that peoples' lives are getting worse. Krugman and other economists are attempting to device economic indicators to enhance our ability to measure whether people's lives are getting better. One approach to improving our measurement tools includes efforts to link economic and environmental information into a framework to measure the condition of the environment, the contribution of the environment to the economy and the impact of the economy on the environment.

This session will present an overview of the efforts to revise our economic and environmental accounting measurement tools. Including but not limited to effort to measure Green GDP, the United Nations development of the System of Environmental Economic Accounting and the United Nations global indicator framework for the Sustainable Development Goals. Specifically, how do these efforts differ, what progress is being made and what data is needed?

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Spatial Patterns and Interactions Among Multiple Cultural Ecosystem Services Across Urban Greenspaces

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Urban greenspaces (UGS) deliver substantial benefits to human wellbeing by providing valuable ecosystem services. Prior research on UGS has been primarily focused on provisioning and regulating services, with less efforts on cultural services (CES), presumably due to methodological challenges in their quantification and characterization. Social media data have emerged as novel datasets that could provide new insights into the quantification of these intangible but critically important CES. In this study, using Broward County (Florida, USA) as a case study that has been experiencing rapid and accelerated urbanization, we merged different platforms and datasets, including TripAdvisor and Google Maps, to map and quantify the spatial distribution of 11 CES. Employing named-entity recognition models, this study extracted 60,156 textual entities related to CES from scraped reviews, allowing us to categorize 30,599 reviews into different CES types across 426 urban greenspaces. Our research demonstrated substantial spatial heterogeneity in the presence and diversity of CES, identified six key CES bundles, and further revealed more occurrences of CES synergies than tradeoffs across UGS. Geographical random forest models were applied to determine the relative importance of natural landscape elements, biodiversity proxies, and human utility metrics in explaining the spatial heterogeneity of CES. We found that factors such as greenspace size, tree cover percentage, biodiversity, and water features emerged as strong predictors of CES provision. Our study provides a roadmap and research framework for understanding and quantifying CES in urban settings and has implications for the sustainable planning and management of UGS to improve social wellbeing through the contribution of multiple and diverse CES.

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Inflation Reduction Act Investments in Urban and Community Forestry

Nausheen Iqbal *Presented by:* ***Dana Coelho***
USDA Forest Service, Washington, DC, USA

The Urban & Community Forestry (UCF) Program of the USDA Forest Service is the only federal program dedicated to growing and maintaining urban trees, forests, and green spaces where 84% of Americans live, work, and play. Authorized under the Cooperative Forestry Assistance Act of 1978, the UCF Program assists state forestry agencies and partner organizations in applying nature-based solutions to chronic and emergent economic, social, and environmental challenges. Traditionally operating at $36-$40 million per year, including a $1 million per year competitive grant program delivered in collaboration with the National Urban & Community Forestry Advisory Council, the UCF Program has focused on building and sustaining state forestry agency capacity to support community-based efforts.

In response to increasing demand for the life-saving benefits of urban trees, the Inflation Reduction Act (IRA) has forever changed this landscape and fostered an historic investment in the UCF Program -- $1.5 billion going to tree planting and related activities in urban areas with a priority on serving disadvantaged and overburdened communities. In April 2023, the UCF Program announced a $250 million investment in state forestry agencies and launched a $1 billion competitive grant program. In September 2023, the UCF Program announced nearly 400 awards to community-based organizations, government agencies, public colleges and universities, and nonprofit organizations in all 50 States, the District of Columbia, U.S. Affiliated Pacific Islands, and several Tribal Nations.

Now in the process of implementing funded projects, these partners are working hard to provide equitable access to trees and nature and the benefits they provide including:

- Increased tree canopy -- planting, monitoring, and long-term maintenance of environmentally adapted urban trees supports climate resilience and reduces the impact of extreme heat.
- Workforce development – creating and sustaining living-wage jobs in green industries protects urban tree canopy and fosters community resilience and prosperity.
- Community engagement – empowering communities to participate in urban forestry planning informs and improves decision making by diversifying the perspectives and voices considered.

BlueValue: A Searchable Database of Ecosystem Valuation Information

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The natural world supports, sustains, and enriches human life in numerous ways. Scientists and resource managers refer to these benefits as "ecosystem services". The newly updated Bluevalue (www.bluevalue.org), previously known as GecoServ, is a searchable online database of ecosystem service valuation studies relevant to coastal habitats in the Gulf of Mexico region. Although ecosystem services are critical to human well-being, cases in which they have been successfully applied to real policies and decisions are rare. For society to make informed decisions about sustainable use of the environment, directly linking the valuation — or quantification — of ecosystem services to society's needs, is necessary. Bluevalue is that link. Many scientists, economists, practitioners, and others around the world have conducted ecosystem valuation studies. However, it can be difficult and time-consuming for decision-makers to find and access the results of those studies. Bluevalue offers quick and easy access to actual ecosystem values in numbers. It houses literature from around the world that users can download, cite, bring to meetings, and share with others. Data stored in Bluevalue can be used to inform management decisions when the option to conduct a primary valuation study is not possible due to monetary or time constraints. The main goals of Bluevalue are to allow for the distribution and sharing of information on ecosystem service valuation, facilitate the application of the value transfer methodology, help managers include ecosystem services in the decision-making process, and identify current gaps in ecosystem service literature. The Bluevalue database is an international powerhouse of information concerning the economic value of coastal habitat ecosystem services. The previous version was GecoServ (Gulf of Mexico Ecosystem Services Valuation Database), which was originally launched in 2011 and was supported by the United States Environmental Protection Agency's Gulf of Mexico Program, National Oceanic and Atmospheric Administration (NOAA), and the Harte Research Institute for Gulf of Mexico Studies. The tool's geographic area is focused on worldwide data. The tool was initially intended for use by audience in the Gulf of Mexico, but now has international use.

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Wetlands of the Northern Ridge and Valley: Possible indicators of Effects of Climate Change

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Much attention has been given to wetlands throughout the United States on issues ranging from aerial loss to the legal definition of waters of the United States. Recently, there have been several examples of the impact of loss of wetlands on humans, from the devastation from Hurricane Katrina to the complexities of the mismanagement of the Everglades. Less attention has been given to smaller wetlands in less populated areas. I describe an ongoing study on 9 wetlands in the Ridge and Valley Province of Pennsylvania that picks up on a longer-term assessment of those same sites. This subsequent study looks possible changes in site hydrology, soil characteristics, and plant community composition as a means of assessing long-term changes as a result of changing climatic conditions. As these types of sites sit in the upper drainages of major river systems down in the coastal regions, any ecological changes in the mountain regions will likely result in changes lower down a watershed.

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Context Matters: Adapting Vegetation Management Strategies to Various Forest Types

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Forests constitute a multi-billion dollar national resource in natural product, recreation, and ecosystem service valuation. Managing sustainability in these forests requires ensuring recruitment of dominant tree species (e.g., oaks) and maximizing understory plant biodiversity. A practical challenge is that because these forests occur in different landscape contexts (e.g., forests surrounded by urban development or agriculture), they may require different approaches to maximize tree recruitment and understory plant diversity. For example, the utility of common management techniques (e.g., removing invasive woody shrubs) may differ among forests situated in different landscape contexts, but little research has compared whether the outcomes of common management techniques differ depending upon a forest's landscape context. Our project used large-scale experiments across 16 deciduous forest sites in Wisconsin to evaluate how invasive shrub removal and exclusion of herbivores modify tree seedling establishment and understory plant diversity in forests situated along a rural-to-urban gradient.

Our findings strongly support invasive shrub removal as a management practice in upper Midwestern deciduous forests, but also highlight how the effect of shrub removal on plant recruitment corresponds with surrounding landscape context. When invasive shrubs were removed in rural and urban forests, planted oak seedlings exhibited >35% greater survival five months after planting; shrub removal did not affect oak seedling survival in agricultural adjacent forests as survival was high (~85%) regardless of shrub removal. Our work implicates large herbivores (i.e., white-tailed deer) as a driver of this oak mortality: fencing seedlings improved oak seedling survival by ~50% in situations where oak survival was otherwise low (e.g., urban forests without shrub removal). Understory plant species richness also increased rapidly in response to the removal of invasive shrubs, and the magnitude of the response depended upon forest type. For example, removal of invasive shrubs in urban forests doubles native understory plant diversity 12 months post-removal, whereas native understory diversity increases by 40% and 24% in rural and agricultural-adjacent forests, respectively.

Our work emphasizes that the design of land management plans can and should consider how landscape context affects the extent to which common forest management practices help meet plant regeneration objectives.

Forest Management Impacts on Ecosystem Services–A Bayesian Belief Network Approach

Kathleen Conroy[1]*, Francesco Martini*[1]*, Mary Kelly-Quinn*[2]*, Yvonne Buckley*[1]*, and Jane Stout*

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Forests provide a vast number of services that are essential to life on Earth. Nearly reduced to a forest-barren country, Ireland is now experiencing the highest forest cover in centuries. This was achieved by a combination of afforestation and reforestation of reclaimed or degraded land. Being a mixture of publicly and privately owned, Irish forests are fragmented and experience a variety of management methods and objectives. Some stakeholders will be using their forests for timber production, while others may want to invest in restoration efforts, and some others may want a combination of maximizing profit and maintaining the value and integrity of their forests. However, due to the many, interrelated variables involved and their connections, measuring ecosystem services and assessing the trade-offs is important as improper management may lead to degradation and ecosystems may no longer provide services or the services may become more limited.

Probabilistic graphical models, such as Bayesian Belief Network (BBN) models, are a useful tool to understand dependencies between variables. In a BBN model, variables are represented as nodes, and they are connected by lines known as arches; the variables' impact on each other is captured in the accompanying probability tables. The relationships and connections made within a BBN can be used to drive decision-making. A BBN model was created to connect forest management decisions and ecosystem services through a series of workshops with key stakeholders. The model included: four ecosystem services (global climate regulation services; wild animals, plants, and other biomass provisioning services; recreation-related services; and wood provisioning Services), four management decisions, thirty-one site-specific characteristics. This led to a total of seventy-one model variables (i.e., nodes) and over one hundred relationships between the variables (i.e., arches). The results of this model will help land managers make data-driven decisions on the delivery of desired ecosystem services.

An Overview of the HAWQS and BenSPLASH Tools: Development and Use

Joel Corona *and Julie Hewitt*
Office of Water, United States Environmental Protection Agency, Washington, DC, USA

The United States Environmental Protection Agency developed two models that can be used together as a water quality integrated assessment model. The Hydrologic and Water Quality System (HAWQS) is a web-based interactive water quantity and quality modeling system that simulates the effects of management practices on key water quality parameters. The Benefits Spatial Platform for Aggregating Socioeconomics and H_2O Quality (BenSPLASH) model is a desktop-based tool designed to quantify the economic benefits of changes in those water quality parameters. HAWQS and BenSPLASH can work independently or together depending on the targeted analysis. They each provide national data layers and modeling capability to facilitate the analysis of water quality impacts in the lower 48 states. Together they offer the ability to streamline the analysis of how policy actions impact water quality at the national, subnational, and regional levels, and help inform decisionmakers and the interested public in a timely manner.

Both tools have benefited from recent upgrades that will improve the ability for analysts to provide useful information on water quality impacts and benefits to stakeholders. HAWQS has improved capabilities to measure the impact of wetlands, model water temperature, track point sources, and model at higher resolutions. BenSPLASH has new capabilities to report out on uncertainty and analyze environmental justice and the distributional impacts of benefits, as well as updates to existing valuation approaches.

This presentation will serve as an overview for both models, demonstrate recent improvements, and highlight future development plans, which will in turn set the stage for other session presentations to focus on particular valuation approaches.

Disclaimer: The views expressed in this document are those of the author(s) and do not necessarily reflect the views or policies of the United States Environmental Protection Agency.

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Increasing Accuracy of National-scale Urban Ecosystem Service Accounts

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The journey to producing national-scale ecosystem service accounts for all U.S. urban areas involves many critical steps. These include identifying and creating national-scale data sets, validating those data sets, and incorporating these new data into novel urban ecosystem service models that are reflecting underlying ecological and socioeconomic processes and compatible with environmental-economic accounting principles. As part of the interagency Natural Capital Accounting (NCA) project, the U.S. Geological Survey and other agency and academic partners aim to produce a series of urban ecosystem service models that quantify the supply, demand, and value of urban ecosystems for every city in the country.

To achieve this goal, we have created a corrected urban tree canopy cover data set for all urban areas in the conterminous U.S. Previously available national-scale tree canopy data, such as those from the National Land Cover Database (NLCD), are well-vetted and periodically updated products but significantly underperform in urban settings. Our team has developed an "urban-corrected" data set that enhances urban tree canopy predictions by integrating both high-resolution and NLCD tree canopy data. This product provides a more accurate view of the current and past condition of the nationwide urban tree canopy. To evaluate the impact of our new data set, we rigorously tested the sensitivity of urban ecosystem service models across 151 U.S. cities. This analysis will help us to better understand and quantify the underestimation from prior urban ecosystem service accounts which relied primarily on NLCD and ancillary data sets.

With this new urban tree canopy data set and ancillary data, including the Protected Areas Database of the U.S. (PAD-US), we have adapted four ecosystem service models for urban NCA to quantify the physical and monetary value of these services: 1. heat mitigation, 2. rainwater infiltration, 3. carbon sequestration, and 4. access to public green space. Using our national-scale data sets, we can assess the supply, use, and value of these services across different ecosystem types, industries, and population demographics. The valuation will also provide a more accurate monetary estimate of the value of urban trees and greenspaces, which can be used by local stakeholders and Federal agencies working to implement the National Strategy for Environmental-Economic Decisions.

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Ecological and Socio-Economic Valuation of the Ecosystem Services Provided by a Multifunctional Green Infrastructure for Flood Mitigation

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Old Dominion University, Norfolk, VA, USA

Compared to traditional grey infrastructures, nature-based solutions (NBS) offer a multifunctional approach to address climate change and other environmental challenges. A robust evaluation of their effectiveness and a comprehensive assessment of the ecosystem services and benefits to people and nature are crucial for integrating NBS into cross-sectoral projects and policy development. This study aims to evaluate the full spectrum of co-benefits that a NBS project can provide, ensuring that investments are both economically sensible and environmentally beneficial. This study evaluates the co-benefits of an NBS project implemented by the City of Virginia Beach (VA, USA) as part of their Flood Protection Program, which transformed a city-owned golf course into a multi-faceted stormwater park. This park not only aids in flood mitigation but also restores natural systems and offers both active and passive recreational spaces. We identified and quantified four ecosystem services provided by this conversion: stormwater storage and flood mitigation; mitigation of the urban heat island effect; enhancement of pollinator abundance; and environmental amenities, such as aesthetic views and proximity to recreational sites. These services are crucial for a comprehensive evaluation of the impacts of this NBS, covering flood mitigation, wildlife support, and human benefits.

Results from the Hydrologic and Hydraulic (PC SWMM) model indicated that the stormwater park will reduce flooding occurrences by approximately 50% compared to the former golf course. Outputs from the InVEST pollination model predict an increase in the pollinator abundance index from 0.085 to 0.132, suggesting a greater presence of bees and native pollinators due to the native vegetation. A microclimatic simulation using the ENVI-Met climate model showed that the additional tree cover in the stormwater park would lower average temperatures by 5.6°C in areas with added trees, which also correspond to a walkable path. The impact of the proposed project on nearby housing prices was explored using the hedonic price approach. Our findings indicate that the implementation of the stormwater park will increase property prices by an average of 4.5% for properties located within 1500m buffer of the park. The approach we have developed can help integrate NBS into urban planning.

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Valuing the Co-Benefits of Source Water Protection: Modeling the Effects of Forest Management on Ecosystem Services

Ken Cousins
Earth Economics, Tacoma, WA USA

Source Water Protection (SWP) is a cost-effective means of reducing treatment costs for water utilities, while simultaneously providing valuable co-benefits. Yet not all management practices are likely to preserve or enhance water quality, and some management goals may force trade-offs between economic viability and watershed health.

To address such concerns, a West Coast utility (WCU) developed a Watershed Management Plan for a watershed in which the utility owns extensive forestlands, a portion of which it manages commercially. A core goals of the WCU is to produce environmental benefits (including water quality improvements) while also maintaining a source of income for the utility. The Plan describes three strategies for the utility's forests: *commercial management* with a 70-year harvest rotation period (common industry rotations are just 35-50 years); *conservation management*, largely limited to thinning to encourage larger, old growth trees; and *natural management*, minimal intervention for stands which have achieved old growth characteristics.

Most other commercial forests within the watershed are held by two private companies. The WCU has considered acquiring lands owned by either (or both) companies. To assess the potential benefits, they asked Earth Economics to develop scenario analyses of comparing business-as-usual to the effects of shifting the private commercial forests to the WCU management model. To model effects on ecosystem services provisioning, we developed profiles for mature forests (80 years), old-growth forests (≥196 years), scrublands (a proxy for newly harvested stands), and stands withing riparian areas and endangered species habitat. We modeled post-harvest impacts as linear increases in the value of ecosystem services from 1-80 years (maturity) and 81-196 years (transitioning to old growth). Annual values over the course of the 140 period were discounted at 0, 3, and 7-percent rates.

We found that transitioning management to the WCU would produce an additional $2.86–$3.06B in ecosystem service benefits over 140 years (discounted at 3 percent, an increase of 48–83 percent over business-as-usual). The results reaffirm the WCU's overall management goals and have strengthened their interest in acquiring additional forestlands within the watershed. Pending governing board approval, the WCU intends to submit this scenario analysis as evidence to support a future public bond to acquire additional forestlands within the watershed.

Positioning State Lands for the Energy Transition

Bea Covington
Greene Economics, Mill Creek, WA, USA

The Washington Department of Natural Resources (DNR) manages nearly 6 million acres of terrestrial and aquatic lands across the state. Activity on these lands generates revenue through leasing and product sales (including timber harvesting, grazing and other agricultural leases, leases for wind, solar and communications equipment, commercial leases, and recreational activities among other activities). Currently DNR does not directly utilize the sale of carbon or other ecosystem service credits to generate revenue from DNR managed lands. In fact, DNR is currently prohibited by statute from doing so independently. Any credit sales associated with DNR managed lands are done by a third party on the basis of a lease held with DNR. DNR receives income from the lease, not the credit itself- in much the same way that DNR leasing pasture to a rancher for cattle does not actually benefit from the sale of beef when those cattle are slaughtered.

In 2020 the Washington State Legislature passed the Climate Commitment Act which set Greenhouse Gas (GHG) limits and targets and creates a Cap and Invest system to support achieving the mandated reduction targets. Through the Cap and Invest system the legislature is also seeking to "marry" the emerging WA market with the established markets in CA and Quebec.

In addition to these regulatory markets, there is also growing demand from the corporate sector (many of whom make their headquarters in Washington State- Amazon, Microsoft, Paccar, to name a few) for opportunities to purchase voluntary offset credits in order to meet their net-zero commitments.

DNR recognizes that there is potentially a tremendous opportunity associated with the sale of carbon and other ecosystem service credits – not only to help the state and corporate America meet their Climate Commitment Act and net zero goals, but also, through the revenue generated from the sale of credits- to finance conservation and preservation efforts that will provide additional ecological lift and create broader environmental benefit.

Greene Economics was engaged by DNR in April of 2024 to evaluate the landscape of potential opportunities for DNR to develop projects to offer credits for carbon, habitat, biodiversity and other ecosystem services. The project looked at the market landscape into which DNR might offer credits, evaluated the ecosystem service provision potential across DNR lands and developed a roadmap for DNR to develop and manage projects that could result in the generation of credits that could be offered for sale in a potential market.
This presentation will highlight the findings and recommendations from this work and will identify opportunities, risks and lessons learned that may be applicable to other state agencies seeking to explore the potential for scoping, creating and launching offset credit projects on state managed lands.

FICOR (Federal Council on Outdoor Recreation) Coordinating Federal Recreation Efforts

Christian Crowley
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The Federal Interagency Council on Outdoor Recreation (FICOR) was re-launched in July 2022 to coordinate recreation efforts across eight agency directors in four Federal departments: Agriculture (US Forest Service), Commerce (NOAA), Defense (U.S. Army Corps of Engineers), and Interior (BIA, BLM, FWS, NPS, Reclamation). The Memorandum of Understanding among these parties includes two goals relating to the ACES 2024 theme of "Investing in Community Resilience and Equity":

- Build partnerships…to promote stewardship of and sustainable recreation on Federal lands and waters, and
- Promote equitable access to outdoor recreation opportunities on Federal lands and waters.

This session will discuss what FICOR is and why it was established, FICOR's goals, and FICOR's coordination across Federal agencies' current and future efforts to (1) build partnerships to support resilience of Federal recreation areas and resources and (2) promote equitable access to outdoor recreation.

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Socioeconomic Outcomes of Oyster Reef Restoration Projects: Case Study of Galveston Bay, TX and Calcasieu Lake, LA

***Diana C. Del Angel*[1]*, Christine Hale*[1]*, Coral Lozada*[1]*, Kathy Sweezey*[2]*, Lauren Williams*[2]*, Seth Blitch*[3]

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The study assessed socioeconomic outcomes of two Nature Conservancy restoration projects: Beezley Reef in Galveston Bay, TX, and Calcasieu Lake, LA. Using an Ecosystem Service Logic Model, we identified potential socioeconomic metrics for monitoring oyster reef restoration outcomes. These models capture how restoration impacts cascade through the biophysical system to produce social and economic outcomes, serving as a starting point for identifying potential restoration project outcomes.

Expert interviews conducted in August and September 2023 ensured local relevance of the model components. Insights from these interviews shaped the survey instrument, distribution strategies, and project details. Experts provided concrete evidence of linkages within the Ecosystem Service Logic Model, reinforcing the monitoring plan. The public survey, distributed through flyers and a targeted Facebook ad campaign, garnered 136 responses on Qualtrics between November 1 and December 7, 2023.

Findings for Beezley Reef showed strong understanding of restoration concepts but low awareness of the TNC project (34%). Most respondents (87%) had no occupational links to Galveston Bay. The site is used for recreational fishing, boating/kayaking, and social gatherings. Key concerns (over 50%) included pollution, water quality, wildlife loss, biodiversity depletion, and potential loss of access to natural areas. Most did not report significant effects from reef construction, and overall perceptions were positive.

For Calcasieu Lake, respondents had a good understanding of restoration, though awareness of the TNC project was below 50%. A substantial percentage (41%) had job ties to the lake in roles like wholesale/retail seafood buyers, commercial fishing, and natural resource management. Popular activities included recreational fishing, birding, wildlife viewing, and social gatherings. Major concerns (over 50%) were shoreline erosion and severe storms. Subsistence fishing was likely at the site. Most respondents experienced no project impacts, and comments were positive about the restoration project.

Lastly, this work presents a reproducible methodology based on an Ecosystem Services Logic Model framework to generate local evidence linking restoration to socioeconomic outcomes like economic activity, property protection, human health, and cultural values. These results supported the development of site-specific socioeconomic monitoring plans.

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The Value of Restoring Forested Wetlands: The Avahoula Climate Mitigation Project

Glen Delaney, *Angela Fletcher, and Laura Villegas*
Earth Economics, Tacoma, WA, USA

As the voluntary carbon market prioritizes high-integrity projects that improve co-benefits, ecosystem services valuation can be used to articulate a nature-positive narrative and potentially support a credit price premium.

The Avahoula Climate Mitigation Project (Avahoula) is a 7,200-acre afforestation and restoration project in the Lower Mississippi Alluvial Valley of east-central Louisiana, owned and managed by Delta Land Services, LCC. The site is part of the Saline-Larto Lake complex, a diverse ecosystem that has experienced loss of bottomland hardwood forest over the last 70 years due to agricultural conversion.

In partnership with Pachama, a forest carbon technology provider, and an appropriate climate mitigation investor, Delta will discontinue crop production, reconnect natural surface drainage patterns, and plant approximately 3.5 million native trees on 6,500 acres. Additionally, moist soil areas will be developed to create and enhance waterfowl and wading bird habitat.

The restoration will ultimately be funded through the sale of carbon credits generated by in-situ sequestration and storage over a period of 40 years. However, the value of the ecosystem services created by the project is much higher than the market price of the carbon credits sold, as Avahoula provides broad benefits to society. Furthermore, Avahoula will be placed under a perpetual conservation easement, ensuring these services are protected into perpetuity.

Earth Economics was commissioned to conduct an ecosystem service valuation and other ad hoc analyses to articulate the broader impact of the Avahoula restoration. The goal of the study was to:

- Communicate the integrity of the Avahoula project for buyers in the Voluntary Carbon Market (VCM).
- Demonstrate that return to forested wetland is more viable than less-resilient cropland long term in this area.
- Illustrate all additional benefits associated with afforestation and reforestation (i.e., better water quality, community advantages, flood retention, etc.).

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Quantitative Prediction, Prioritization, and Decision Support for Reforestation Efforts in the Western USA

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Risks to forests are accelerating in the US and globally. Resource managers within the western U.S. and elsewhere have begun to see recruitment failures in semi-arid forests in recent decades. Increased fire frequency, size and severity, along with drought and extreme temperature events have increased reforestation needs. These needs are out-pacing the ability of managers to respond and this trend is expected to accelerate. The primary goal of this project is to model the likelihood of recruitment success and failure in forests of the western US to support prioritization and decision support of reforestation efforts by the USFS. The proposed work integrates earth observation data, *in-situ* data, and a coupled ecohydrologic/plant hydraulics model to estimate the likelihood of conifer seedling establishment due to seed source availability, drought, and lethal soil surface temperatures.

We developed a model-data assimilation framework that supports reforestation planning by enabling the USFS to prioritize and develop targeted and efficient planting efforts. We developed a suite of high resolution (30 m) gridded products for the western United States that quantify plant hydrologic and physiological stress, the likelihood of seedling mortality, and integrated these products into a reforestation decision support tool. The online tool determines: 1) the probability of seed availability based on conspecific basal area and distance to seed source as first order constraints on seedling establishment; 2) the probability of suitable hydroclimatic conditions for seedling establishment based on simulated soil moisture and lethal surface temperatures; and 3) the intersection of seed availability and suitable hydroclimate which defines areas where natural regeneration is likely to occur. The DSS additionally includes a risk-benefit framework to guide resource allocation and prioritization of reforestation sites. These tools provide critical capacity for stakeholders to improve decision making relevant for current and future reforestation efforts in the western US.

Putting Numbers on Nature: A New Approach to Biodiversity Measurement in the Americas

Dan Rockefeller, Sara Copp Franz, Rodolfo Jaffe and Lis Nelis Presented by: ***Matthew Dreimiller***
Ramboll, Binghamton, NY, USA

Biodiversity is in crisis. Since COP15 and the adoption of the Kunming-Montreal Global Biodiversity Framework by nearly 200 nations, the call to "take urgent action to halt and reverse biodiversity loss" has reverberated across the globe through all levels of government and business. Demonstrating progress requires measuring biodiversity. However, measuring nature is complex and doing so in a consistent and scientifically robust way remains a challenge. In this talk, we discuss why we need to measure biodiversity, how we measure it, and how measurement translates to action with real world benefits to the natural and human communities. We also highlight the Americas Biodiversity Metric 1.0, a first of its kind tool for the Americas.

The Americas Biodiversity Metric 1.0 (Metric) is an efficient and scientifically robust tool built upon the extensively tested and widely used metric developed by Natural England to deliver biodiversity net gain policy. Key adaptations include the use of habitats derived from the International Vegetation Classification system, and the development of habitat quality indicators underpinned by the Ecological Integrity Assessment criteria produced by NatureServe.

Core to the Metric is the ecological principle that habitats of larger size and higher quality are better able to support the range of species typically associated with a given habitat and thereby are of greater value to biodiversity. As such, the Metric is designed to evaluate biodiversity using the product of habitat size, quality (i.e., condition), and conservation priority (i.e., based on global conservation rank status) as a proxy for biodiversity value. The metric generates a score, expressed in biodiversity units, which can be used to evaluate baseline biodiversity value, consistently track changes over time, perform alternatives analyses, and support the decision-making process as it relates to the mitigation hierarchy.

The Americas Biodiversity Metric 1.0 has broad application for development and land-use planning, and aligns with global biodiversity reporting frameworks, serving as a common language to evaluate biodiversity across expansive site portfolios and diverse geographies. As such, the Metric is poised to be a leading means of assessing biodiversity in the U.S., Mexico, and Canada, particularly as the driver for supporting and measuring biodiversity increases over time in the Americas.

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Silvicultural Principles for Northern Forest Restoration Based on Financial Productivity and Avian Functional Diversity

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The northern forest of Maine, New Hampshire, and Vermont saw dramatic changes in ownership and management in the late 20th and early 21st centuries. Previous work has shown that nearly 40% of forestland in is in a degraded state, with impaired stocking relative to goals for high-quality timber management. We conducted a field study to understand the relationship between economic degradation and avian functional diversity, with particular attention on avian functional traits that support seed dispersal, nutrient cycling, and pest control.

Avian functional diversity responds to economic degradation in a unimodal fashion, not a monotonic one. Within an original five-level degradation framework (Category 1 being least degraded, and Category 5 the most degraded) the highest levels of functional diversity were found in stands of intermediate status. Tree species composition and canopy structure, and their relationship to avian behavioral traits, were underlying drivers of the degradation-diversity relationship.

Both economic degradation and avian functional diversity can be improved through ecological silviculture. Our results suggest that an effective compromise can be found by shifting stands higher on the degradation scale (e.g. from Categories 3 and 4 into Category 2) without trying to push all the way to Category 1. Vertical structural heterogeneity emerged as a key driver, but attempting to create vertical structure through single-tree selection will likely shift composition toward American beech, with low timber quality and significant forest health risks. Stratified single-cohort mixtures, and deliberate creation of two-cohort stands, may be more effective in balancing timber production and carbon sequestration with avian functional diversity. Retention of long-lived, high-value conifer species (such as eastern white pine and red spruce) within hardwood-dominated stands can be particularly effective at enhancing both composition for timber production and avian functional diversity. Finally, deliberate attention to the volume and diversity of standing and downed dead wood will help maintain the full complement of avian species, along with the functions and services they support.

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Pathways to Preserving Wetland Carbon I: Improving and Expanding Wetland Inventories with Machine Learning and Multi-scale Predictors

Rafter Sass Ferguson*, Sebastian Gutwein, Eric Giordano and Keith Zaltzberg-Drezdahl*
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Wetlands provide a vital array of ecosystem services, supporting biodiversity, regulating and stabilizing water flow, removing pollutants from surface waters, and sequestering carbon. Much of historic wetland area has been lost to development, and remaining wetlands continue to be threatened by encroachment. The protection of wetlands is increasingly important under climate change, as wetlands represent some of the most intense concentrations of sequestered carbon in the biosphere and provide critical buffers against extreme weather events. Accurate, comprehensive maps are critical for the management and protection of wetland resources. The creation of wetland inventories, however, is resource intensive. Recent advances in machine learning provide avenues for the rapid and efficient identification of wetlands, complementing investments in field mapping and desk methods.

In this paper we discuss the development of a wetland probability map that took place as part of a project to advise the Massachusetts Department of Environmental Protection on pathways to achieving no net loss of wetland carbon. We discuss the development of a random forest (RF) model to estimate the extent and location of unmapped wetlands missing from the state inventory. We developed the random forest model using the existing state inventory as training data, and using spatial data including terrain, vegetation, soils, and spectral datasets, as predictors. Using multi-scale predictors, i.e. calculating, resampling, or smoothing spatial predictors at several scales and including all scales in the model, was a key part of the strategy. All analysis was conducted using free, open-source software, principally QGIS and R.

Model performance exceeded expectations by all metrics, with an overall accuracy of 92% and an AUC score of 0.97. The model identified an additional 225,781 acres of probable wetland--an increase of 40% over the existing state inventory. The forested, higher-topography western portion of the state showed the highest proportional increase (49%), and the low-lying, sandy coastal areas showed the lowest (15%). The wetland probability map is now being combined with the existing inventory and directly impacting ongoing efforts to map wetland carbon in the state (described in separate presentation).

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Outdoor Recreation on State Lands in Washington: What Mobile Device Data Reveal About Visitation

Angela Fletcher
Earth Economics, Tacoma, WA, USA

Public land in Washington State totals 18.8M acres, 6.5M of which are managed by state agencies, providing recreational opportunities to both residents and tourists. Effective management relies on understanding the scale of visitation and benefits to local communities, yet tracking visitorship for many state lands is difficult, due to porous boundaries that are difficult to identify on the ground. Earth Economics improved prior visitation estimates by leveraging voluntarily-provided mobile device location data to model recreation on lands where visitation is not tracked. The spatial and temporal resolution offered by mobile device data can be particularly useful when attempting to monitor the impact of factors such as air quality, traffic disruptions, or changes in site amenities. These data can be used to map movement within recreation areas, identifying the most popular amenities, and whether visitors are day trips or overnight stays.

Calibrating statistical models to on-site visitor counts (e.g. campground check-ins, road counters) and other locational data (e.g. site amenities, air quality), we produced monthly visitation estimates for recreation lands managed by the Washington Department of Fish and Wildlife (WDFW), Washington State Parks and Recreation Commission (Parks), and Washington State Department of Natural Resources (WDNR). We constructed a series of models comparing unique device days, site characteristics, and other contextual factors (e.g. traffic disruptions) calibrated against site visitation data. We tested multiple functional forms, including linear regression and random forest models to estimate visitation for sites lacking visitation observations.

We estimated a total of 78M visitor days on state recreation lands in 2019, which increased to 87M in 2020. State Parks supported the largest share, accounting for 44% of all visits across both years. WDFW and WDNR lands supported 34% and 22% of recreation on state lands, respectively. Year-over-year trends across all 3 agencies show that overall visitation increased 12%, with WDNR seeing the largest increase—an estimated 21% increase from 2019 to 2020. This confirms anecdotal data from land managers that recreational use increased throughout the COVID-19 pandemic. The anonymized locational data include the Common Evening Locations of each device, reported by Census Tract. From this, we determined that about 30% of all visitors travelled more than 50 miles to visit state lands.

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Integrated Response to Flood Resilience Planning based on Ecosystem Services and an Eco-Decisional Network

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Community decision making based on the sustainability of ecosystem services is an integrated process that involves multiple complex decisions and is greatly aided by an understanding of how those decisions are interrelated. The interrelatedness of decisions can be understood and even measured based on connections between actions and services and influence of services on domains of human well-being. These connections can be formed into a network structure so that quantifiable properties of networks can be applied to understanding decision impacts. We developed an eco-decisional network as a tool for integrated decision making based on ecosystem services and human well-being. Nodes are actions, services, or domains of human well-being and they are linked by weighted influence derived from community stakeholder input. Examination of the eco-decisional network suggest there are important patterns of influence among different pathways between actions and community well-being, which describe community priorities and define unique roles through which chosen actions can influence human well-being. The eco-decisional network is generalized across communities but can also be made community specific. Here we apply the approach to understanding flood resilience planning in two parishes in southeast LA that have been heavily impacted by recent flooding events. Based on stakeholder input, expert opinion, and objective data the Flood Resilience Roadmap provides a service-based examination of integrated planning as a tool for local decision makers.

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Applying Trait-based Approaches to Restore Drought-resilient and Invasion-resistant Rangeland

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The restoration of rangelands is more challenging today than at any point in human history. Dry and variable rainfall patterns have unknown consequences for plant communities, and invasive species have altered a range of ecosystem services in rangelands. A community assembly framework that emphasizes functional traits could enhance restoration, but empirical tests of these ideas are lacking. We used different seeding mixes and drought manipulations in two grasslands (California, Wyoming) to (1) determine if trait-based theories can be applied to restore rangelands that are drought-tolerant, invasion-resistant, and functionally diverse; and (2) quantify how communities optimized for drought tolerance, invasion resistance, or functional diversity influence critical ecosystem functions including productivity and soil carbon sequestration.

Functionally diverse communities at both sites were easier to assemble and maintain compared to drought-tolerant and invasion-resistant communities, which included more traits when generating targets. While drought reduced plant cover at both sites in the first two years, droughted plots experienced increased cover in year 3 due to the proliferation of drought-escaping annual species. Communities with drought-tolerant traits had higher drought resilience in year 2, but lower recovery in year 3. None of the seeding treatments were more effective at resisting invasion. Our results demonstrate that the restoration of native species, regardless of trait-based targets, results in drought-resilient communities. Because long-lived perennials may suffer in response to extreme drought, including annuals or short-lived perennials in seed mixes will enhance drought resiliency.

In California, we found that functional traits and diversity differentially influenced soil carbon pools, and relationships varied with precipitation, land use history, and the year of vegetation measured. Notably, water-extractible (WEOC) and mineral-associated organic carbon correlated positively with fine roots (high specific root length), highlighting the direct role of roots in feeding these pools. All pools except the most labile (WEOC) were most strongly predicted by land use history three to four years earlier, showing that variations in plant communities and management will likely have enduring effects on soil carbon. These results help clarify how plant communities contribute to soil carbon through disparate pathways and on various timescales.

Leveraging Federal Guidance and Tools for Assessing Ecosystem Services

Kelly Garbach[1]*, Lydia Olander*[2]*, Fushcia-Ann Hoover*[3]*, Leah Sharpe*[4]*, and Tammy Newcomer-Johnson*[5]

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This panel explores recent federal policy guidance and tools to evaluate ecosystem services and how they can be leveraged to evaluate tradeoffs among services and potential beneficiaries in agricultural, rural, and historically underserved communities. Specifically, we will discuss the Guidance for Assessing Changes in Ecosystem Services, Nature-Based Solutions Roadmap, and related decision-support tools. Panel discussion will span government agencies and partners for an in-depth evaluation of policy guidance, tools and their potential applications to advance protection of healthy, functioning ecosystems and the biodiversity that underpins them. This session will be useful for decision-makers and practitioners that using policy guidance for funding, project design, and tool implementation with a focus on historically marginalized and underserved communities.

Panelist Biographies:

Dr. Garbach leads research, education and extension experience in ecosystem services in agricultural landscapes, focusing on investigating the social-ecological benefits and tradeoffs of ecosystem services policies.

Dr. Olander leads the National Ecosystem Services Partnership and works on improving evidence-based policy and accelerating implementation of climate resilience, nature-based solutions, natural capital accounting, and environmental markets.

Dr. Hoover is an interdisciplinary researcher specializing in social-ecological urban systems, employing a range of approaches and perspectives that include environmental justice and nature-based solutions. She is a Radcliffe-Salata Climate Justice Fellow in the Harvard Radcliffe Institute for Advanced Study.

Dr. Sharpe is a decision scientist leading work to incorporate ecosystem service thinking into decision making processes and developing tools and approaches for doing so. Her expertise includes decision support, science communication, and policy analysis.

Dr. Newcomer-Johnson leads research on restoration effectiveness and ecosystem services, including the Great Lakes Areas of Concern "Remediation to Restoration to Revitalization" (R2R2R) research team comprising Federal and local partners. She is the technical lead for the Ecoservice Models Library and National Ecosystem Services Classification System Plus.

Valuing the Wetlands Ecosystem Services Using Meta-Regression: Applications to Bipartisan Infrastructure Law Grant-Funded Projects

George Gardner
National Oceanic and Atmospheric Administration, Silver Spring, MD, USA

The Bipartisan Infrastructure Law (BIL) provided historic investments for coastal protection and restoration efforts. Many BIL grant-funded projects include efforts to preserve wetlands via land purchases of wetlands or areas that may become wetlands, the planting of native wetlands, and other actions. Wetlands provide a myriad of ecosystem service benefits. These include provisioning services such as fishing and waterfowl hunting; regulating services such as flood protection, erosion control, and water purification; and cultural services such as recreational fishing. This study utilizes benefit transfer (BT) with a meta-regression model (MRM) that was recently used in the EPA's and Department of the Army's Economic Analysis for the Final "Revised Definition of 'Waters of the United States'" Rule to assess the potential value of these wetland-provided ecosystem services preserved through BIL project investments. The MRM is similar, but the scope of the BT approach differs. While the EPA and Department of the Army used the MRM to value changes in protected freshwater wetlands, due to mitigation requirements, at a national scale, for this analysis the MRM is used to value both preserved freshwater and saltwater wetlands at a local scale across the coastal United States. The MRM estimates household willingness-to-pay (WTP) for wetland preservation given the number of wetland acres preserved, the current number of wetland acres within a 30-mile radius of project worksites (an estimate of the baseline wetlands), the wetland type (forested or non-forested and freshwater or saltwater), and provided ecosystem services. Additionally, the MRM employs a Bayesian linear meta-regression framework to make the most out of its small 52-observation sample size (i.e., to improve BT accuracy). The key data for this analysis comes from grant application documents and is further supplemented with demographic data taken from the U.S. Census, population projections taken from NASA's Socioeconomic Data and Applications Center, and wetlands data taken from the U.S. Fish and Wildlife Service's National Wetlands Inventory. Assuming wetland functionality is fully restored and maintained, results reveal potentially significant ecosystem service benefits to coastal communities.

A Comprehensive Look at Ecosystem Service Valuation (ESV) in Sanctuaries and the Great Lakes (GL)

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Purpose: The National Oceanic and Atmospheric Agency (NOAA) and the National Marine Sanctuary Foundation (NMSF) are working with 15 other federal natural resource agencies across the US to incorporate ecosystem services into agency decision-making. NOAA and NMSF are conducting preliminary research in the Great Lakes region to understand human use, economic contributions and ecosystem service values of sanctuaries (i.e., Lake Ontario, Thunder Bay, Wisconsin Shipwreck Coast, and the proposed Lake Erie Quadrangle) in the region. This work pulls together social science and local experts and methods of evaluation in a highly collaborative approach to provide ecosystem service values for four sanctuaries or designations that protect historical shipwrecks. This work will help collect baseline socioeconomic data to help track and understand human impacts to the sanctuaries over time. It will also inform the sanctuary designation and rulemaking processes (such as the National Environmental Policy Act) in the Great Lakes and other regions across the Sanctuary system.

Focus: Panelists will introduce and discuss methods and outcomes used in ecosystem service valuation to inform the decision making process.

Key Takeaways: Decision makers often need socioeconomic data but may not understand the differences in various types of approaches. We will discuss a suite of approaches that contributes to ecosystem service valuation to tell a story about the importance of great lake-adjacent economies. Panelists may also draw from related work in other areas of the country.

Attendees: Decision Makers; Resource Managers; Economists.

Panelist Biographies:

Mr. Goodhue is a senior economist and project management professional with more than 15 years leading economic analyses related to coastal management and ecosystem services.

Dr. Schwarzmann is the Chief Economist of NOAA's Office of National Marine Sanctuaries with more than 15 years of economic analyses related to coastal management.

Dr. Burns is a professor of Natural Resources at West Virginia University. He has 30 years of experience conducting socio-economic research and visitor monitoring in federal, state and international natural resource settings.

Dr. Nadeau is a senior economist at ERG with more than 28 years of experience leading benefit-cost analyses, economic impact analyses, and ecosystem service valuation work.

Mr. Gray is the superintendent of the Thunder Bay National Marine Sanctuary located in Alpena, Michigan, and has over 28 years of experience working in conservation and historic preservation in the Great Lakes.

NOAA's BIL-IRA Investments in Nature-Based Solutions

Jessica Grannis
National Oceanic and Atmospheric Administration

From sea level rise and storm surges to eroding infrastructure, coastal communities are on the frontlines of dealing with the worsening impacts of climate change. To help communities address these challenges, the National Oceanic and Atmospheric Administration (NOAA) is deploying significant funding from the Bipartisan Infrastructure Law (BIL) and the Inflation Reduction Act (IRA) to support investments in building climate resilience coastal communities. This session will explore how NOAA is deploying historic BIL and IRA resources and share lessons from case study examples of BIL and IRA funded projects.

BIL and IRA have provided a game-changing opportunity to mobilize transformational efforts across the nation to help communities to build resilience to extreme weather and climate-driven hazards. The first part of the session will discuss how NOAA is strategically deploying more than $4 billion in BIL and IRA funding through its Climate Ready Coasts initiative. Through programs focused on restoring coastal habitats, enhancing community resilience, and delivering needed climate data and services, NOAA is investing in communities across the country to help them plan for, design and implement climate resilience solutions addressing different hazards and climate stressors, in a variety of landscapes and geographies. NOAA's work to center equity across all of its BIL and IRA programs will be discussed including through the delivery of technical assistance and climate services, and by prioritizing investments focused on frontline communities facing disproportionate risk. We will also discuss how NOAA is catalyzing both private-sector efforts to advance resilience solutions, through innovative programs like our Ocean Based Climate Resilience Accelerators. Participants will learn about NOAA's BIL and IRA programs, and future opportunities to fund projects and leverage NOAA investments to support their own resilience initiatives on the ground.

The second part of the session will use case studies of on-the-ground projects from awards across NOAA programs to share key best practices and lessons learned. For more than a decade NOAA has been supporting cutting-edge nature-based approaches for building resilience in coastal communities across the U.S. Through this work, NOAA has supported a broad cohort of practitioners that have moved through the pipeline from planning and design to implementation of nature-based solutions (NbS) – like restoring wetlands and floodplains, building living shorelines, and rebuilding reefs and dunes – to reduce risks from coastal hazards. Through these projects, practitioners are learning how to develop plans and designs that lead to the effective implementation of adaptation projects and monitor and assess the efficacy of NbS. Lessons will be shared on how grantees are advancing NbS projects from planning to implementation, including how they are meaningfully engaging communities in the work; overcoming barriers, such as permitting; and assessing the efficacy of NbS projects.

To ensure progress continues long into the future it is important that we learn from this historic mobilization generated by BIL and IRA, while also developing the enduring capacity needed to carry this work forward after the funding from these programs draw down. The goal of this session is to ensure that federal agencies and practitioners are learning from these transformational investments and building the needed capacity to advance this important work into the future.

Smart and Green: Water Supply and Stormwater Retention Benefits of Real Time Control in Different Climate Regimes

***Stanley B. Grant**, Emily A. Parker*
Virginia Tech Occoquan Watershed Monitoring Laboratory, Manassas, VA, USA

Stormwater capture systems have the potential to address many urban stormwater management challenges, particularly in water-scarce regions like Southern California. In this talk we discuss the potential best-case limits of water supply and stormwater retention benefits delivered by a 10,000 m^3 stormwater capture system equipped with real-time control (RTC) on a university campus in Southern California. Using a copula-based conditional probability analysis, two performance metrics (percent of water demand satisfied and the percent of stormwater runoff captured) are benchmarked relative to (1) precipitation seasonality (historical rainfall and a counterfactual in which the same average annual rainfall is distributed evenly over the year); (2) annual precipitation (dry, median, and wet years); and (3) three RTC algorithms (no knowledge of future rainfall or perfect knowledge of future rainfall 1 or 2 days in advance). RTC improves stormwater retention, particularly for the highly seasonal rainfall patterns in Southern California, but not water supply. Improvement to the latter will likely require implementing stormwater capture RTC in conjunction with other stormwater infrastructure innovations, such as spreading basins for groundwater recharge and widespread adoption of green stormwater infrastructure.

NBS in the Trinity River Floodway

***Nick Grewe**, Craig Taylor*
LimnoTech, Oakdale, MN, USA

The Trinity Floodway is a quarter-mile dividing line between downtown Dallas and west Dallas. The proposed Harold Simmons Park is a gathering place where the two unique communities can come together and explore a park several times larger than New York's Central Park. Developing a park in a floodway that provides both environmental uplift and a vibrant space for the community poses many unique challenges. This poster will highlight NBS techniques used in the design and provide a review of how we communicated those design elements to the community stakeholders.

Pathways to Preserving Wetland Carbon II: Leveraging Public Data to Map Wetland Carbon in Massachusetts

Sebastian Gutwein, *Rafter Sass Ferguson, Eric Giordano and Keith Zaltzberg-Drezdahl*
Regenerative Design Group, Greenfield, MA, USA

The protection of wetlands and the ecosystem services they provide becomes ever more important in the face of climate change. In addition to offering critical buffers against extreme weather events, wetlands represent some of the most intense concentrations of sequestered carbon in the biosphere. Managing wetland carbon to keep it out of the atmosphere depends in part on a thorough and accurate accounting of the scale and distribution of wetland carbon stocks. Recent decades have seen the appearance of national and international wetland carbon inventories, but the broad scope and large resolution of these inventories makes them of limited utility to state-level wetland management efforts.

In this presentation we discuss one of the first state-level estimations of wetland carbon stocks, which took place as part of a project to advise the Massachusetts Department of Environmental Protection on pathways to achieving no net loss of wetland carbon. Building on public datasets this project produced a geodatabase with estimated values for biomass carbon and soil organic carbon for wetlands across the Commonwealth.

This project drew on multiple datasets to construct and populate the geodatabase. The starting point for wetland extents was the state wetland inventory maintained by the Massachusetts Department of Environmental Protection. Additional wetland areas estimated in the wetland mapping project (discussed in a separate presentation). In addition to the above datasets, the project drew extensively on the Soil Survey Geographic (SSURGO) Database for Massachusetts and the MassGIS 2016 Land Cover/Land Use data layer. Soil carbon data was derived from SSURGO estimates, and biomass carbon data for forest and shrubland were drawn primarily from a dataset from the National Forest Carbon Monitoring System. In the absence of datasets for herbaceous wetlands, data for biomass carbon was drawn from multiple individual studies.

For every polygon in the geodatabase, carbon was estimated for three pools: aboveground biomass, belowground biomass, and soil organic carbon. Across these pools the total wetland carbon in Massachusetts was estimated at 211,954,000 metric tons. The soil pool accounted for 86.5% of the total, with 11% and 3.5% in the aboveground and belowground biomass, respectively. The estimates in this geodatabase can now serve as a baseline for the development of ongoing monitoring of stocks and the protection of sequestered wetland carbon.

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Ecosystem-Based Adaptation to Climate Change of Indigenous Women in Sumatra, Indonesia

Hamid Arrum Harahap[1], *Simone Maynard*[2], *Yonariza*[1]

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Ecosystem services are vital for supporting the well-being of indigenous women, providing essential resources for their sustenance, health, and livelihoods. Their significant reliance on natural ecosystems makes them especially vulnerable to the impacts of climate change. This study investigates the effects of current and projected climate change on these crucial ecosystem services in Aceh Singkil and the Mentawai Islands of Sumatra, Indonesia. Our data collection involved two stages with indigenous women: Stage 1 comprised interviews with eight women at each site in December 2023, lasting 1-2 hours per interview. Stage 2 involved Focus Group Discussions (FGDs) in 2024, bringing together the interviewed women from each site for 2-3 hours. Employing a Whole-of-System, Value-Based Framework integrated with climate modeling from year 2030, 2050, and 2100, we analyze shifts in local ecosystems, identify threats to key services, and address resulting environmental, social, and economic challenges. Our mixed-methods approach combines traditional knowledge with scientific insights to propose ecosystem-based adaptation strategies. Climate projections for both regions indicate increasing risks such as sea-level rise, intensified precipitation, and higher temperatures, heightening vulnerabilities. Meanwhile, indigenous women rely heavily on diverse ecosystem services—from marine and forest resources to cultural practices and staple foods—that enhance their resilience and community cohesion. Effective adaptation strategies must integrate these insights to foster sustainable development and safeguard the critical roles of ecosystems in the lives of indigenous women.

No Cent in Incentives: Sustaining Ecosystem Services through Indigenous Payment Practices in Tapanuli, Indonesia

Hamid Arrum Harahap[1], *Yonariza*[1], *Simone Maynard*[2] , *Endrizal Ridwan*[1], *Yuerlita*[1]

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Despite their initial promise, Payment for Ecosystem Services (PES) schemes have been criticized for inequitably distributing benefits among communities, often marginalizing vulnerable groups, and oversimplifying complex ecosystem dynamics into tradable commodities. Responding to these critiques, there is a growing interest in integrating non-monetary incentives within PES frameworks to foster inclusive community engagement in conservation efforts, though challenges remain in ensuring their long-term viability and effectiveness in addressing socioeconomic issues. This study examines the Indigenous Practices on payment for Ecosystem Services (IPES) model in Tapanuli, Indonesia, where conservation practices are deeply embedded in community life of Batak people. Led by indigenous communities, IPES programs sustain local economies and ecological integrity without solely relying on monetary incentives. Employing a mixed-methods approach, the research investigates the objectives, implementation, and impacts of IPES in Tapanuli. Data collection included 60 semi-structured interviews with farmers, 10 key informant interviews with IPES implementers, and two focus group discussions to explore ecological and economic impacts. Analysis using SPSS for quantitative data and NVivo for qualitative insights offers a comprehensive understanding of how IPES supports ecological conservation, enhances local economies, and promotes community engagement through non-monetary incentives. Findings underscore significant influences on agricultural-economic factors, cultural heritage, forest management, and social capital in the Hatabosi and Simardangiang communities, with broader implications for local institutions, cultural dynamics, and safety and security considerations. The study provides valuable insights into IPES as a potential alternative or complement to mainstream PES schemes, proposing recommendations for advancing sustainable practices and enhancing community well-being in Indonesia and similar global contexts.

Estimating Avoided Drinking Water Treatment Costs From Improved Source Water Quality

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Water management actions have the potential to affect water quality and, in turn, the benefits of a wide range of ecosystem services. In particular, economic studies have shown that improving the quality of source water used by a drinking water treatment plant can help lower its treatment costs. However, this category of benefits of improved water quality or source water protection (SWP) has often been missing or incompletely estimated in prior cost-benefit analyses due to data gaps, methodological limitations, or the high cost of implementing engineering-based models. The absence of quantified benefits in the form of avoided drinking water treatment costs has challenged water managers' ability to determine when SWP may be the most cost-effective strategy in the provision of safe drinking water. Similarly, advancing our understanding of this key knowledge gap could lead to more complete accounting of the benefits of federal regulations to reduce surface water pollution.

Prior work on the benefits of SWP has generally estimated cost functions that relate drinking water treatment costs to their determinants, such as production output, input prices, reservoir level, well depth, and measures of source water quality. When cost functions include source water quality, economists can calculate the avoided drinking water treatment costs from improved water quality. For example, if total suspended sediments decrease by x% from a regulatory option, drinking water treatment costs will decrease by y%. Using y% and median treatment costs of affected drinking water systems, managers and policymakers can estimate the avoided drinking water treatment costs. We refer to this as the treatment cost elasticity approach.

This presentation will introduce the role of economics in estimating avoided drinking water treatment costs. It will begin with a review of studies that estimate the benefits (i.e., avoided treatment costs) of improving source water quality for treatment plants. We also will present a general approach for estimating the avoided treatment costs. We will then explain how the EPA implemented a treatment cost elasticity approach to quantify avoided treatment costs from reductions in total nitrogen and total suspended solids for the Steam Electric Power Generating Effluent Guidelines and a potential framework for the Meat and Poultry Products Effluent Guidelines. Finally, we will identify future research, including adding a potential new module for BenSPLASH.

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Constraints and Enablers for Meaningful Consideration of Plural CES Values in Decision-Making

Kristin R. Hoelting[1]*, Rachelle K. Gould*[2]*, Amanda E. Cravens*[3] *and Brian D. Winter*[4]

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Cultural ecosystem services (CES) make foundational contributions to human well-being, and yet they are consistently underrepresented in research products intended to inform decision-making. In particular, the relational and holistic values associated with CES categories such as cultural identity and maintenance of knowledge systems have been inadequately conveyed through existing instrumental approaches to ecosystem service assessment and ecosystem valuation. This presentation will detail 1) a spectrum of forms in which CES knowledge may be conveyed to inform decision-making and 2) constraints and enabling factors that influence whether plural CES values are meaningfully considered in decision-making. This research considers how these constraints/enablers commonly influence integration of distinct CES knowledge forms in natural resource management decision contexts. Examples are offered from case study research on Elwha River dam removal decision-making (Washington State, USA). These examples illustrate that factors commonly constraining integration of diverse CES knowledge forms can transform into enablers for meaningful consideration of relational values and holistic value perspectives, alongside instrumental values. The talk will conclude with takeaways for decision-makers, managers, and those who hold CES knowledge and seek to convey plural CES values to inform decision-making.

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Creating Space for Diverse Knowledge Systems and Plural Values in Federal Resource Management

Kristin Hoelting[1]*, Carolina Behe*[2]*, Doreen E. Martinez*[3]*, Jeffrey Thomas*[4]*, Richard Begay*[5]

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[5]Navajo Historic Preservation Department, Window Rock, AZ, USA

This panel will explore Federal agencies' increasing efforts to elevate multiple knowledge systems alongside western scientific approaches to resource management and ecosystem valuation. Panelists have diverse experience and expertise working across knowledge systems in the context of ecosystem management in both the United States and Canada. They will discuss common barriers encountered in their efforts to support elevation of Indigenous Knowledge, identify success stories, and highlight needs and opportunities to improve meaningful consideration of diverse knowledges.

Panelist Biographies:

Carolina Behe is with the NOAA Office of National Marine Sanctuaries (ONMS) as the National Cultural Resource Coordinator. Within her role, Carolina is working with her team to strengthen and support Indigenous engagement within ONMS.

Dr. Martinez is an Associate Professor in the Department of Race, Gender, and Ethnic Studies at Colorado State University. Her expertise is in Indigenous knowledge systems, research methodologies, visual culture, and sociopolitical land and environment issues. Her work focuses on how diverse knowledges, life's theoretical grounding, are engaged and practiced every day.

Jeffrey Thomas (Muckleshoot/Warm Springs), is Director of the Puyallup Tribal Timber, Fish & Wildlife Program (August 1989), Board President of the Tahoma Indian Center, Northwest Indian College Cultural Sovereignty instructor, and Facilitator of Medicine Creek- as well as Point Elliot- Urban Forestry Councils

Richard Begay, Navajo Historic Preservation Department
Mr. Begay is the designated Tribal Historic Preservation Officer (THPO) for the Navajo Nation. He works with Navajo people, Navajo Nation departments and programs, and with federal and state partners to oversee and manage the Navajo Nation's vast inventory of cultural resources

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Benefits to Human Health from Improving Great Lakes Ecosystem Services

Joel C. Hoffman[1]*, Erik D. Slawsky*[2]*, Marie C. Russell*[3]*, Kristen N. Cowan*[3]*, Beth M. Haley*[4]*, Hanna Jardel*[3]*, David T. Dillon*[5]*, Caitlin A. McConaghy*[6]*, and Kristen M. Rappazzo*[5]

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The Laurentian Great Lakes offer a diverse and critical array of ecosystem services that provide beneficial uses to the surrounding population of more than 40 million people. These ecosystems services include providing drinking water, storm protection, recreational services such as fishing and boating, and cultural services such as a providing a place for healing and reflection. The Great Lakes Restoration Initiative aims to restore and protect these beneficial uses by addressing longstanding degradation in Areas of Concern (AOCs), which are the most ecologically degraded coastal communities in the Great Lakes. Remediation and restoration efforts to address ecological impairments impact Great Lakes coastal communities through a change in ecosystem services delivery, which in turn affect human health and wellbeing. Despite recognition of the potential for improved human health, there is no research, to our knowledge, demonstrating a direct effect of improved environmental quality and ecological health (regardless of the beneficial use impairment addressed) on human health. Nevertheless, human health is among the most preferred outcomes of remediation and restoration efforts in AOCs. We brought together a multidisciplinary team of researchers to use systematic review to determine the direct effect of improved environmental quality through improved aesthetics and reductions of combined sewer overflows (CSOs) on human health. We found numerous studies that support links between green space and various metrics of health, with additional evidence for blue space benefits on health. For example, beach litter was associated with injuries across demographic groups and especially in children. Beach litter can also provide ideal microhabitats for invasive mosquito larvae, which can serve as a vector for numerous infectious diseases, to reproduce. Perceived naturalness of green space, plant diversity, aesthetic improvements to blue space, and green space maintenance were also self-reported to be beneficial to both mental and physical health in surveys. Further, we found strong scientific evidence supporting a positive association between CSOs and gastrointestinal illness, particularly during intense rainfall events, related to a diverse set of exposure pathways. We conclude that ongoing efforts to remediate and restore Great Lakes AOCs present broad opportunities to improve physical and mental health, as well as to reduce the spread of infectious disease.

Restoring Dynamic Disturbance Processes to Promote Ecological Services

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Rangeland systems are inherently complex with high levels of floral and structural diversity resulting from disturbances such as fire and grazing. Current rangelands are highly simplified as a result of multiple, often synergistic drivers such as invasive species, altered disturbance regimes, and fragmentation. Restoring ecological disturbances to rangelands with careful consideration for spatial and temporal scales has the opportunity to increase both livestock production and conservation, ultimately increasing multiple ecological services. We assessed the influence of grazing regimes designed to promote structural and compositional heterogeneity to more traditional practices and assessed both cattle production and a number of ecological responses. In general, we found that grazing practices that varied grazing distribution and intensity to promote heterogeneity were more resilient to annual precipitation variation and created more consistent cattle gains than traditional practices that promote uniform grazing distribution. Additionally, we found that patch-burning consistently increased cattle gains compared to heterogeneity-focused grazing systems without fire. Ecologically, we found that including patchy-fire in grazing systems increased floral abundance, diversity, and expression time while also promoting greater bird densities compared to traditional grazing practices in the region. Overall, our results support the idea that creating dynamic and complex rangeland systems is beneficial to both production and ecological goals. Moreover, in areas where a cultural aversion to fire may create barriers to management, creative practices can be used to create vegetation heterogeneity in ways that promote conservation without taking away from production goals.

A Trade-off Between Soil Carbon Storage and Nitrogen Supply in a Diversified Cropping System

***Wenjuan Huang*[1], *Bo Yi*[1], *Matt Liebman*[2], *Matthew Woods*[2], *Marshall D. McDaniel*[2], *Chaoqun Lu*[1], *Andy VanLoocke*[2], *Sotirios Archontoulis*[2], *Bryan Petersen*[2], *Siyang Jian*[3], *Hanna J. Poffenbarger*[4], *Gangsheng Wang*[5], *Yiqi Luo*[6], *Steven J Hall*[7]**

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Diversified cropping systems that integrate production of grains, forages, and animals offer a chance to address myriad environmental challenges that often go unmet in simpler systems. However, impacts of diversified cropping systems on soil organic carbon sequestration and nitrogen dynamics remain debated. We integrated a 20-year field experiment and laboratory measurements with three isotope-enabled mechanistic models to examine the stocks and decomposition of soil organic carbon in a conventional corn-soybean rotation and diversified crop rotations that included small grains, forage legumes, and manure inputs, in addition to corn and soybean. Contrary to the prevalent hypothesis that diversified systems increase soil organic matter, we found no differences in the stocks of soil organic carbon and nitrogen in either topsoil (0–0.3 m) or the whole soil profile (0–1 m). Nevertheless, the diversified cropping systems markedly increased carbon and nitrogen mineralization rates. Lab incubations and natural abundance isotope measurements showed increased decomposition of older carbon and increased nitrogen availability under diversified cropping systems. We calibrated three different isotope-enabled models with our empirical measurements. Models consistently showed that increased carbon decomposition with months-years residence times counteracted higher carbon inputs and increased nitrogen supply. Our findings highlight a critical trade-off between carbon storage and nitrogen supply in diversified cropping systems, demonstrating that their key climate benefits may result from decreased nitrogen fertilizer inputs, but not soil organic carbon sequestration.

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Simulating Visible Greenness in Urban Settings: Computational Approaches to Assessing and Enhancing Urban Green Spaces

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The provision of urban green spaces has been widely acknowledged to offer numerous benefits to individuals and communities. Recently, there has been a growing recognition of the importance of evaluating urban greenness from a human-centered perspective, partly due to the rapid development of eye-level greenness measurement. In this study, I first conducted a systematic review of measurement approaches and topics related to eye-level urban greenness and revealed that street view images are the primarily utilized data source to quantify eye-level urban greenness in urban analysis. Additionally, simulated eye-level urban greenness represents a new frontier for the general public and urban planners, offering the potential to acquire universally applicable quantitative greenness data. In addition, I designed a field experiment in Fayetteville, Arkansas, by collecting 360-degree panoramas to evaluate the simulation of the Viewshed Greenness Visibility Index (VGVI) in different local climate zones. Further, I assessed the performance of simulated greenness by comparing it with the greenness calculated from field-collected panoramas. The results showed that, despite the disparity of performance in different local climate zones, simulated greenness highly correlates to the ones from panoramas, indicating its great potential for various domains that favor urban human-perceived greenness exposure.

Reviewing the Recruitment and Qualitative Methods in Deliberative Valuation Experiments

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Deliberative valuation methods have been used widely to assist in improving the quality of environmental decisions and the valuation of ecosystem services by promoting in-depth dialogue among community members. Proponents of the deliberative methods suggest that the active engagement of the communities, as well as the ability to trace the reasoning behind people's choices by analyzing qualitative data, create opportunities for legitimate and equitable decisions. Deliberative outputs are also useful for policy making that incorporate community engagement and lead to more public-supported policies and projects.

To better understand current practices of deliberative valuation and gaps that need to be filled, a literature review was conducted on deliberative valuation studies with a special focus on shared social values formation. A total of 222 papers were initially reviewed, with 61 papers analyzed in-depth focusing on existing recruitment and qualitative methods used in deliberative case studies and important challenges that need further investigation. Transcript analysis from workshops was also a focus of this review as this is an important part of the qualitative methodology process.

Preliminary results from this review suggest that the challenges we are looking to address were only explored in a small portion of the papers. For example, i) few papers addressed if the outputs from workshops were used, or useful, for policy making, ii) only about a third of the papers addressed how to ensure fair recruitment, which can play a big role in workshop results, and iii) less than half of the papers addressed how to ensure fair participation within the workshops, which also plays a big role in workshop success. The information from this review will be used when conducting our own workshops in the upcoming year looking at how communities value attributes of renewable energy. The goal of this review is to provide a guide for practitioners in deliberative valuation on the most appropriate methods to use when designing their studies, with special emphasis given to recruitment and qualitative methods. Ultimately, the deliberative valuation methodology is transferable to many different topics, especially those under the ecosystem services umbrella, and the information provided in this review will further this approach and the ability to equitably measure and value ecosystem services.

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Graduate Training in Agroecology at Florida International University

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The Agroecology Program implemented an innovative model for attracting students into food and agriculture sciences from the large Hispanic communities in South Florida, which are predominantly urban in culture but are beginning to experience an emerging interest in a broad range of urban agriculture/horticulture and environmental sustainability and management. The FIU Earth and Environment Department (EED) offers the B.S, and M.S. programs in Environmental Studies and Geosciences and doctoral degree in Earth Systems Science. The Earth Systems Science doctoral program evolved from Geosciences in Fall 2014 to accommodate interdisciplinary agriculture and natural resources sciences. The Earth Systems Science program has 75 doctoral students with 25 students in Geoscience concentration and 50 students in Natural Resources Sciences and Management concentration. We also have a successful MS program in Environmental Studies and graduated more than 250 master's students, and most of them enjoy private or public sector employment in areas dealing with water or soils and ecosystem management, which includes eight recent graduate students that joined the USDA –NRCS, –AMS and -ARS.

As part of the bachelor, masters, doctoral and certificate programs, the Department offers several courses in sustainable agriculture, sustainable bioenergy, soil sciences, soil microbiology, agro-ecosystem studies, horticulture, crop production, farm economics, water management, wetlands ecosystems, biogeochemistry, natural resource management and policy.

The Agroecology Program at FIU is specialized in dealing with scientific and socio-economic underpinnings of 21st century agriculture education, research, and outreach. For instance, graduate students and faculty in the program have researched into conventional versus organic agriculture, regenerative agricultural practices through symbiotic biological nitrogen fixation (BNF), arbuscular mycorrhizal fungi (AMF) inoculation, plant growth promoting rhizobacteria (PGPR), cyanobacteria as biofertilizer, vermicompost, biochar amendments, urban sustainable agriculture, community gardens, pesticide bioremediation, pollinators and agro-biodiversity, economic analysis of supply chain of produce, and farm economics. The National Needs Fellowship program is built on novelty and innovation for student success through institutional resources, faculty expertise, critical thinking, communication skills, mentorship, research training, and student career path.

Enhancing Arthropod-Mediated Ecosystem Services by Alleviating Key Stressors in Specialty Crop Production

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External inputs have become a hallmark of modern-day agriculture. However, these inputs can give rise to sub-optimal production systems typified by solution-caused problems. Increasingly, these inputs are contributing to problems on farms, leading to a managerial whack-a-mole. Solutions for one problem inadvertently create issues for another. Without greater consideration for problems at a system level, inputs are unnecessarily maximized, and ecosystem services underutilized. Transforming the *watermelon* system is used as a model for understanding ubiquitous stressors underlying ecosystem service delivery across fruit and vegetable cropping systems, many of which suffer from the same 'symptoms' and use the same input-intensive approach.

We focus on *pollination* and *biological control* as the two primary ecosystem services provided by arthropods in these crops. Our preliminary evidence strongly indicates that current management practices used by growers undermine effective pollination and biological control, leading to a treadmill of ever-increasing inputs intended to substitute these services. Specifically, this project addresses three aspects of the system: i) cover crop choice; ii) insecticide use practices; and iii) supplementation with managed bees. We show that these three components degrade ecosystem services in grower fields, both individually and in combination, i.e., some synergistically reduce the function of beneficial arthropods. Moreover, we outline a path forward by comparing the status quo with proposed transformations that would simultaneously enhance agroecosystem sustainability and farm profitability.

We aim to transform the watermelon system by implementing flowering cover crops, managing pests with action thresholds, and relying on wild bees as pollinators. To do so, we test different permutations of cover crop type, use of insecticide thresholds, and managed bee supplementation (presence/absence). Our *working hypothesis* is that the transformed system will necessitate far fewer inputs, while maintaining similar or higher watermelon yields than the current system.

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Department of the Interior: Nature-based Solutions for Ecosystem Resilience and Community Well-being

Liza Khmara[1]*, Alisa Wade*[2]*, Sara Ward*[3]*, Courtney Schupp*[4]*, and Jeff DeQuattro*[5]

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Nature-based solutions (NBS) incorporate natural features and processes in ecosystem management to provide multiple benefits to nature and society. They serve as tools to deliver ecosystem services by addressing socio-environmental challenges. The U.S. Department of the Interior (DOI) is working with partners to deploy NBS across its lands and waters and nearby communities to advance ecosystem resilience and human well-being. This session provides an overview of some of DOI's NBS programs and projects, which follow the recent publication of the DOI NBS policy, outlining key principles for NBS and overarching guidance for implementation. Bipartisan Infrastructure Law and Inflation Reduction Act funding are making historic investments in public lands including peatland restoration to provide carbon services, research and release of mosquitoes incapable of reproducing in an effort to combat avian malaria in Hawai'i, reintroduction of bison to restore grassland soil health, and Tribal-built greenhouses that not only provide native plant seedlings for restoration, but also foster cultural pathways for stewarding the landscape. Key takeaways of the panel include early NBS successes, current challenges to NBS implementation, and opportunities to collaborate with partners and leverage efforts to sustain NBS initiatives. This panel would benefit any member of the Ecosystem Services community interested in learning more about how DOI is building momentum from policy to practice to become a leader in implementing NBS across bureaus and public lands, as well as in coordination with partners across the nation.

Panelist Biographies:

Liza Khmara is a Policy Analyst in the U.S. Department of the Interior, Office of Policy Analysis coordinating implementation of nature-based solutions.

Dr. Alisa Wade is Program Manager for the BIL Ecosystem Restoration Program in the U.S. Department of Interior, Office of Policy Analysis and has led the investment of over $700M toward over 700 restoration projects across the US, many applying NBS principles.

Sara Ward is the Nature Based Resiliency Coordinator for the U.S. Fish and Wildlife Service. Her work is focused on nature based solutions and leveraging resources and emerging climate tools to expand priority conservation and restoration to meet climate mitigation and adaptation goals.

Courtney Schupp is a coastal geologist for the National Park Service Southeast Region, and has 25 years of experience in coastal processes, restoration, resilience, monitoring, and adaptive management.

Jeff DeQuattro is the Director of Restoration for The Nature Conservancy's Gulf of Mexico Program, and the Project Director for the Tyndall Air Force Base Coastal Resilience Project and the GulfCorps Program. His work focuses on the practical application of nature-based solutions and the engagement of young adults from underserved communities to build the resilience of people, the built environment, and natural systems.

Update of the Recreation Use Values Database for Estimating Outdoor Recreation Benefits

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Outdoor recreation opportunities are among the most visible and familiar ecosystem service benefits provided by national forests and grasslands, and one of significant interest to the public. Natural resource professionals are often in need of information with which to evaluate changes in outdoor recreation benefits associated with land-use policies or specific management activities. In many cases, federal regulations may even require such evaluations explicitly. In this presentation we will report on the most recent update of the Recreation Use Values Database. The Database has long provided federal land managers, non-governmental organizations, and private consultants with reliable recreation use value estimates. The update is based on an exhaustive review of economic outdoor recreation studies spanning 1958 to 2024 conducted in the United States and Canada and provides the most up-to-date recreation use values available. When combined with data pertaining to recreation activities and the quantity of recreation use, such as is provided by National Visitor Use Monitoring data, the recreation use values can be used for estimating the economic benefits of outdoor recreation for various landscape scales of interest. This proposed presentation will: (1) highlight the history of the Recreation Use Values Database; (2) describe the expanded source research literature on which it is based; (3) briefly review the methods used to develop use values for the array of outdoor recreation activities included; and (4) present an example application of the database involving the computation of total economic benefit of recreation for a given landscape. The presentation will provide an introduction to the Recreation Use Values Database update, and the accompanying report which will likely be available for distribution within the year following the conference.

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Unlocking Capital and Understanding Risk: The Business Case for Investing in Nature

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Unlocking capital and understanding risk in the context of investing in nature provides businesses with a solid foundation for sustainable growth, risk management, and long-term value creation. It enhances economic performance, builds resilience, and positions companies as leaders in the transition to a sustainable future. The panel session focuses on why the private sector should consider investing in nature as a key source of untapped potential and provides a nuanced understanding of risks and opportunities. Panelists will bridge the gap between stakeholders who often operate on two different planes: those developing measurement and valuation practices and those who they hope will benefit (market participants) from these practices. Attendees will leave with a practical understanding of the current state of play and considerations for private sector players interested in investing in nature. This session is especially beneficial for attendees from the private sector and scientists/practitioners.

Panelist Biographies:

Ms. Lauren Knight is an International Trade Specialist at the U.S. Department of Commerce's International Trade Administration (ITA) where she leads ITA's new workstream focused on the intersection of natural capital and competitiveness. She also covers development finance, serving as Commerce's Board liaison to the International Development Finance Corporation.

Dr. Bagstad is a research economist at the U.S. Geological Survey with more than 15 years of experience dedicated to research and policy to build a better understanding of economic development, conservation and natural resource management tradeoffs.

Dr. Briceno is Chief Economist with Intrinsic Exchange Group with more than 15 years of experience as an ecological economist conducting environmental valuations, socioeconomic analyses, and ecosystem services assessments.

Dr. Laura Costadone is an Assistant Research Professor at the Institute for Coastal Adaptation and Resilience (ODU), where she is leading an effort to develop a natural capital approach to enhance coastal resilience and adaptation.

Dr. Ethan Aumann is the senior director of environmental issues and resiliency at the American Property Casualty Insurance Association (APCIA), where he works on environmental insurance and risk mitigation strategies related to climate, nature, and natural catastrophe.

Supporting Inclusive Community Engagement and Equitable Development in Underserved Communities: Lessons from Detroit's Joe Louis Greenway

Kenneth J. Kokroko
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Detroit's Joe Louis Greenway (JLG) is a 27.5-mile non-motorized pathway that will connect neighborhoods across the city. Currently under construction, the JLG will provide safe travel options for residents through a combination of off-street trails, on-street protected bike lanes, and connections to existing mobility infrastructure. This case study explores how an equity-centered public participation approach was implemented in the planning of the JLG to support positive social, environmental, and economic outcomes for underserved communities adjacent to the trail. Specifically, this work explores inclusive engagement methods and policy interventions used to protect existing communities from green gentrification and displacement.

This study is informed by a review of literature on inclusive community engagement, equitable development, and non-motorized infrastructure planning in urban contexts. A review of community engagement methods developed by consultants contracted to plan the JLG—including the author—is also provided. This review outlines strategies that researchers, decision-makers, and practitioners can employ to more meaningfully understand and respond to the needs of the communities in which they work.

Study findings describe how negative outcomes stemming from infrastructure development in underserved communities can be mitigated by equity-centered approaches to public participation. Importantly, such approaches can help address community concerns related to development, including displacement of existing residents, ongoing environmental injustices, and inequitable access to the benefits of proposed improvements. Results indicate that community empowerment and capacity-building should be integrated into public participation processes associated with urban trail planning, if equitable outcomes are to be achieved.

Prioritizing equitable access to the beneficial outcomes of infrastructure development is critical for improving quality of life for underserved communities. Community-driven and place-based planning approaches can be leveraged to provide benefits for communities that are often negatively impacted by development. This study explores how such approaches can enhance access to the benefits of development for those that need them most and provides guidance for authentically including residents' aspirations and concerns in decision-making processes.

Investigation of Mechanisms for Oak Seedling Success under Pine in the Lake States Region

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Oak (*Quercus spp*.) are an important component of forest ecosystems in the Lake States Region. However, oak dominance has declined partly due to poor regeneration and limited seedling establishment. Interestingly, successful germination, seedling establishment, and growth of oak have been regularly observed in adjacent red pine (*Pinus resinosa*) plantations. We investigated potential biotic and abiotic factors contributing to greater oak seedling success under red pine than oak overstory. Specifically, we conducted a greenhouse experiment designed to evaluate the contribution soil microbial and nutrient feedback on northern red oak (*Q. rubra*) seedlings by using soils collected from four pairs of adjacent oak/red pine stands across the Lower Peninsula of Michigan. We also evaluated the abiotic effects, including light availability, in the same study sites.

In the greenhouse experiments, oak seedlings were grown in soils for 10 weeks to assess soil microbial and nutrient feedback on seedling performance. Soil pH was measured and fungal microbiomes were assessed from the soil inoculum and the roots of the seedlings. We hypothesize that *Q. rubra* seedlings perform better in pine than oak soils due to beneficial microbial and nutrient feedback. In the microbial feedback experiment, seedling biomass was greater in pine than oak soils, but only when grown in soils from sites with low soil pH (< 5). In these low pH soils, we found higher relative abundances of fungal endophytes associated with oak roots grown in pine than oak soils. In addition, relative abundances of fungal plant pathogens were greater in seedlings grown in pine than oak soils with high pH (> 5) in the microbial feedback experiment. We found no significant effect of nutrient feedback on seedling biomass.

In the field study sites, light availability for oak seedlings was similar between the pine and oak stands. This was partly due to the high mortality rates of mature oak trees caused by the infestation of spongy moth (*Lymantria dispar*) and early summer drought in 2020. When the light levels were adjusted by offsetting the light availability difference in mid-May when mature oak trees broke buds for each paired stand, light availability was greater under pine and oak trees during the 2023 growing season.

Our findings suggest that both biotic (soil fungal communities) and abiotic (light availability) characteristics of red pine stands may contribute to oak seedling success in the Lake State Region.

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How Equitably Are Ecosystem Services Distributed in U.S. Metropolitan Areas?

Libby Kula
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Using Urban Integrated Valuation of Ecosystem Services and Tradeoffs results for the ecosystem services of urban cooling and urban nature access for the years 2001, 2011, and 2021 for 380 metropolitan areas in the contiguous U.S., I analyze the distribution of these ecosystem services, a.k.a. ecosystem services inequality, across various socioeconomic variables. I find significant inequities in the provision of ecosystem services across socioeconomic status, race and ethnic minority status, household characteristics, and housing type and transportation. In some cases, the amount of energy savings from urban cooling experienced by disadvantaged communities is roughly half that of the advantaged metropolitan population. For 2021, Census tracts with a relatively high proportion of people of color have less than 1/4 of the urban nature supply per capita of relatively white tracts. I find inequities in ecosystem services provision typically persist, and in some cases worsen, over the 20-year period of study.

A Nationally Recognized Master's Program for Extension Training in Agricultural Economics

Yoko Kusunose
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Agriculture has long been implicated as one of the causes of global climate change. This is still the case, but the conversation now includes the possibility of agriculture being part of the solution. Research is starting to reveal the mechanisms and effect magnitudes of new and old agricultural management practices in reducing pollution and even generating ecosystem services, two important examples of which are abating planet-warming emissions and sequestering carbon. But this research must be translated to practical and realistic changes in farm management, and this translation much take place quickly, given the possibility of climate- and other environmental tipping points.

Departments of Agricultural Economics (also known as Applied Economics departments) have long been concerned with i) evaluating the cost-effectiveness of regulations and policies, ii) understanding who adopts new technology and why, and—related to this—iii) how governments can incentivize producers to implement specific practices. One more powerful but underrecognized area of expertise is Extension. Agricultural Economics departments are not unique in this aspect; it is common for departments in Colleges of Agriculture to have Extension. But in Agricultural Economics, Extension faculty speak the language of costs, feasibility, and longer-term profitability. They have long-standing relationships with farmers as well as a rich a tradition of working should-to-shoulder with 'hard scientists,' the ones who identify, hone, and evaluate the effectiveness of the technologies themselves.

Extension faculty serve as a conduit between researchers, policy makers, on-the-ground decisionmakers, and other stakeholders. If the US is to quickly identify effective and practical solutions to slow climate change through agriculture, it needs more graduates who are conversant in i) the research process, and ii) the objectives and constraints of decisionmakers, and iii) communication (both education and listening). The Agricultural Economics department at the University of Kentucky has re-oriented its Master's program to produce such graduates. In my talk, I will describe what this looks like. I will also provide examples of existing Agricultural Economics Extension programming that facilitates producers adopting technologies that reduce pollution or increase the provision of ecosystem services.

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Community Perceptions of Ecosystems in St. Thomas, United States Virgin Islands

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In the social-ecological systems framework, effective management of a resource relies on understanding how resource actors use and perceive the value of that resource. Public perceptions have been incorporated into research on ecosystems, hazard mitigation, and resource management in the continental United States. Recently, the U.S. Virgin Islands – an unincorporated territory of the United States of America – has prioritized incorporating the territory's natural ecosystems into their hazard mitigation approaches. These ecosystems – namely forests, guts, mangroves, salt ponds, beaches, seagrass beds, and coral reefs; collectively are often referred to as the "Ridge to Reef ecosystem"– characterize the islands and provide notable mitigating services such as stormwater and flood control, carbon sequestration, coastal protection and shoreline stabilization. However, current effective management of these ecosystems is threatened by urban development, and a perception held by some local experts is that many residents do not recognize the importance the territory's ecosystems.

As such, this research seeks to establish the community perceptions of ecosystems in St. Thomas (one of the three main islands comprising the U.S. Virgin Islands), and if those perceptions are reflected in territorial governing documents. Additional objectives of the study seek to assess how communities benefit from these ecosystems, determine what communities think about the health of these ecosystems, and ascertain if there are any differences in perceptions based on community location.

This research employed a mixed methods approach, using the explanatory sequential design. For the quantitative analysis, twenty territorial governing documents were selected, and their content was analyzed. Four general themes and 34 sub- themes were created for the governing documents. Using the sub-themes as search parameters, a total of 22,584 codes were present across the governing documents when analyzed using MAXQDA software. This analysis was used to guide the creation of a survey and interview instrument, which was the basis of the qualitative portion of this research. 384 St. Thomas residents were surveyed and eight were interviewed. The preliminary results establishing community perceptions will be provided, and conclusions will establish the perceptions of ecosystems, their relationship with the governing documents, and provide recommendations to local management, as applicable.

Cultivated Meat: A Comprehensive Analysis of Themes and Sentiments in Academic Discourse

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Cultivated meat, also known as lab-grown or in vitro meat has been proposed as a solution to sustain our global food systems. This production method aims to replicate the biological process of building muscle in lab-controlled conditions to grow meat for human consumption. To gain a holistic understanding of expectations for cultivated meat's success or failure across disciplines and through time, we analyze peer-reviewed literature using qualitative methods, including a thematic analysis and a sentiment analysis. Phase 1 uses a thematic analysis to examine how articles report (A) the problems cultivated meat may solve, (B) the challenges faced in solving each problem, and (C) the problems exacerbated or created by using cultivated meat as a solution. Phase 2 uses a sentiment analysis to understand how speculation is used in each paper regarding outcomes where cultivated meat (D) solves these problems, (E) exacerbates existing problems, and (F) creates new problems. We will use this to understand the evolution of thinking and communication around the potential outcomes of cultivated meat innovation. The results will be aggregated across time, discipline of publication, and the level of speculation for any occurrences of (D) through (F). This method is particularly relevant for evaluating cultivated meat, as new technology is typically accompanied by speculative language. As advancements are made, speculations for the expected outcomes evolve as well. Our findings will provide insights into when changes in speculation occurred and offer a starting point for future research on why patterns may have occurred over time. This methodology applies to technological developments in food sustainability as well as other fields where technological innovations are proposed to solve sustainability problems.

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Integrating Multidisciplinary Approaches to Understand Ecosystem Services in Changing Agricultural Landscapes

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Agricultural landscapes are necessarily social-ecological systems where ecosystem function is inextricably linked to outcomes in agricultural systems. Yet, these systems and the stakeholders within are far from homogeneous and thus whether ecosystem function translates to ecosystem services, disservices, or neither depends on perspective. This heterogeneity of perspective is particularly challenging in the context of widespread environmental and policy change. For example, in California, a historical drought, and associated environmental challenges, in 2011-2015 led to the passage of the Sustainable Groundwater Management Act (SGMA) that is anticipated to result in extensive and long-term land fallowing (i.e. retirement). Such widespread land use change results in numerous potential ecosystem services and disservices, only a subset of which accrues to any particular individual. Here we discuss multidisciplinary research to understand how widespread land retirement impacts biodiversity, regulating ecosystem services, and how different stakeholders including farmers, NGOs and resource managers perceive groundwater regulation and land retirement. Our stakeholder interviews suggest varied perspectives even within specific stakeholder groups, despite general recognition of the need for groundwater management. Further, our landscape modeling efforts reveal widely differing economic costs and social-ecological benefits depending on where land retirement occurs. Policies such as SGMA necessarily generate winners and losers at an individual level, yet our research suggests who perceives a benefit is complex, while the net societal benefits and costs depends on the type and spatial distribution of retired croplands.

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Forestry of the Future: Improving Student Readiness and Workforce Participation of Underrepresented Minority Populations in Forest Resources

Zakiya Leggett[1], *Porche' Spence*[2], *Rajan Parajuli*[1], *Mark Megalos*[3], *Sam Cook*[1], *Elizabeth Nichols*[1], *and Stacy Nelson*[1]

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Forest systems are major economic engines to rural economies. However, nationwide, forest resources has the lowest minority representation within Food, Agricultural, Natural Resources, and Human Sciences and even lower representation in the US South. Diversity enrollment and matriculation have failed due to poor intersections of academic support, peer community support, mentoring, leadership development, and "readiness" work skills. This NNF program builds on a pilot program to provide a pathway for undergraduate students of color from HBCUs to enroll in a graduate program in forest resources at NC State University (NCSU).

The NCSU NNF program has recruited and graduated seven forestry graduate students of color and prepared them for matriculation and professional success through NNF-specific programmatic, curricular, and industry experiences in forest resources. Key NNF program elements are a minority Mentoring/Leadership Community (MLC), certified forest curriculum, and industry internships. This program supports USDA's goal to develop a diverse and highly-skilled workforce for employment shortages in forest resources.

Surveys were distributed to students participating in the program to further understand the reasons graduate students of color in a National Needs Fellowship (NNF) program decided to pursue a career in forestry. Initial survey data showed that graduate students of color are motivated by pursuing specific forestry topics in the field while also having differing expectations with regard to career and financial opportunities. The results of this study could provide insight for NNF-funded and other programs to further support diversity in the field of forestry. However, additional information would be helpful in strengthening the results of this study, which could include increasing the number of participants for more quantitative data and/or collecting qualitative data to gather additional details and information on the survey responses.

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Examining the Influence of Diverse Stakeholder Collaboration on Land Management & Agricultural Sustainability in the Thunder Basin Ecoregion

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The 11 states in the American West represent over 20% of the U.S. beef cow inventory, or approximately 6.4 million cows. Given the constraints of agricultural production on semi-arid rangelands, ranchers are dependent upon the use of public rangelands for livestock grazing in order to supplement the amount of available forage. Grazing is a permitted use on 270 million acres of public lands across the West, but public lands are federally-mandated to be managed for multiple uses, including natural resource harvesting, energy extraction, conservation, and recreation, which can provide ecosystem services that meet the needs of the American people. However, sustainable management that supports both agricultural production and conservation can be threatened by conflict between stakeholders with diverse perspectives. Creating a shared vision for the landscape can be challenging for stakeholders who value different ecosystem services. A better understanding is needed of how management decisions and policies are created in response to diverse stakeholder needs, as well as the socio-ecological impacts of these decisions, in order to maintain sustainable working landscapes that support both agricultural systems and natural resource conservation.

In northeastern Wyoming, the Thunder Basin ecoregion is managed for varied interests, including livestock grazing and conservation. Ranchers support their operations through the use of permitted grazing in the Thunder Basin National Grassland. While livestock grazing is a major land use supported in Thunder Basin, land managers have become increasingly concerned about management of black-tailed prairie dogs, because this region contains the only remaining large prairie dog complex within the historical range of the endangered black-footed ferret. Accordingly, the U.S. Fish and Wildlife Service has identified Thunder Basin as an important site for future black-footed ferret recovery. Managing agencies like the U.S. Forest Service have attempted to respond to conflicting management goals through collaborative decision-making processes, but it remains unclear how multi-stakeholder collaboration is impacting management decisions.

Working at the invitation of a local non-profit organization aiming to enhance the sustainability of working lands in the region, we utilized a mixed-method approach to investigate how and why public lands management is changing in the Thunder Basin ecoregion. We analyzed semi-structured interviews (40) with ranchers, land managers, agency personnel, government officials, and researchers, in order to identify the diverse perspectives, knowledge, and beliefs of stakeholders in Thunder Basin. We then analyzed 80+ years of U.S. Forest Service rangeland management records to examine historical patterns and drivers of land use. We find that different stakeholders describe different ways of knowing Thunder Basin, which impacts their interactions with different sources of knowledge in management decisions. We also identify a decline in grazing intensity over time and describe changing paradigms in rangeland management in response to multiple competing societal demands. Our analysis illustrates how diverse viewpoints can present constraints on ecosystem services while also introducing new opportunities of realizing them. Understanding these factors is critical to our ability to maintain sustainable working landscapes that support western livelihoods, communities, and ecosystems.

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Model-Based Tandem Assessment of Human and Ecological Exposures to Environmental Chemicals

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Humans and wildlife are exposed to a multitude of chemical substances emitted from multiple lifecycle sources and present in multi-scale, multimedia environments, through multiple exposure pathways. These exposures are often interconnected because humans and wildlife may share habitats, food webs, and ecological services. For instance, contaminated surface or subsurface water not only threatens aquatic organisms but also affects human health if it serves as a source of drinking water. However, exposure levels and associated risks may differ between humans and wildlife due to inter-species variations in exposure sources, pathways, and severity. This multidimensional and interconnected nature of chemical exposures necessitates a systematic, mechanistic perspective in exposure modeling, and therefore, a holistic approach to track a chemical's journey from production to presence in both humans and ecological receptors.

In this presentation, we introduce the state-of-the-science modeling framework named PROduction-To-EXposure (PROTEX), designed to characterize the entire continuum from chemical production, multi-source emissions, multi-scale and multimedia environmental fate and transport, and multi-pathway exposure, to the presence in humans and wildlife. PROTEX is grounded in theories of substance flow analysis, multimedia fate and transport, bioaccumulation, and exposure and toxicokinetics. It integrates mechanistic descriptions of various physical, chemical, biological, and socioeconomic processes that impact human and ecological exposures.

As an illustrative case study, we will demonstrate the use of PROTEX to screen and rank 95 chemical substances commonly used in the United States (e.g., biocides, construction material additives, solvents, plasticizers, and personal care product ingredients) based on exposure rates and health risks posed to both humans and wildlife species. These chemicals receive different rankings in assessments depending on the specific goals of the assessment. Through this case study, we will provide an in-depth discussion of the connections and differences in chemical assessments that aim to safeguard human health and ecosystem integrity, respectively. We will also explore how such a holistic modeling approach promotes both human health and ecological health within the One Health framework.

Note: A high-throughput version of PROTEX (PROTEX-HT) is implemented in a user-friendly online platform, the Exposure And Safety Estimation (EAS-E) Suite (https://www.eas-e-suite.com), to facilitate its application and evaluation by interested parties.

Sustainability and Resilience: An Ecosystem Service Perspective for the National Environmental Policy Act

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Sustainability reflects resilience. Resulted from excellent management of the ecosystem in generating continuous ecosystem services for human societies, a higher level of sustainability reflects a higher level of resilience in the coupled socio-ecological systems in adapting to internal and external stressors or disturbances such as climate change. Sustainability measures can be understood from the aspects of ecosystem services (flows in various physical units) and the economic and natural capitals (stocks in monetary units). As a contribution to effective implementation of the National Environmental Policy Act, this presentation elaborates an interdisciplinary and holistic framework for understanding integrated impacts of proposed natural resource management actions on human communities and the tradeoff of management decisions.

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Increasing Co-benefits of Green Infrastructure Using Interactive Decision Support Systems

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Urban greenspaces, when thoughtfully designed, have the potential to enhance residents' quality of life, substantially contribute to biodiversity conservation and socio-ecological resilience, and support climate mitigation and adaptation efforts. However, transforming these greenspaces presents several challenges: 1) Urban greenspaces are often viewed as isolated entities disconnected from the broader landscape; 2) There is a reluctance to implement the active management techniques needed to create high-quality connections between urban greenspaces and the larger landscape matrix; and 3) Traditionally, urban greenspace management has been driven by top-down approaches that prioritize technical expertise or bureaucratic processes, often at the expense of meaningful community engagement.

In the context of climate change, achieving successful nature-based transitions for both improved quality of life and climate resilience will require not just ecological changes, but also radical interventions, social transformation, and adaptation. To create new urban ecologies that better integrate cities, people, and nature, social tipping points are required that shift perceptions away from viewing cities as separate from natural ecosystems. This presentation outlines transdisciplinary research on developing an online platform designed to actively engage the public in the co-design of landscapes. This effort led to the creation of a new online, citizen-interactive video game-based decision-support system (DSS) for designing high-performance landscapes. The DSS: 1) Integrates 3D visualization, gamification, and interactive landscape design; 2) Crowdsources local designs that function collectively on larger scales; and 3) Evaluates the effectiveness of this approach and its outcomes. The presentation will highlight lessons learned, best practices for developing DSSs, and the efficacy of crowdsourcing designs. We will conclude by discussing future development and research opportunities.

A Biogeographic Contrast of Invasive *Bromus tectorum* Abundance and Management in its Native vs. Non-native Ranges

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Widespread biological invasions by exotic plant species are degrading the biodiversity and ecosystem functioning (BEF) of rangelands at tremendous economic costs, creating an urgent need for management actions that provide sustainable solutions to rangeland plant invasions. However, most studies of invasive plant ecology and management are conducted solely within the non-native range of invaders, where they are most destructive. This lack of biogeographical context severely limits our ability to mechanistically explain why target invaders are much more abundant – and hence more problematic – in their non-native ranges relative to their native ranges. Addressing this fundamental question is a powerful step towards sustainably controlling plant invasions.

Our project takes an experimental, biogeographical approach to examine how biotic and abiotic processes affect the invasion and management of *Bromus tectorum* – an annual grass native to Eurasia but exotic and extremely invasive across North American rangelands – in its native and non-native ranges. Our primary research objectives are to 1) Quantify how biotic and abiotic processes independently and jointly affect *B. tectorum* abundance and BEF in the native and non-native ranges; and 2) Identify combinations of management actions that lead to effective, process-based management of local *B. tectorum* abundance and BEF. To achieve our first objective, we are replicating simultaneous, coordinated experiments in actively grazed rangelands in the native (Hungary, Greece) and non-native (Nevada, Wyoming) ranges of *B. tectorum*. These experiments manipulate key biotic (*plant-fungal interactions, insect herbivory, cattle grazing*) and abiotic (*fire, mechanical soil damage*) processes in a full-factorial design. To achieve our second objective, we have developed a graphical tool that clearly depicts how experimental treatment combinations (i.e., possible management actions) affect local trajectories of *B. tectorum* abundance and BEF.

Our project increases our mechanistic understanding of *B. tectorum* invasion and, perhaps more urgently, poises rangeland managers to control *B. tectorum* either by mimicking population controls that are more effective in the native range, or by disrupting positive feedbacks present mainly in the non-native range. Thus, our work translates foundational ecological science to actionable knowledge.

Manager Education and Agriculture Technical Skills Workforce

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The project's goal is to invest in underrepresented students to meet the needs of local and regional meat and poultry facilities through developing production workers, supervisors, and managers through training, certifications, and networking. The design of the project is based on the assumption that some students initially desire to pursue technical job positions while others desire leadership job positions such as supervisors. Thus, all participants are trained in the technical aspects of the meat and poultry industries while a select group is trained in leadership. The project has the following main components: a) meat and poultry workshops, b) certifications, c) internships, d) leadership conference, and e) networking opportunities at industry conferences/meetings. Imbedded in those components are mentoring by key personnel, and training-the-trainer as bachelor and master students will be trained to train the students pursing an associate's degree technical skills and applying the training at the meat and poultry workshops. The impact the project has will be discussed as well as demonstrating how different experiences can provide meaningful experiences that propel students to pursue careers in a specific field.

The Economic Benefits of Natural Climate Solutions in Minnesota

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Natural climate solutions (NCS) offer significant potential for both environmental and economic benefits. This study explores the economic impacts of implementing NCS in Minnesota, drawing on recent findings and data analyses. By focusing on strategies such as reforestation, wetland restoration, and sustainable agricultural practices, NCS can play a crucial role in mitigating climate change while also providing economic advantages.

The Nature Conservancy and Earth Economics study highlights that investing in NCS can lead to job creation, increased land productivity, and enhanced ecosystem services. Quantitative assessments reveal that these solutions not only contribute to carbon sequestration but also generate substantial financial returns for local economies. For instance, reforestation efforts can enhance timber yields, while wetland restoration improves water quality and flood management, reducing costs associated with environmental degradation.

The findings underscore the importance of integrating NCS into state-level climate strategies. Policymakers and stakeholders are encouraged to consider these benefits when designing and implementing sustainability initiatives. This abstract aims to provide a comprehensive overview of the economic advantages of NCS, advocating for their broader adoption as part of Minnesota's approach to combating climate change.

This presentation will delve into specific case studies and economic models, offering valuable insights for researchers, policymakers, and practitioners interested in the intersection of climate action and economic development.

Our results show that even with the minimum level of implementation (which is the least amount of acreage applied, consistent with current trends), NCS practices would support an average of 2,700 local jobs every year until 2050. Should decision makers opt for the maximum implementation scenario, it could support 5,200 jobs every year until 2050.

Because these benefits have generally been unevenly distributed across communities, this report also explores the value of benefits on lands within historically disadvantaged communities. These communities include Tribal lands, where NCS practices would protect and provide $753 million in benefits, as well as “environmental justice areas”—where the majority of the population identify as people of color and face poverty—that would see $425 million in benefits from NCS.

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Methods to Measure Relative Importance of Cultural Ecosystem Services

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ES management and decision-making often involves balancing tradeoffs between ES preferences. Monetary valuations can provide data on relative ES importance, but this set of methods is often poorly suited to represent the value of cultural ecosystems services (CES). Yet, CES are central to human-nature interactions, and their exclusion from ES assessments and management can have negative equity consequences. Here, we discuss four methods that can be used to measure CES relative importance: conventional Q-method, deliberative Q-method, weighting, and ranking. We argue that these methods can help overcome some of the limitations of the monetary methods and provide quantitative, generalizable data that supports ES decision-making.

We present ways to implement each method, their benefits and drawbacks, and examples for their application. We also explore the effectiveness of using physical objects to facilitate expression of relative importance for in-person implementation of some of the methods. We focus on the results from our empirical research for weighting and ranking methods. Specifically, we present the results from an in-person visitor survey conducted at the Intervale Center, an urban farm and park in Burlington, VT, USA.

The findings indicate that the use of the scoring method might be suitable to assess the relative importance of different facets of complex constructs like CES and relational values. Yet findings also suggest drawbacks to these relative measures, including that this relative importance between CES might often be challenging to measure, or even inappropriate to represent how people conceptualize their relationships with the natural world. We hope the results from this study can improve the consideration of CES in land management.

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Wildfire Risk Reduction in the Wildland-Urban Interface: Conflicts, Politics, and Urban Ecology

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As wildfires rage across the Canada and the United States, concerns about the vulnerability of wildland-urban interface communities are driving interests in managing forests to preventive wildfire. Programs like FireSmart Canada and FireWise USA have been developed to assist residents of the wildland-urban interface in evaluating their wildfire risk and applying mitigating measures. While the recommendations are diverse, there is particular emphasis on broad, generalizable recommendations that focus on the built infrastructure (e.g., exterior materials, wooden fences and decks) and the immediate landscape (e.g., grass heights, tree density). These recommendations are made simple so that they can be readily communicated to property owners and can be unilaterally disseminated across Canada and the United States.

Wildfire risk reduction in the wildland-urban interface focuses principally on reducing the volume of combustible materials on and around structures. For structures that have been recently constructed, the use of non-combustible building materials can substantially reduce ignition and consequential damage. However, when reducing risk on properties with existing structures, renovations to non-combustible materials are often cost-prohibitive. Instead, or in addition, changes to the surrounding vegetated landscape can prevent fire from spreading to the structure. Landscaping recommendations include using fire-resistant plants, using rock mulch instead of wood mulch, maintaining short grass, removing ladder fuels, and removing coniferous trees around the structure. Both the structural and landscaping recommendations have been successful in mitigating the impacts of embers or firebrands – carried beyond the extent of the wildfire itself – that would otherwise ignite combustible materials and set the structure ablaze.

In the Rural Municipality of Victoria Beach, Manitoba, Canada – the province's Model Forest – the FireSmart Canada recommendations have been frequently communicated to residents over the preceding 30 years. Following wildfires within the community, assessments were conducted of each property in 2004. Now, 20 years later, few changes have been made and FireSmart recommendations remain contentious. To explore why resistance exists despite on-going national and international coverage of wildfires, a qualitative survey was distributed to the community's 689 residents. Fifty-two properties returned the survey. The survey was complemented by a forest inventory and canopy cover assessment.

Using the remotely sensed canopy cover assessment, deciduous broadleaf trees were differentiated from evergreen coniferous trees. If residents implement the spacing and conifer-removal recommendations of FireSmart Canada would yield a 7.49% decrease in canopy cover. Forest biodiversity would also decrease in each sample plot following removals.

Community resistance to FireSmart Canada broadly occurred in reactions to the conifer removal recommendation. In response to being told to remove coniferous trees from their properties, residents end up rejecting the many recommendations of the program in its entirety. Concerns with conifer removals were based largely on cultural ecosystem services, including loss of sense of place and loss of community character. Other ecosystem services, including habitat provisioning, biodiversity, shading, and cooling benefits were cited in addition to the cultural ecosystem services. However, the majority of residents have or would consider implementing other recommendations from FireSmart Canada if it meant preserving the character of their forested community. FireSmart and FireWise should consider de-emphasizing the focus on coniferous tree removals to ensure uptake.

Misunderstanding of wildfire risk reduction also impeded implementation of risk reduction activities. Residents viewed the Municipality as forcing FireSmart practices while not implementing it on municipally owned properties. Residents also felt that, because their neighbors were not doing anything, their results would be futile. Improving public understanding of reducing risk of embers/firebrands ignition versus an approaching "wall of fire" could help explain to residents why risk reduction practices remain beneficial even when those around them do not take action.

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Building Resilience to Climate Change in the Colorado River Basin

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The Colorado River Basin is a critical resource for drinking water, food, and energy production, an engine for local economies and recreation, and an irreplaceable habitat for wildlife. The Basin is also an essential part of the cultural fabric of 30 federally recognized Tribal Nations and nearly 40 million people. Chronic overuse of the Basin system, exacerbated by climate-related changes, poses an increasing risk. Investing in on-the-ground water resilience strategies across the Basin is essential to prevent the system from crashing.

Resilience, in this context, is the ability of the Colorado River Basin to prepare for and adapt to climate shifts and extremes, including rising temperatures, more variable precipitation, and decreasing stream flows. Virga Labs partnered with a coalition of non-governmental organizations to outline how, as a Basin, we can improve the resilience of the Colorado River by implementing strategies and projects that reduce the risk and impacts of climate change, while generating co-benefits for people and nature. To most effectively identify, pilot, and scale strategies, ten investment strategies were identified that range from well-demonstrated to emerging at scale. Key resilience project categories including restoring headwater wetlands, improving agricultural practices, and boosting urban water conservation and efficiency.

To highlight the importance of these solutions, Virga Labs developed the Colorado River Resilience website which describes the need for resilience strategies for the Colorado River Basin and outlines what needs to be done to reduce our risk of increased drought, fire, and flood. We created an interactive project map and database, collected vignettes from extant on-the-ground projects, aggregated information about current funding opportunities for on-the-ground work, and a developed suite of resources that can be used to educate decision-makers and other stakeholders about the importance of resilience solutions and the benefits they have for local communities.

By investing in coordinated, durable resilience strategies, Colorado River communities can better adjust to and absorb the impacts of a hotter, drier climate while creating local jobs, improving water security, preserving cultural and traditional significance for Tribal Nations, protecting agriculture and food supply chains, and restoring and reducing pressure on rivers and ecosystems.

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The Colorado River Basin Post-2026 Operations Exploration Tool: Using Decision Making under Deep Uncertainty Methods in a Web-Based Decision Support Tool to Connect Policymakers and Stakeholders

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The Colorado River Basin is the lifeblood to 150 at-risk species, nearly 40 million people, and is a driver of economies, agriculture, and recreation. The operations of the two main reservoirs, Lakes Powell and Mead, impact all stakeholders and resources. The operating agreements of these reservoirs are set to expire in 2026, and the U.S. Bureau of Reclamation is currently leading the NEPA Process to replace them. This decision-making process is especially challenging given current outpacing of supply by demand, often conflicting stakeholder objectives, and deep uncertainty in future hydrologic conditions and water demands. Enabling a wide range of stakeholders to engage with the technical information is key to creating successor guidelines that are robust to the effects of climate change and balance diverse resource priorities (e.g. environment, hydropower, and water supply).

To support these objectives, Reclamation partnered with the University of Colorado and Virga Labs to create a publicly available web-based platform on which stakeholders can create and evaluate operational strategies through a Decision Making under Deep Uncertainty framework based on their priorities. The tool features over 100 evaluative metrics, including water quality, invasive fish population growth, and economic value of rafting. This tool represents an advancement in the ability of policymakers at Reclamation to collaborate with stakeholders in the generation and analysis of technical information. The platform is also an example of a successful years-long partnership between a government agency, academia, and private industry to create an innovative tool that is supporting an impactful and transparent long-term planning process that aims to increase resilience to climate change uncertainties and balance diverse stakeholder priorities.

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Citizen Science as an Approach for Valuation of Biodiversity in Environmental Impact Statements

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As urbanization and population growth increasingly exert pressure on natural ecosystems, the integration of sustainable development with biodiversity conservation becomes critically important, with a particular emphasis on protecting ecosystem services. Maintaining biodiverse ecosystems is crucial for sustaining the ecosystem services they provide. Citizen science, defined as the involvement of the public in scientific research and monitoring, is an increasingly important approach to the measurement and valuation of biodiversity. This approach not only enhances data collection across large spatial scales but also engages the public, potentially leading to more effective conservation efforts. Despite its growing relevance, the full potential of citizen science in policy frameworks has yet to be investigated and documented.

We highlight the role of citizen science in advancing our understanding of ecosystem services, emphasizing its integration into sustainable environmental management and policy frameworks to foster resilient ecological and human communities. First, we explore the role of citizen science in enhancing environmental impact statements under the United States National Environmental Policy Act. By analyzing over 1,000 environmental impact statements, we assess the extent to which these policy documents currently leverage citizen science data. Our findings reveal that approximately 40% of national-level environmental impact statements in 2022 referenced or used citizen science data, underscoring its growing influence in environmental decision-making. Second, we discuss illustrative case studies demonstrating how platforms like iNaturalist are effectively used to measure and enhance ecosystem services, providing practical examples of citizen science in action and its impact on conservation practices and policy formulation.

This integration not only enriches biodiversity monitoring but also democratizes the data gathering process, potentially leading to more informed and inclusive environmental governance. Broader adoption requires addressing significant considerations around data validity, participant engagement, and policy alignment. Our work highlights the transformative potential of citizen science in bridging the gap between community involvement and ecosystem service conservation, a critical dialogue for stakeholders at all levels of environmental policy and management.

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Scaling Up Investment in Nature-Based Solutions Using Green Banks and Community Lenders

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Nature-based solutions (NBS) are actions to protect, manage, or restore natural or modified ecosystems that address societal challenges, simultaneously benefiting people and nature. Many of the societal benefits gained from NBS are in the form of ecosystem services. Recent government investment in NBS through programs funded by the Inflation Reduction Act and Bipartisan Infrastructure Law is unprecedented, but there is still a need for scaled-up financing of NBS projects in the United States. EPA's $14 billion National Clean Investment Fund allows investment in NBS that contribute to climate change mitigation, remediation of legacy pollution, and development of clean water infrastructure. These funds are meant to catalyze additional investments through financing mechanisms established by Green Banks and Community Development Finance Institutions (CDFIs).

Green banks and CDFIs are mission-driven financial institutions with mandates often related to decarbonization, climate, health, and equitable communities. NBS have the capacity to deliver on some, if not all of those goals. While green banks and CDFIs have not traditionally focused on NBS, there is an opportunity to work with these financial institutions to more explicitly include nature-based projects into their missions and charters to help enable scaled-up financing of these types of projects. A workshop held in summer 2023 gathered a group of academics, practitioners, financiers, and NBS investors to create resources that could help green banks and other similar financial institutions gain access to the information and resources they need to begin to scale-up these types of investments. This poster will provide an overview of these resources and an update on the status of green bank investment in NBS.

An Assessment and Valuation of Ecosystem Services Derived from National Parks in Queensland (Australia)

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It is recognised national parks protect a range of ecosystem services (ES). However, the types and extent of ES and their value to people's wellbeing, communities and economies is poorly understood. This research focused on national parks in the state of Queensland, Australia, with a view to illustrating to decision makers and communities the often-invisible values of ES.

For the first time, an ES framework was used to identify and evaluate the potential ES in 36 national parks. The framework used was the award-winning and internationally recognised South East Queensland Ecosystem Services Framework (the framework). The park management agency provided the extent in hectares of ecosystem types in each national park. Applying the framework's expert derived scores allowed a potential ES score to be developed and a ranking of each ecosystem area within each park. Also, the total ES potential score for each park. Overall patterns observed were that some parks earned higher ES scores due to the higher scoring of some ecosystems. In addition, generally the bigger the park the higher the total potential ES. This information points to ES values being a useful complement to traditional Comprehensive, Adequate and Representative approaches to prioritising protected areas.

For ES to be actualised as benefits to human wellbeing beneficiaries need to be identified. Three ES in three national parks were chosen to provide tangible examples of actual ES. Dollar values were generated for eight ES, and a descriptive approach for cultural values. Dollar values were generated using benefit transfer. Tourism and recreation services based on a study of Queensland national parks were given a 'high level' of confidence. Other values were estimated using the ESVD database of global studies and labelled 'indicative'. Estimated annual dollar values for the eight ES across three national parks ranged from $0.4 million (p*ollination*) to over $140 million (*tourism and recreation*). Most estimates are in the millions to tens of millions per annum. These represent the annual flows of services to local or broader communities which come free of charge from national parks. The asset values over 30 and 50 years of retaining these parks to provide ES were also estimated. Notable high asset values include *tourism and recreation* and *habitable climate*, each in the billions of dollars, and *buffering against extremes* and *food from fisheries*, each in the hundreds of millions of dollars.

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Ecosystem-Based Adaptation to Climate Change of Indigenous Women in Indonesia (Sumatra) and Australia (Queensland)

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The contributions of ecosystems to human well-being are commonly referred to as *ecosystem services*. Indigenous women rely heavily on ecosystem services for their food, physical and mental health, and livelihoods, making them particularly vulnerable to the effects of climate change. Our project sought to investigate the impacts of climate change on ecosystem services important to Indigenous women in the Mentawai Islands and Aceh Singkil (Sumatra, Indonesia) and two sites in the Wet Tropics of Queensland (Australia).

The aim of this project was to assist Indigenous women to identify potential ecosystem-based adaptation measures that could improve their resilience and future proof their communities. The study applied the Whole-of-System Value-Based Framework (developed by the Queensland Government) and outcomes from climate modelling to identify how climate change is changing ecosystems, ecosystem services, threats to and pressures on ecosystem services, the losses and damages caused by climate and non-climate change drivers and pressures, and potential environmental, social, economic and governance interventions.

To populate the framework, we used a mixed-methods approach combining traditional and local knowledge with western science. First, we conducted ecological assessments, then open-ended and semi structured questionnaires and focus-group discussions with Indigenous women in each of the four case study areas, before applying outcomes of climate models. To empower Indigenous women to future proof their communities and cultural lands and safeguard their livelihoods and well-being, this research facilitated cross-cultural knowledge exchange between the women through visitations to each other's cultural lands where women learned from each other and developed their own robust evidence based and culturally sensitive ecosystem-based adaptation plans.

The outcomes will provide policymakers, community leaders, and other stakeholders with insights that will aid in developing more effective, socially just and equitable climate change adaptation policies, strategies, programs. As well, nature conservation strategies and protected area management plans. This project will contribute to the Australian and Indonesian Government's commitment to achieving the SDGs 3, 5, 10, 13, 14, 15 and 17. As well, commitments under international agreements such as the United Nations 30 by 30 target, the Convention on Biological Diversity, Ramsar, UNESCO Biosphere Reserves and the Paris Agreement.

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Cultural Ecosystem Services (CES) Enhance Investments in Other Ecosystem Services: Carbon Credits in Haiti

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This presentation examines opportunities for collaborative solutions between the Global North and South that can improve ecosystem services (ES) provision by also focusing on CES. We demonstrate how the CES of education, sense of place, and inspiration served to strengthen a carbon sequestration project involving tree planting and maintenance in a region of the global south where poverty and deforestation are intertwined. Where other carbon offset credit programs have not lived up to anticipated goals, this project – with its emphasis on cultural ecosystem services – succeeded in sequestering carbon and improving small-holder incomes and other ecosystem service co-benefits that increase agricultural resiliency. The case study involves an educational program in Haiti developed collaboratively by a liberal arts college in the U.S., a local non-profit organization, and a community of small farmers who sequester carbon in coffee-agroforestry systems. The carbon credits were verified by students, building workforce and technical skills, while educating about carbon and approaches that build resiliency to climate change. A focus of the program was not only to help farmers make more secure the place they value, but also to immerse students in place-based learning about historical injustices between the Global North and South. Working with Haitian farmers to establish these agroecosystems inspired students to act towards effective solutions to climate mitigation and to pursue other means of addressing inequality and injustices. This case, and others, suggests that intentional integration of CES into ES programs not only better addresses the needs of different stakeholders, but also strengthens the provision of other ecosystem services, especially in contexts where, historically, such services have been difficult to protect and maintain.

Cumulative Impact assessment and Actions in the Context of Environmental Justice

***Charles Menzie**, Ann Michelle Morrison, Melissa Kleven, Andrew Deines, Qiyuan Yu, Brianne Duncan, Sean Ryan*
Exponent Inc. , Tampa FL, Burlington MA, Bellevue WA

This presentation lays out an approach for incorporating ecosystem services - as well as human health considerations - into a holistic assessment of cumulative impacts. This need has arisen in the context of addressing vulnerabilities of populations living under marginal conditions. These vulnerabilities arise from socioeconomics, access to health care, physical changes in environments due to climate and other factors, and pollution. United States environmental policies at the national and state levels are currently emphasizing the need for cumulative impact analyses to support programmatic, regulatory, and project decisions that pose additional burdens on already overburdened communities. At the national level, these policies fall under the Environmental Justice initiative. Similar policy attention is emerging around the globe especially with respect to impacts of climate change, chemicals, and migrations of people. We have developed a holistic multiple stressor assessment methodology that involves participation from the impacted communities, government agencies, and business community. The methodology is organized around the concept of Human Well Being (aka One Health) and integrates human health risks with impacts upon ecosystem services. Human health risks and ecological impacts are normalized to common metric scales so that baseline conditions and subsequent changes can be viewed collectively for individual health risks and environmental impacts; these individual risks/impacts are not added together as that can obscure important directional changes in health or environmental conditions. The integration of multiple stressors is accomplished through the presentation of results as part of discussions within and among the different groups. Thus, dialogue is essential to the process as different groups will likely perceive the results from varied cultural and personal perspectives. The proposed methodology focuses on defined populations that share common attributes, and the analytical framework allows for the designation of multiple populations so that cumulative impacts and associated gains and losses can be understood at various societal and spatial scales. The strength of this approach is that it integrates the technical aspects of cumulative impact assessment with stakeholder engagement. Achieving the right level of detail and using various communication tools are important for reaching a shared understanding among diverse groups.

Exploring the Synergies Between Biodiversity and Human Use of Urban Greenspaces

Nataly G. Miguez[1]*, Brittany Mason*[1]*, Jiangxiao Qiu*[2]*, Haojie Cao*[2] *and Corey T. Callaghan*[1]

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Urban greenspaces are essential for both human well-being and biodiversity, with their importance continually growing in the face of increasing urbanization. The use of urban greenspaces by humans and biodiversity are often not considered simultaneously, even though wildlife watching is an ecosystem service that contributes to human well-being. Examining the interplay between human activity and use of an urban greenspace, including wildlife watching, and biodiversity within urban greenspaces can inform how planning and management can best serve the diverse needs of both people and biodiversity.

We compared human utility, defined as the services that people derive from urban greenspaces, and biodiversity to advance our understanding of possible synergies and tradeoffs between the two. Through a detailed inventory, we mapped 639 urban greenspaces throughout Broward County, Florida—one of the most populous counties in the United States. We identified and categorized various physical attributes contributing to human utility, including playgrounds, athletic facilities, and picnic areas. Concurrently, we assessed biodiversity by estimating species richness within each urban greenspace using citizen science data.

The use of citizen science data allowed us to estimate the overall level of biodiversity and wildlife viewing activities by the public, thereby determining the biodiversity benefits of these greenspaces. We found little relationship between overall human utility and biodiversity. However, we discovered a positive correlation between specific physical attributes—such as playgrounds, bodies of water, and nature preserves—and biodiversity. These features potentially encourage greater greenspace visitation by individuals who engage in wildlife watching and increase overall park biodiversity.

Both human utility and biodiversity correlate with greenspace size, emphasizing the significance of larger greenspaces in accommodating diverse values. This alignment between human utility, wildlife watching, and biodiversity benefits suggests that urban parks can effectively serve multiple values without necessarily sacrificing one for the other. Our results offer insights for optimizing planning and management of urban greenspaces to simultaneously benefit local communities, provide ecosystem services, and increase biodiversity, highlighting the potential for harmonizing human and biodiversity needs to foster sustainable cities.

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A National Study Valuing Ecological and Recreational Improvements in Water Quality

***Chris Moore*[1]*, Matt Massey*[1]*, Steve Newbold*[2]*, David Smith*[1]*, Bryan Parthum*[1]*, Wes Austin*[1]

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We report results from a nationwide stated preference study valuing water quality improvements in lakes, rivers, and streams of the contripinental US. The study is motivated by challenges that economists in the US Environmental Protection Agency (EPA) face when estimating non-market benefits from regulations that impact surface waters. We designed this study to answer several research questions that arise from gaps in the peer reviewed literature on water quality valuation and become obstacles when assessing Clean Water Act regulations.

Nearly all the peer reviewed stated preference studies that can provide values for benefit transfer examine improvements in just one or two states. The spatial scopes of those studies limit the EPA's ability to establish empirical support for the extent of market for water quality improvements. Further, there are large areas of the US that are not represented in these studies, raising questions about regional differences in household willingness to pay for water quality improvements. This study sampled households in all 48 contiguous states and the District of Columbia, collecting data from previously underrepresented regions of the country with unique perspectives on water quality. Half of the valuation scenarios viewed by respondents involved improvements happening outside their home state which allows us to examine the extent of market for those improvements. By varying the location and size of the regions referenced in the valuation scenarios we also introduce variation in the quantity of water being improved, something that is rarely a feature in the experimental design of other stated preference studies. This additional source of variation across scenarios allows us to examine the impact of quantity on willingness to pay and estimate interactions with quality improvements (i.e., their marginal rate of substitution).

Another challenge regulatory analysts face when estimating water quality benefits is that different sources of benefits are not necessarily impacted the same way by a given regulation. Specifically, the safety and suitability of lakes, rivers, and streams for recreation may respond differently than the ecological integrity of those waterbodies. Through extensive focus group research, we identified metrics of water quality that convey those sources of benefits independently. The valuation scenarios on the survey used in this study describe changes in water quality using two indices, a water recreation score and an aquatic biodiversity score. Improvements in those scores varied orthogonally in the experimental design allowing us to estimate a marginal willingness to pay for each.

We find that willingness to pay declines quickly as the distance from the improved region to the respondent's household increases. There is a fraction of willingness to pay, however, that is invariant to distance and can be partially explained by recent trips to distant regions while the remaining fraction could represent existence value. We also find significant regional differences in willingness to pay, revealing the importance of sampling previously unstudied regions of the country. Finally, our results indicate that people consider improvements in recreation activities and aquatic ecosystem integrity separately and the slope of the willingness to pay function differs across those dimensions.

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Incorporating Native Plant Selections to Beautify and Enhance Ecosystem Services in an Underserved Community

Leslie N. Munroe
University of Florida, Gainesville, FL, USA

We used Florida-Friendly Landscaping (FFL) principles to rejuvenate and transform a learning garden in an underserved community into an educational hub, promoting simple gardening practices, inexpensive planting techniques, and adding low-impact beauty to a landscape. FFL practices emphasize putting the right plant in the right place. We selected a palette featuring attractive native plants to support ecological balance, efficient water use, and other environmentally sound management practices in this urban environment. Native plants are distributed throughout the garden.

In 2023, the agent applied for and received a grant, including funds for plant materials. We reduced the cost of many other inputs by putting the right plant in the right place. The funds were used to purchase 22 plant species, 60% of which are eye-catching Florida natives. Incorporation of these lovely native plants supports sustainability, biodiversity, soil health, water management, and pest control.

We will assess the impact of including natives on critical ecosystem services through ecological surveys, garden management logs, and feedback from community members. Preliminary results indicate improvements in garden biodiversity and increased community engagement. By growing native plant species and populations in urban gardening areas, we can create more resilient, sustainable, and enjoyable green spaces that support ecological health and human well-being. Community engagement, empowerment, and increased knowledge of best landscaping practices are key outcomes of the revitalization initiative.

By highlighting the successes and challenges of emphasizing native plants in this context, we aim to provide a scalable model for other communities seeking to enhance ecosystem services equitably. Our findings suggest that appropriate plant selection is vital in promoting practices advancing environmental justice and improving the quality of life in underserved areas. This pragmatic practice also allows projects of this nature to be economically feasible.

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The Business Case for Salmon Parks

Angela Fletcher, ***Abby Needell,*** *Alice Lin, Olivia Molden*
Earth Economics, Tacoma, WA, USA

The Mowachaht-Muchalaht First Nation (MMFN) seeks to establish a network of "Salmon Parks," conservation areas to support the protection and recovery of key watersheds and wild salmon populations within its territories on Vancouver Island, British Columbia. This ongoing project seeks to provide a business case for Salmon Parks through a holistic benefit-cost analysis that includes economic, ecological, and sociocultural benefits associated with implementing Indigenous-led conservation for local and provincial economies, ecosystems, and communities. To structure the benefits and costs related to management changes for Salmon Parks areas, we analyzed a Business As Usual (BAU) scenario where timber harvest would continue with no change in management and a No Harvest scenario with a complete moratorium on logging. In this preliminary assessment, the benefits of the No Harvest scenario (as an alternative to BAU) include the sale of carbon credits, improved ecosystem services provisioning, and avoided costs of managing conflict and responding to disasters (e.g. wildfire). Costs include forgone timber income and the cost to participate in (or establish) a carbon credit marketplace. Benefits and costs were projected over 20, 75, and 140 years to reflect the short-, mid- and long-term on the forestry industry, local communities, and future generations. Accounting for all benefits, the benefit-cost ratio of the No-Harvest Scenario is 23.6 over 140 years and at a 3 percent discount rate.

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Getting Occupational Student Training in Agricultural Research Through Novel Workshops

Shad D. Nelson[1], *Randy L. Stanko*[1], *Consuelo Donato-Molina*[1], *Tanner Machado*[1], *Steven Chumbley*[1], *David Sotomayor*[2], *Krishnaswamy Jayachandran*[3], *and Mahadev Bhat*[3]

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Faculty from three Hispanic Serving Institutions in Texas, Florida and Puerto Rico have collaborated together for over a decade to increase diversity within the agricultural and federal government workforce. The 'GO START NOW' project is a collaborative grant funded by the USDA-NIFA Hispanic Serving Institute program. This project brings undergraduate students and faculty together from three institutions to collaborate in agricultural research studies in outdoor working laboratory environments in various regions of Costa Rica. The objective is to capture students through engaged, hands-on learning workshops and training them in the basics of research. Students work in a team-oriented approach to analyze data at the Texas A&M University Soltis Center where labs and classrooms are provided for research engagement. Additional educational lecture-based and field-based workshops are provided by faculty covering topics in soil science, animal science, water and environmental science, and culture. Student groups are required to provide a team presentation with open question and answer assessment provided by the professors in a mock oral exam related to their research topic. The impact of these workshops will be discussed with emphasis on the importance of time-intensive faculty engagement in student-centered research training in the agricultural sciences. The results of this collaborative HSI institutional approach will be demonstrated and how it can increase student diversity in agricultural science centered careers and enhance their preparation for higher education and graduate degrees.

Regional Place Meanings as Precursors to Attitudes Toward Socioeconomic Change

Haley Netherton-Morrison[1], *Morey Burnham*[2], *Rebecca Som Castellano*[1,3] *and Kelly Hopping*[1]

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Socioeconomic change is intensifying the pressure on rural livelihoods and well-being. This has prompted the increased application of place-based approaches to understand and measure people-place relationships, including investigations of sense of place, which has been explored as a type of cultural ecosystem service. These approaches can be used to identify the tangible and intangible values, meanings, and feelings that are associated with these relationships. Place meanings, which include values, emotional bonds, and experiences, are a dimension of sense of place that can influence well-being and responses to change. However, more work is needed to understand the meanings at risk as communities undergo change, as well as how those meanings inform community discourse around change. Our study addresses this need by adopting a regional approach to (1) identify how place meanings are expressed at a regional scale and (2) explore narratives connecting expressed regional place meanings and the discourse surrounding socioeconomic change. Combining iterative qualitative coding and thematic analysis, we analyzed interviews (N = 111 participants) and county comprehensive plans (N = 3) from three rural counties in Idaho that are experiencing a gradient of socioeconomic change. Our analysis revealed eight regional place meanings, each describing a distinct set of characteristics that may be important to community members. These include *Agricultural Pride* focusing on the aesthetic and functional benefits derived from agriculture and *Attractive Outdoor Destination* describing the diverse amenities and recreational opportunities for residents and visitors. Using these regional meanings as a lens, we were then able to identify how each may be affected by socioeconomic change and inform residents' responses to those changes. For example, though the *Attractive Outdoor Destination* meaning is fairly widely held, people who also strongly express the *Shared Stewardship* meaning may view population growth and economic development in the tourism sector more negatively because they disrupt a shared land use ethic. This has resulted in conflict and calls for greater enforcement in recreation areas and education of residents and visitors. Our assessment of how people-place relationships inform responses to change will better equip rural communities and land management agencies to make more effective and socially desirable decisions to promote more resilient rural communities.

Using Ecosystem Service Tools in Environmental Justice Community Development Project

***Tammy Newcomer-Johnson*[1], *Leah M. Sharpe*[2], *Kaitlyn Hines*[1,3], *Gregg Lomnicky*[4], *Adam Schlenger*[4], *Jim Harvey*[2]**

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The United States Environmental Protection Agency's Office of Research and Development has developed a collection of final ecosystem goods and services (FEGS) analysis tools connected by a shared ecosystem service classification system. The EPA's National Ecosystem Services Classification System (NESCS) Plus ensures consistency and enables decision-makers to move smoothly between the Ecosystem Services Tool Selection Portal, FST Scoping Tool, the FEGS Metrics Report, EnviroAtlas, and the EcoService Models Library.

This presentation will demonstrate how these tools can support the clean-up and reuse of contaminated sites. The focal case study will be the Lake Sandy Jo Superfund site in Gary, Indiana which is a former landfill site that was added to the National Priorities List in 1983. The site underwent a Superfund cleanup in 1994, which included adding a soil cover, providing a municipal water supply, and implementing controls to prevent direct contact with the buried landfill material. Recently, there has been interest in redeveloping the site, and the EPA undertook a project with state and municipal agencies to generate ideas for its redevelopment based on community priorities, using a values-led structured decision-making framework. The Lake Sandy Jo site is situated in a mixed-use area close to a heavily industrialized, low-income section of the city. Reuse of the site presents an opportunity to address concerns about environmental justice.

This case study included the application of several EcoService Models Library Models to estimate tradeoffs associated with site reuse scenarios. Some of the tradeoffs estimated included environmental education, stormwater management impacts (estimated using EPA SWMM—Stormwater Management Model), and possible fauna that could benefit from the site (estimated using IPaC—Information for Planning and Consulting).

Presenter Bio:

Dr. Tammy Newcomer-Johnson is an ecologist at the United States Environmental Protection Agency's Office of Research and Development. She is the technical lead for the Ecoservice Models Library ESML, https://esml.epa.gov/) and the National Ecosystem Services Classification System (NESCS Plus, https://www.epa.gov/eco-research/national-ecosystem-services-classification-system-nescs-plus).

Developing Resilient Grazing Systems for the Fescue Belt with Native Warm-Season Grasses

*Megan Berry[1], Pat Keyser[1], **Christine Nieman[2]**, Sindhu Jagadamma[1], Harley Nauman[3], Ken Coffey[4], Phillip Owens[2], Amanda Ashworth[5], Eric Bisangwa[1]*

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Tall fescue is a cool-season, non-native, perennial grass, that is the primary forage for cow-calf operations in the "Fescue Belt". Tall fescue exhibits semi-dormancy in mid-summer, particularly in drought conditions, limiting its use for grazing during summer. Additionally, tall fescue's symbiotic relationship with the endophyte *Epichloë coenophiala,* can cause tall fescue toxicosis in cattle, resulting in reduced weight gain and reproductive inefficiencies. A changing climate may add further challenges to production systems within the Fescue Belt. Native warm-season grasses can tolerate a wide range of adverse ecological conditions, are productive during summer months, and provide high quality forage. Thus, the incorporation of native warm-season grasses into a tall fescue-based system may increase overall resiliency. An experiment was conducted at three sites, Booneville, AR, Linneus, MO, and Louisville, TN with 12 cow-calf pairs per experimental unit. Two forage systems were evaluated: 1) incorporated a native warm-season species, big bluestem, switchgrass, or eastern gamagrass with tall fescue 2) tall fescue only. The TN study site tested eastern gamagrass, the MO study site tested big bluestem, and both big bluestem and switchgrass were tested at the AR site. Cattle were weighed yearly before initial grazing and again after final removal. Forage samples were collected at the beginning of grazing and once every twenty-eight days during the grazing season and later analyzed for nutrient composition. For AR and MO sites, weaning weights were greater, and for just AR, pregnancy rates were greater in the complementary systems. At TN, no differences in weaning weights or pregnancy rates were detected between treatments. Cow weights and grazing days were similar among treatments at all locations. Forage mass was greatest in the switchgrass system at AR and the complementary system at MO, but forage mass was consistent between treatments at TN. Nutrient composition did not differ among treatments at any location. At TN, the influence of warm-season grasses within the tall fescue only pastures and limited time on eastern gamagrass may have muted differences between treatments. These results may indicate that a mixed tall fescue stand may be of some benefit to a producer, however, on sites with less contaminated tall fescue only pastures, native warm-season grasses consistently improved weaning weights in two locations and pregnancy rates in one location.

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Greater Than the Sum of the Parts: Working Together to Support Data Collection and Multi-Model Ensembles for Carbon and GHG Services at Field, Watershed and Regional Scales

Yushu Xia[1], Xuesong Zhang[2], Anthony Aufdenkampe[3], Matt Sheffer[4] and ***Terry Nipp[5]***

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Fields and farms are located in places. Land management occurs at times. Water, nutrients, sediments, chemicals and biologicals flow into fields and farms and flow out again. To improve ecosystem services, to measure baselines, and to associate changes in carbon and GHG emissions with changes in land management practices, it is essential that measurement and modeling strategies be built with an awareness of the temporal and spatial dynamics of carbon and GHG cycles. In this session we're exploring how to develop more effective data sampling and collection strategies across scales, from fields to watersheds to regional agroecosystems. We're exploring how we can improve measurements and monitoring by better modeling of carbon and GHG cycles within and through watersheds by recognizing that they are not static and accounting for spatial and temporal dynamics in cycles. In order to develop these better measurements, we also have to assemble better teams. We've all been taught now that "real world" applied research is often best undertaken with multidisciplinary and multi-institutional teams, utilizing strong engagement with stakeholders. This is proving to be especially necessary for developing research and outreach projects that are assessing the interactions between land management practices, soil carbon, and GHG emissions. Data sampling strategies need to be developed in collaboration with the modelers who will be using the data and with stakeholder farm, forest and land managers who understand best the context within which the data is being collected. Each of us needs the others to develop meaningful and useful solutions.

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Quantifying Changes in Evapotranspiration and Carbon Sequestration in a Restored Longleaf Pine System

A. Christopher Oishi [1], *Thomas O'Halloran* [2], *Devendra Amatya* [3], *Ge Sun* [4], *Carl Trettin* [3]

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Large-scale restoration efforts are currently underway to restore ecosystems dominated by longleaf pine (*Pinus palustris Mil*l.) throughout much of the southeastern US coastal plain and lower piedmont, from Virginia to Texas. In many of these locations, native longleaf systems were converted into short-rotation loblolly pine (*Pinus taeda L.*). plantations. Restoring loblolly plantations to longleaf systems has the potential to provide a range of ecosystem services, including wildlife habitat, fire suppression, biodiversity, carbon sequestration, and water resources. However, because the geographical range includes sandy, well-drained soils to loamy, frequently-saturated soils, we currently lack data and effective models to predict how longleaf and loblolly stands across the region will respond to a changing climate. It is hypothesized that lower-density, deeply rooted longleaf pine will be more drought-resilient than loblolly at the individual level and will produce higher water yield (i.e., have lower evapotranspiration) at the stand level. In contrast, aggrading longleaf systems may not accumulate carbon as rapidly as loblolly plantations. For this study, we focus on changes in evapotranspiration and carbon sequestration during the initial stages of longleaf restoration. By using a network of eddy covariance towers that quantify sub-daily ecosystem exchange of water and carbon dioxide, we quantify the sensitivity of forest water use and carbon sequestration to short- and long-term climatic drivers.

Imagining How a National Nature Statistical Bureau Could Help Quantify Ecosystem Services

***Lydia Olander*[1], *Chris Hartley*[2], *Ken Bagstad*[3], *Emily Silverman*[4], *and Regan Smyth*[5]**

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[5]NatureServe, VA, USA

Three major federal activities, the Conservation and Stewardship Atlas, Natural Capital Accounting, and National Nature Assessment highlighted the need for coordinated national nature data. Despite ever-growing amounts of data, investments in data coordination, and some amazing projects to create useful data products, the lack of a consolidated, comprehensive, and authoritative source of national nature data and statistics is slowing progress for these federal nature data applications. To address these challenges, it is essential to go beyond incremental change in how nature-related data are managed, and build a more efficient, automated, credible, and interoperable nature data system. For example, a data system that provides a clear, documented understanding of the strengths and weaknesses of each data source can begin to address those weaknesses, enable appropriate reuses of the data (fitness-for-use), and reinforce the credibility of ultimate nature-related data products. The session will discuss options for more efficient, credible, interoperable, and automated nature data systems that clearly document the strengths and weaknesses of data while balancing data privacy and accessibility needs. The discussion will be of interest to those with a stake in improved data credibility and accessibility to facilitate quantification of and investment in ecosystem services.

Panelist Biographies:

Dr. Olander (moderator) has worked at the interface of science and policy on accelerating implementation of climate resilience, nature-based solutions, ecosystem services, and environmental markets for 20 years. She also recently spent two years at the White House Council on Environmental Quality as Director of Nature-based Resilience.

Dr. Hartley has spent more than a decade leading efforts on environmental markets and ecosystems services quantification to support policy and decision making at USDA. His work focusses on developing tools and metrics and improving public access to data. Recent activities include the America the Beautiful Conservation and Stewardship Atlas, the National Nature Assessment, and the initiative to develop and maintain Statistics for Environmental-Economic Decision-making for the United States.

Dr. Bagstad has led work on natural capital accounting in the U.S. since 2016, and currently coordinates USGS work on this topic. He has been involved in data interoperability for ecosystem services since 2007 through his work on the Artificial Intelligence for Ecosystem Services (ARIES) Project and worked with the U.N. to develop the ARIES for SEEA application and SEEA interoperability strategy.

Emily Silverman is an Advisor on Statistical Policy. In this capacity, she supports the Department's statistical staff and works to ensure that DOI is developing sound evidence for policy evaluation. She was previously as a statistician in the Migratory Bird Program of the U.S. Fish & Wildlife Service, where she designed large-scale monitoring surveys and worked on population estimation, harvest management. data management planning, science support, and sea duck conservation. .

Ms. Smyth is the Vice President of Conservation Data and Science at NatureServe, a leading provider of multi-jurisdictional data on at-risk species and ecosystems. She oversees a shared infrastructure for data collection, curation, development and dissemination deployed by a distributed network of state partners and brokers access to those data to federal, industry, and conservation actors.

Metrics and Data Needs for Nature-Based Solutions Monitoring, Evaluation, and Design Guidance

***Lydia Olander*[1]*, Emily Corwn*[2]*, Ellen Bolen*[3]*, Vamsi Sridharan*[4]*, and Jones-Farrand*[5]

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Nature-based solutions (NBS), which are being deployed at an accelerating rate, encompass a wide range of actions to protect, sustainably manage, or restore natural or modified ecosystems to address pressing societal challenges, including helping ecosystems and communities adapt to climate change impacts. Governments, funders, practitioners, and communities are seeking information on the performance and reliability of NBS in mitigating climate risks and supporting climate adaptation to inform project planning and design guidance as well as evaluation of project performance. Ideally these NBS also support healthy ecosystems and biodiversity. This session will bring together NBS practitioners, planners, and researchers to explore various needs for evaluating NBS, so we can learn and build better over time. Our goal is to instigate a discussion on what a national strategy to collect data on the effectiveness of NBS would look like. What kinds of data already existing that could be collated? What kind of additional data would we need to collect? How could this data collection be embedded in monitoring or new measurement networks? How could this data be collated and organized in consistent and shareable data platform?

Panelist Biographies:

Dr. Olander has worked at the interface of science and policy on accelerating implementation of climate resilience, nature-based solutions, ecosystem services, and environmental markets for 20 years. She also recently spent two years at the White House Council on Environmental Quality as Director of Nature-based Resilience.

Emily Corwin is a Registered Professional Civil Engineer in the State of California with over 20 years of professional experience in the field of civil and water resources engineering and hydrology with a focus on nature-based solutions, green stormwater infrastructure, water resource planning, and climate resiliency. Emily is a member of the American Society of Civil Engineers NBS Task Force, working towards publishing NBS engineering guidance for practitioners.

Ms. Bolen has worked i Ocean and Coastal conservation at the intersections of people and policies for 15 years. Most recently, she is the Director of Marine and Coastal Conservation Programs at the National Fish and Wildlife Foundation where she oversees strategy and implantation for the National Coastal Resilience Fund and the Emergency Coastal Resilience Fund.

Dr. Vamsi Krishna Sridharan has over 18 years of experience in leading water resources and coastal resilience projects in both the East and West coasts of the United States. He uses computer simulations to develop solutions to complex challenges and communicate the science to stakeholders. Vamsi is a member of the American Society of Civil Engineers NBS Task Force, working towards publishing NBS engineering guidance for practitioners.

Dr. Jones-Farrand has worked in conservation partnerships focused on sustaining the fish & wildlife populations of the southeastern US for the last 19 years. Currently, his primary focus is on evaluating the impacts of conservation actions at landscape & regional scales.

White House Nature-based Solutions Roadmap

Lydia P. Olander
Nicholas Institute, Duke University, Durham, NC USA

Nature-based solutions (NBS) – "actions to protect, sustainably manage, or restore natural or modified ecosystems to address societal challenges, simultaneously providing benefits for people and the environment" – can help ecosystems and communities adapt to climate change while protecting the productivity and quality of the natural environment and supporting community needs. The Biden-Harris Administration released a national nature-based solutions roadmap in fall of 2022 and has since taken a number of actions to elevate and accelerate the deployment of nature-based solutions. This talk will provide an overview of this roadmap and discuss many of the changes to policy and funding, and other actions the administration has taken. These include benefit cost analysis, natural capital accounting, guidance on natural infrastructure, new agency wide policy, inclusion in notices of funding opportunities. The talk will also include initial ideas for how the ACES community can help in ways the federal government cannot, in the hopes of fostering a broader discussion, coordinating action, and building new partnerships.

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gROWing Chicago Habitat and Developing a Habitat Network for the Chicago Wilderness Region

Caroline Hernandez, ***Catherine O'Reilly***
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This presentation will cover the conservation strategies and impacts of gROWing Chicago Habitat. The Chicago Wilderness region is a seven-million-acre area stretching across the Midwest that is home to almost 200 threatened and endangered species and houses rare ecosystems. When managed for habitat, utility and transportation rights-of-way can provide necessary resources and serve as safe havens that link ecosystems for different species. Recognizing the opportunity rights-of-way present for developing sustainable landscapes, the University of Illinois Chicago created the gROWing Chicago Habitat initiative in 2022. gROWing Chicago Habitat is a working group that engages energy and transportation organizations, conservation groups, public and private landowners, and other stakeholders in creating habitat in the Chicago Wilderness region. Since 2022, the network has expanded to 54 partners who have started over thirty habitat restoration projects across their footprint.

Participants of gROWing Chicago Habitat created a tool to identify and prioritize key areas for establishing ecosystems along rights-of-way in the Chicago Wilderness region. The prioritization tool uses geospatial software to focus habitat creation in areas with the highest potential for impact, using insights from gROWing Chicago Habitat participants to identify biodiversity hotspots, areas for enhanced equity, and zones with high connectivity potential. Using this tool, gROWing Chicago Habitat participants identified focus areas for habitat projects that would build environmental resiliency in key neighborhoods and began engaging with the neighboring landowners to 1) assess interest in habitat initiatives, and 2) to determine a plan for these restoration projects with the community. To date, three habitat projects have been started involving community organizations and energy companies focusing on reducing neighborhood flooding, increasing educational engagement, and improving habitat connectivity.

The development of gROWing Chicago Habitat highlights the necessity of collaboration in building resilient ecosystems and relationships. The collective achievements of the group demonstrate how collaboration can lead to the development of sustainable corridors, promote environmental well-being, and build community resilience. The gROWing Chicago Habitat initiative stands as a model for cross-sector collaboration, inspiring participants to actionable outcomes for shaping sustainable landscapes.

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Exploring the Potential Energy Resilience Benefits of Coastal Ecosystems and Protected Areas in Puerto Rico

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As the climate changes and sea levels rise, coastal hazards continue to harm people and property – especially in Small Island Developing States. In Puerto Rico, Hurricanes Irma and Maria destroyed the electrical grid in 2017, leading to a prolonged blackout. Decision makers have utilized grey infrastructure such as seawalls to mitigate storms and other coastal hazards, but these approaches can be erosive and expensive. A more sustainable alternative is to conserve and restore coastal ecosystems that buffer shorelines and reduce the impact of hazards. Mangrove forests, coral reefs, and seagrass beds have the potential to improve resilience for nearby populations and energy infrastructure. However, not all of these ecosystems benefit from protected area status in Puerto Rico. To identify where protected and unprotected ecosystems could reduce exposure to coastal hazards under future sea-level rise, we used a spatial model that takes in biophysical data to estimate an exposure index. Our model shows that the number of people highly exposed to coastal hazards would nearly triple if coastal ecosystems were lost – and the number of electrical substations at highest risk would nearly quadruple. In total, ecosystems reduce risk for more than 370 km of coastline under sea-level rise, and over two-thirds of that risk reduction is provided by protected ecosystems. Additionally, the contribution of ecosystems to coastal resilience varies substantially across Puerto Rico's 44 coastal municipalities. By exploring where communities and energy infrastructure benefit from coastal risk reduction provided by corals, mangroves, and seagrasses, our results suggest sites for conservation and restoration projects that would maximize risk reduction ecosystem services. This study highlights the potential for protected areas to enhance energy resilience, which could inform broader efforts to conserve nature and its benefits, such as the 30 by 30 Initiative and the Ocean Climate Action Plan. Further, our approach is replicable in other Small Island Developing States to build capacity for nature-based climate adaptation.

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Ecological Networks, Management Shifts, and Ecosystem Services in Urban Agroecosystems

***Stacy Philpott*[1], *Brenda Lin*[2], *Heidi Liere*[3] *and Shalene Jha*[4]**

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Upwards of 80% of the US population lives in urban areas, and urbanization results in biodiversity loss. Yet, many urban households lack access to fresh produce. Urban agroecosystems can support both biodiversity and people in cities; however, gardeners express challenges in pest management (90% surveyed) and maintaining yields (89%) revealing knowledge gaps about how to shift management to optimize ecosystem services. Garden management and landscape surroundings drive of biodiversity and ecosystem services in urban agroecosystems. However, while biodiversity is often positively associated with ecosystem services, this is not always so, perhaps because provisioning also depends on species traits and representation in ecological networks. Understanding relationships between local and landscape factors, functional traits, and ecological networks can inform management, and optimize ecosystem services and resulting benefits. We examined how management and landscape filters influence (a) functional traits of plants, pollinators, and natural enemies, (b) ecological networks, and (c) provisioning of pest control and pollination services, as well as how (d) gardener social context influences the potential for implementing beneficial management changes.

We found that pollinator communities are shaped by floral abundance and richness, ground cover, and landscape change. Both floral richness and shorter herbaceous vegetation promote ecological network shifts associated with more stability. Shifts in pollinator diversity and abundance interact with floral resources to boost pollen deposition, and trees and shrubs suppress fruit production, revealing a key trade-off between food production and tree cover. Certain plant traits (extrafloral nectaries, smaller flowers) boost abundance and richness of natural enemies, and floral richness increases natural enemy-herbivore and host-parasitoid network changes associated with higher pest control. Ground cover management affects microclimates, predator communities, and pest control. Gardener gender, national origin, motivations, time spent gardening, as well as land tenure and neighborhood wealth influence plant richness, composition, and diversity of plant traits. Moreover, gardener lived experiences (gender, agriculture background) and participation in educational programs can shape preferences for ‘tidy’ or ‘wild’ gardens with implications for plants, ground cover, insect biodiversity, and ecosystem services delivered in gardens.

Incorporating Ecosystem Services in Federal Decision-Making

Emily J. Pindilli[1]*, Matthew Oreska*[2]*, Christian Crowley*[3]*, Kate Quigley*[4]*, and Travis Warziniack*[5]

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Consideration of ecosystem services varies across the U.S. Federal government. Some Federal agencies have long recognized the importance of ecosystem services; in other cases, ecosystem services have received insufficient attention. The Executive Office of the President (EOP) is coordinating several efforts to help advance incorporation of ecosystem services in the benefit-cost analyses that help guide agency decision-making. This panel will include EOP and Federal agency representatives to report on that progress; specifically, speakers will describe the Office of Management and Budget's Ecosystem Services Guidance and the National Science and Technology Council Subcommittee on the Frontiers of Benefit-Cost Analysis Interagency Ecosystem Services Working Group.

Panelist Biographies

Emily Pindilli is Assistant Director for Ecosystem Services and Natural Capital Accounting at OSTP with 20 years of experience in economic and interdisciplinary research on natural resources, ecosystem services, and the value of information.

Matthew Oreska is a physical scientist in OMB's Office of Information and Regulatory Affairs where he worked on OMB's Guidance for Assessing Changes in Environmental and Ecosystem Services in Benefit-Cost Analysis and related EOP regulatory modernization efforts.

Christian Crowley is an environmental economist at the DOI Office of Policy Analysis with over 20 years with experience working on recreation, wildland fire, energy and mineral royalties, and economic impacts.

Kate Quigley is the senior economist for the NOAA Office for Coastal Management with over 20 years of experience in coastal and ocean economic and policy analysis.

Travis Warziniack is the director of the Denver Urban Field Station and leads the Ecosystem Values Lab, which seeks to better understand links between human and ecological systems and provide science in support of better forest management.

Microbial and Root Biomass Drive Rapid Soil Carbon Changes with Diversity in Experimental Grasslands

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Regenerating carbon (C) in soils previously degraded from cultivation represents an important challenge for meeting future agricultural needs. While it is well established that restoring diverse tallgrass prairie plants on previously degraded soils can achieve that goal over decadal timescales, it remains unclear how quickly changes in soil C may occur after plant establishment. We address those questions in a grassland diversity experiment manipulating the species richness of tallgrass prairie plants (including 1, 2, 3, 5, and 5 species), community composition by selecting plant species for mixture from the same or differing families and altering precipitation to 150% and 50% ambient rainfall. Three years after plant establishment, soil C increased with microbial biomass and microbial biomass increased with richness. After five years those patterns strengthened and total C increased with root biomass, as well. These findings replicated pathways observed in other grassland diversity manipulation experiments but did so about four years faster than previous experiments. Precipitation influenced whether root inputs or microbial inputs moderated total C. Generally, with 150% precipitation, total C increased with root inputs, while with 50% precipitation total C increased with microbial biomass. The relationship between soil C and root biomass under elevated precipitation may reflect higher rates of decomposition contributing substantially to the belowground C pool. For example, in communities composed of all forbs from the aster family, total C increased with root and microbial biomass 150% water treatments and with root biomass in 50% water treatments. In those communities, correlations between extracellular enzyme activities (a proxy microbial activity) and root biomass were positive in 150% precipitation treatments, suggesting interactions between plant roots and microbes may be stimulating microbial decomposition releasing limiting resources, such as nitrogen and phosphorus, to increase soil fertility. The composition of the plant community seems to be a strong factor determining whether a relationship between plant diversity, plant inputs, microbial biomass and soil C develops. Our results suggest that the presence of a relatively natural soil microbiome can help generate soil C on previously C-deplete soils and furthermore that forbs from the aster family contribute to the development of relationships between soil C and plant diversity.

Accounting for Ecosystem Services Via Fromal Analysis Frameworks in Canada

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The last few decades have seen a push in the corporate world toward sustainable and socially equitable business practices and projects. Most traditional assessments and analysis frameworks like benefit-cost analysis or economic impact analysis fail to capture project impacts beyond those easily quantifiable, especially for environmental impacts. This has led to discussion surrounding the most effective way to facilitate this shift and incorporate more social and environmental impact considerations during both project development, and day to day business operations. Several formal systems and analysis frameworks have been developed to that effect.

In Canada, there are several systems intended to facilitate a corporation in its transition to more sustainable and socially ethical business practices including, but not limited to Triple Bottom Line, Environmental Social Governance, and Multiple Account Evaluation. Triple Bottom Line is often thought of as "People, Planet, Profit." Though Triple Bottom Line is an accounting and reporting tool, it is primarily intended as a thesis for thinking about the sustainability of a business over time. Environmental Social Governance is an investment strategy for evaluating the environmental and ethical impact of a company's operations. It is like Triple Bottom Line, except these evaluations are completed by a third party. Though growing in popularity and use, neither framework is required within reporting regulations.

Unlike the other frameworks, Multiple Account Evaluation is required under several provincial jurisdictions. The widely accepted general framework for Multiple Account Evaluations was developed specifically for Crown corporations. This framework is designed to evaluate project alternatives, making it less useful for broad business practices or decisions. Multiple account evaluations determine the financial, **environmental**, and social implications of project alternatives. These evaluation accounts are defined criteria by which the projects are judged and can be customized to fit the needs of the corporation implementing the analysis.

This presentation will explore the different applications and methods used within these frameworks, highlighting their ability to capture the value of ecosystem services. In addition, this presentation will discuss whether and how uniformity across these frameworks might help streamline ecosystem service valuations from day-to-day business operations to project development.

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The North American Great Lakes: Powering the Economic Engine in the Region

Rajendra Poudel[1]*, Roy Brouwer*[2]*, John Livernois*[3]*, Salim Hayder*[4]* and Kate Quigley*[5]

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The purpose of this panel session is to share best practices, lessons learnt, and concerted efforts that the United States and Canada are working to fulfill the Great Lakes water Quality Agreement (GLWQA). This panel session offers insights on how the US$6 trillion vibrant economy of the North American Great Lakes is accelerating the growth of regional economy, conserving aquatic, terrestrial and atmospheric environments & wildlife, and safeguarding the Indigenous culture.

The Great Lakes support economic activities, provide food and other resources, regulate natural processes, and offer recreational and cultural experiences. Values of ecosystem services with established commercial markets, including commercial fishing, tourism, and agriculture, are relatively well understood. However, non-market ecosystem services are more challenging to value and may be overlooked in traditional benefit-cost decision frameworks, risking ineffective or inefficient resource management and policy development.

Panelist Biographies:

Dr. Poudel is an Economist in Great Lakes Regional Office of International Joint Commission, Detroit, USA.

Dr. Brouwer is a Professor in the Department of Economics and Executive Director of the University of Waterloo's Water Institute, Ontario, Canada

Dr. Livernois is a Professor in the Department of Economics & Finance of University of Guelph, Ontario, Canada.

Dr. Hayder is an Economic Advisor in the Fisheries and Oceans, Manitoba, Canada.

Dr. Quigley is an Economist in National Ocean Service of National Oceanic and Atmospheric Administration, Charleston, South Carolina, USA.

The Apalachicola Watershed Coordination Blueprint: An Effort to Improve Restoration Partnerships and Coordination for a Healthier Watershed

***Laila Racevskis*[1], *Amy Bainbridge*[2], *Jenna Harper*[3], *Dan Dourte*[4], *Valerie Seidel*[4]**

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The Apalachicola River and Bay System is rich in biodiversity and diverse ecosystems and home to one of the most productive estuaries in the northern hemisphere. The Apalachicola National Estuarine Research Reserve (ANERR) encompasses 234,715 acres of public lands and waters in the region and works with many partners to manage natural systems in the basin to preserve the important biological function of the watershed. To assist with improving collaboration and coordination among these entities, a multi-year research project was initiated to compile information and engage interested parties in the watershed. Research objectives include collecting and summarizing restoration planning documents; identifying key threats and priority efforts to mitigate or prevent threats; connecting data sources and research initiatives; identifying restoration funding sources; and ensuring efforts are conducted with substantial public engagement and feedback.

Research methods include an inventory of interested parties; analysis of restoration planning documents; workshops; expert interviews and surveys; and a funding opportunity inventory. The inventory of interested parties has identified over 150 interested parties representing tribal nations; local, state, and federal government; private industry; educational institutions; non-profit organizations; and partnerships/working groups and is continually updated. Over 95 management/restoration plans or related documents have been identified, and over 2,000 goals and strategies were identified and analyzed across documents. The most common goals include habitat restoration, conservation and management; strengthening community resilience; and improving water quality.

A priority of the work is to identify factors that lead to successful restoration collaborations, and themes that have been identified include information to aid project prioritization; resources to facilitate collaboration; community relationships; and communication. To contribute to the research objective of substantial public engagement and feedback, an online data and watershed information dashboard is being designed with interested party input and will serve as a tool for future engagement, sustained partnerships, and improved community awareness of activities related to the ecological health of the watershed. The research will culminate in strategies and tools to facilitate successful, sustainable restoration partnerships.

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Cost-Effectiveness of Natural Resource-Based Adaptation Strategies in the Florida Keys

Valerie Seidel[1], Cortney Cortez[1], Alicia Barker[1], and ***Laila Racevskis[2]***

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Monroe County, Florida, home of the Florida Keys, has been addressing the need to identify natural resource adaptations and approaches to prepare for sea level rise and other climate conditions. To provide information on the cost-effectiveness of different natural resource-based strategies across the Keys, a spatial cost-benefit analysis (CBA) was conducted. Five natural resource adaptation strategies were selected based on the county's 2021 Vulnerability Assessment: rainwater harvesting; implementation of passive green infrastructure; land acquisition; living shorelines; and wetland restoration.

For each strategy, project candidate sites were identified using GIS software, and costs and benefits were applied to each site using decision rules based on various ecological and practical factors. Ecological factors for candidate sites included whether National Oceanic and Atmospheric Administration sea level rise data and Sea Level Affecting Marshes Model results show the location is viable in 2040; hydrologic or other connectivity compatible with the strategy; and input from scientists studying Keys natural resource adaptation strategies. Practical considerations included restricting candidate sites to the management or ownership regimes appropriate for the strategy. Benefit estimates included nonmarket goods, which are quantified using published economic measures of public natural resource values. A 10-year planning horizon was used, and discount rate of 4% was applied.

Results provide input that can be used in county prioritization of adaptation projects. Costs and benefits vary by strategy and location, and all strategies were cost-effective in the majority of candidate sites. If all strategies were implemented in all locations where benefits exceeded costs, $500 million in total benefits would be realized at a cost of $211 million, for net benefits of $289 million. Based on results, it is recommended that the county consider a rainwater harvesting incentive program due to its significance for preserving threatened and endangered species given the rapid loss of access to freshwater. The county should also carefully consider future shoreline conditions, future connectivity for habitat corridors, and geographic variability of implementation costs when choosing projects. Lastly, land acquisition may be more desirable in larger forested areas that provide greater benefits.

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Decolonizing Ecosystem Valuation and Environmental Management

***Nejem Raheem*[1]*, Erin Genia,*[2] *Doreen Martinez*[3]*,and Ronee Penoi*[1]

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The term "Decolonization" is used in many fields but has made few inroads into ecosystem valuation and management. Indigenous communities often see natural resources and ES in ways that federal or state agencies are just coming to explore or know. It is crucial to build mutual respect and comprehension of these knowledges and practices to effectively and ethically incorporate values into policy and management.

This panel explores how we could rethink valuation measures, land use criteria, and similar metrics. Participants will share what decolonization is and means in their fields, and how they engage in decolonial understandings and practices. Through these offerings, we seek to address the ever-present needs to rethink valuations and economic understanding for our fragile ecosystems.

Panelist Biographies:

Dr. Raheem is Professor of Economics and Chair of the Department of Marketing Communication at Emerson College. His research focuses on ecosystem services and indigenous communities.

Erin Genia, a citizen of the Sisseton-Wahpeton Oyate, is a multidisciplinary artist, educator and cultural organizer. She currently serves as an artist-in-residence with GreenRoots, on a large-scale climate mitigation initiative, The Island End River Flood Resiliency Project.

Dr. Martinez is an Associate Professor in the Department of Race, Gender, and Ethnic Studies at Colorado State University. Her expertise is in Indigenous knowledge systems, research methodologies, visual culture, and sociopolitical land and environment issues. Her work focuses on how diverse knowledges, life's theoretical grounding, are engaged and practiced every day.

Ronee Penoi (Laguna Pueblo/Cherokee) is Director of Artistic Programming and interim Executive Director at ArtsEmerson, Boston's leading presenter of contemporary world theater. She is a co-founder of Groundwater Arts (dedicated to climate justice in the arts), and co-lead of First Nations Performing Arts, an initiative aimed at decolonizing the arts field and making Indigenous arts workers visible. Ronee values the years she spent with the Consensus Building Institute, a facilitation/mediation non-profit that specializes in land use and climate mitigation. She is a two-time ISPA Global Fellow and has been an APAP Leadership Fellow and TCG Rising Leader of Color. Ronee is also on the board of the Producer Hub, a powerful resource for independent producers and artists. She is a composer of two new musicals with collaborator Annalisa Dias (The Carlisle Project, #RESIST), and has been commissioned by Pittsburgh Public Theater and Baltimore CenterStage for her writing. BA, Princeton University.

The Eco-Health Relationship Browser Through the National Ecosystem Services Classification System Plus Framework

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The Eco-Health Relationship Browser is an interactive web-based tool that illustrates linkages between ecosystem good and services and human health and summarizes the scientific evidence for these linkages. It can be used as both an educational tool and as a reference for planning and implementation of decisions based on environmental justice and public health. The National Ecosystem Services Classification System Plus (NESCS Plus) framework provides a consistent approach for identifying and describing ecosystem goods and services. This framework facilitates integration of inputs and outputs of ecosystem service tools through use of a common language. In this presentation we will walk through the application of NESCS Plus to the Eco-Health Relationship Browser; highlighting how this framework can classify uses, users, and beneficiaries of ecosystems goods and services tools, and demonstrating how the framework can be incorporated with existing tools.

Uncovering Cover Crop Mixture Root Abundance and Composition to Maximize Ecosystem Service Provisioning

***Emma Rice*[1]*, Madeline Luthard*[2]*, Jason Kaye*[2]*, and Carolyn Lowry*[1]**

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Cover crops vary in their provisioning of ecosystem services. Our understanding of how composition affects the functioning of cover crop mixtures has largely been based on the aboveground plant community. However, many ecosystem services are tightly linked to roots and the rhizosphere (e.g. nitrogen retention, nitrogen fixation, and soil carbon accumulation), therefore incorporating information on root biomass by species is integral to characterizing how mixtures provide these services. The lack of effective methods to characterize belowground plant species composition remains a major barrier to investigating the relationship between structure and function within cover crop mixtures. We modified an amplicon sequencing approach to determine the relative plant community composition and abundance of field cover crop mixtures. With this method, we are evaluating how closely the aboveground composition predicts the belowground composition in cover crop mixtures and how species alter their root mass fraction and depth proportions between monocultures and mixtures. We expect that accounting for cover crop species belowground root composition and distribution will increase our ability to quantify ecosystem service multifunctionality provided by cover crop mixtures, clarify the relationship between abundance and ecosystem function, and lead to improved mixture design.

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LEVERAGING VIRTUAL SPACES FOR HUMAN-CENTERED DESIGN

Megan A. Rippy*, Lauren Krauss, Megan Blumenauer*
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In the early 2000's the United Nations Declaration on Sustainable Development reaffirmed an urgent need to increase "broad-based participation in policy formulation, decision making and implementation at all levels", giving everyone a voice in earth's future. Achieving this goal for green stormwater infrastructure (GSI) requires enabling public participation in the planning context, facilitating co-design of infrastructure that meets community needs. Doing so is important, both for sustained quality of life in communities and for building trust/acceptance of new infrastructure approaches. Virtual reality (VR) shows great promise for facilitating community-stakeholder co-design because it makes information less abstract, translating concepts from the "expert domain" (design schematics) into a format familiar to everyone (landscapes that can be directly viewed and experienced). To be effective, however, virtual infrastructure must appear real to people and people must respond realistically to it – otherwise built systems based on perceptions of virtual spaces have the potential to disappoint. Accordingly, this study focuses on the perceived realism of virtual simulations of GSI. Results from human subjects survey work conducted on site at two rain gardens in Maryland are compared to results from VR surveys of the same two infrastructure elements to determine whether simulated infrastructure can accurately capture real-world perceptions. Two VR models were prepared for each real site (rain garden only and rain garden plus the surrounding landscape) to explore the importance of incorporating situational context into VR simulations. We find that perceptions of virtual and real green infrastructure elements did not significantly differ for either rain garden or VR model type but that VR simulations were always viewed more positively, consistent with the presence of a VR-associated "wow factor". Differences between VR and onsite perceptions were accentuated in simulations that modeled the broader landscape, counter to our expectation that context would bring them more in line with reality. This pattern was most evident at our site that was poorly maintained, suggesting that factors beyond the visual may play an important perceptual role that was not accounted for here. Overall, our results suggest that VR shows promise as a tool for eliciting greenspace perceptions, but that feedback tends to bias positive and could potentially overstate the value of GSI designs.

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Ecological Economics for Community-Driven Solutions: Lessons for Integrating Equity in Ecosystem Services Valuation Through Pro Bono Partnerships

Olivia Molden *Presented by:* ***Carson Risner***
Earth Economics, WA, USA

Earth Economics has provided pro bono support to over 32 local nonprofits and community-based organizations since 2019. In these partnerships, Earth Economics identifies and assesses multiple social and ecological benefits of the proposed (or implemented) community-based nature-based solutions. These community partners have used these results to support fundraising, decision-making, planning, and awareness-raising efforts. This presentation will share lessons from these partnerships, emphasizing three steps that help to integrate equity in the assessment of ecosystem services: 1) identify intended audiences while discussing data needs and analytical possibilities; 2) co-create analytical frameworks, including definitions of ecosystem services; and 3) describe, and where possible analyze, the spatial flows of ecosystem services and their beneficiaries. This presentation will ground these lessons in examples from recent partnerships.

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Integrating Place-based Understanding of Well-being in NOAA National Marine Sanctuary Condition Reports

Giselle Samonte
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The National Oceanic and Atmospheric Administration's (NOAA) Office of National Marine Sanctuaries serves as the trustee for a network of underwater parks, spanning over 620,000 square miles of marine and Great Lakes waters. The network includes 15 national marine sanctuaries and two marine national monuments, Papahānaumokuākea and Rose Atoll. These sanctuaries safeguard a diverse array of natural and cultural marine resources. Through condition reports, NOAA assesses the health and trends of sanctuary resources and ecosystem services. These reports provide a comprehensive overview of resources, driving forces and pressures on those resources, and current conditions and trends for resources and ecosystem services. Additionally, the evaluation and incorporation of ecosystem services into decision-making processes are crucial for the effective management of national marine sanctuaries.

Ecosystem services are defined as the benefits people obtain from nature through use, consumption, enjoyment, and/or simply knowing these resources exist. Cultural ecosystems services, such as consumptive and non-consumptive recreation, science, education, heritage, and sense of place, are important considerations in this evaluation. The data obtained through assessments and expert discussions inform our understanding of recent trends and historical variability, with qualitative knowledge, including local and indigenous knowledge. Examples from national marine sanctuaries in American Samoa, Stellwagen Bank, and Channel Islands illustrate this evaluation process. Overall, the condition reports play a vital role in monitoring and protecting the cultural and natural resources within national marine sanctuaries.

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Envisioning a New Database Structure to Improve Compensatory Mitigation Outcomes in Offsetting Impacts to Aquatic Resources

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The concept of offsetting wetland and stream losses through compensatory mitigation has grown significantly since it emerged as an environmental incentive in the late 1980s and 1990s. Driven by the passage of the Clean Water Act (CWA) and the adoption of the no-net loss policy, compensatory mitigation for wetland and stream damages has evolved into the largest ecosystem services market in the United States. However, connecting impacts and offsets in compensatory mitigation has proven a challenging task.

Wetland and stream mitigation is currently tracked through two separate databases: (1) the OMBIL+ Regulatory Module, used by the US Army Corps of Engineers to track aquatic resource impacts and (2) the Regulatory In-lieu Fee Banking and Information Tracking System, used to track compensatory mitigation. Although impact areas are well-documented in the ORM database, compensatory mitigation is tracked in a nonuniform way in RIBITS, creating difficulty in tracking the relationship between impacts and offsets.

We discuss opportunities in creating a comprehensive database structure in the compensatory mitigation space for wetlands and streams. We propose a theoretical layout for a database that we argue could more accurately, effectively, and efficiently host aquatic resource impact and offset data than the current database structures. We use an entity-relationship diagram to visualize a modernized database for tracking wetland and stream impacts and offsets, marking one of the first comprehensive theoretical models proposed for managing the aquatic resource mitigation market since the early 1990s. We use a query system to demonstrate how the proposed database structure could be used by practitioners, researchers, and the public to easily obtain information relevant to impact and offset sites.

Little work has endeavored to inform improvements in the established regulatory databases that track environmental impacts and offsets. Additionally, there are likely to be far-reaching implications for aquatic resources protection based on the 2023 U.S. Supreme Court interpretation of the CWA's "waters of the United States." Now, more than ever, is a critical time to reflect and offer guidance on the need to use standardized, structured procedures in collecting and processing data in the space of wetlands and streams, a process lacking in the current aquatic resources market for compensatory mitigation.

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The Dirt on PFAS Uptake: Soil to Crop Movement of PFAS into Lettuce, Tall Fescue and Tomato and Effects of Intercropping

Alexandra E. Scearce[1,2 *], *Jean D. MacRae*[3], *Caleb P. Goossen*[4], *Yong-Jiang Zhang*[2,5], *Kylie P. Holt*[6], *Sandesh Thapa*[7], *Ling Li*[7], *and Rachel E. Schattman*[1,2]

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The historical practice of fertilizing farm fields with sludge, some of which contained high levels of per- and polyfluoroalkyl substances (PFAS), has led to uncertainty surrounding the viability and health risks associated with highly contaminated farming operations. There are adverse health impacts (decreased immune response, decreased fetal growth, liver cancer, and kidney cancer) associated with both prolonged occupational exposure and consumption of crops and livestock grown in PFAS contaminated soils. As a result, farming and Indigenous communities face heavy consequences from the widespread discovery of PFAS concentrations in Maine and beyond.

One of these challenges is the regulatory gap in PFAS policy whereby soil screening guidance has yet to be established for cropping systems besides preliminary forage guidance. In this field study, we partnered with a nearby farm removed from production due to elevated levels of PFAS contamination, to evaluate uptake of PFAS into three distinct crops: lettuce, tall fescue, and tomato. From this, we found 1) PFAS transfer from soil to crop varied greatly by compound and plant part, but perhaps more importantly, this variation was accompanied by high levels of in-field variation of PFAS concentrations in soils, 2) Transfer was greater among short chain compounds than long-chain compounds, with minimal uptake of precursors, 3) The relationship between uptake and chain length was weaker than expected, but functional group heavily mediated uptake, where carboxylates were transferred in higher concentrations than sulfonates, and 4) Intercropping often increased PFAS concentrations in plants, eliminating this as a potential management strategy for these cropping combinations. These results contribute to the growing body of research documenting transfer of PFAS from soil to crops, which will be of use for future models and soil screening thresholds.

It Takes a Village: Community Supported, Farm Scale Climate Change Adaptation and Mitigating Planning

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The Climate Adaptation and Mitigation Fellowship (CAMF) is an innovative program designed by farmers, agricultural advisors, and researchers to (a) assist farmers to create a farm-specific climate adaptation and/or mitigation plan, and (b) assist agricultural advisors to support farmers in aligned efforts. CAMF is based on a pilot program that was conducted in 2021-2022. Through our in-depth evaluation research of the pilot program we seek to shed light on whether learning and planning in a community-supported fashion leads to implementation of climate adaptive/mitigative practices, continued learning, and community cohesion.

Social connectivity is facilitated through a unique programmatic structure. The CAMF program (and its precursor) pairs farmers and agricultural advisors (called "Fellows") over two years. Fellows attend workshops on a range of topics including climate science, climate adaptation, climate mitigation, climate communication, emergency preparedness, and finding funding to implement climate responses. Following these opening workshops, Fellows work with their partner through a planning process to create a farm-specific climate adaptation and mitigation plan. Currently, four CAMF cohorts are active across the Midwest and Northeast United States: (a) row crops in the upper Midwest, (b) diversified agriculture and agroforestry in the Northeast; (c) dairy in the Northeast; and (d) women and non-binary vegetable growers in the Midwest and Northeast.

Between these cohorts, over 110 farmers and agricultural advisor Fellows are actively engaged in peer-to-peer learning, planning, and sharing information within their communities. In this session, we will present the program's history and development, the results of the pilot version of this program, outcomes from the opening workshops for current cohorts, and future plans for this program.

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One Health Approach for Evaluation Risks of Pharmaceuticals Discharged via Norwegian Wastewater Treatment Plant in the Marine Environment

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Marine sewage outfalls are major contributors of complex mixtures of pharmaceuticals, personal care products, other emerging contaminants and legacy contaminants, which together represent important ecological challenges in aquatic environments. Most traditional wastewater treatment plants are not designed to remove pharmaceuticals, which are increasingly used, especially after the pandemic. To face such challenge the One Health approach has been chose in order to combine the impact of discharged pharmaceuticals on human, organisms, and environmental health, by focussing on the interaction between disciplines and effects on the total environment. The case scenario of the wastewater discharge of Stavanger, the 4th largest city in Norway, is presented as an example of evaluation of the presence and effects of pharmaceuticals in the marine environment, combining disciplines like chemistry, biology, modelling, environmental economics and social science.

A Tiered Assessment Framework for Interregional Flows of Ecosystem Services from Migratory Species

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The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) has called for assessments that explicitly account for interregional flows of ecosystem services across geographic scales. An important type of interregional ecosystem service flow is generated by the movements of migratory species. Migratory species provide important benefits to people and, due to migration dynamics, ecosystem services provided in one location depend on the availability and quality of habitat throughout the migratory range. As a result, ecosystem service assessments that consider the services of migratory species cannot be comprehensive without considering the species' full migratory range. We review the state of the science on interregional flows of ecosystem services from migratory species and present a tiered assessment framework. We describe four tiers of flow assessment for ecosystem services from migratory species: telecoupled ecosystem services, qualitative flows, quantitative flows, and dynamic quantitative flows. The tiers are defined based on differing levels of detail in the quantification of range-wide ecological and socioeconomic information on a species and the services it provides. We review recent assessment studies and find that most fall within a first tier that does not quantify flows. We identify relevant data needs for analyses at increasing levels of specificity associated with each tier. Our framework outlines a range of methods, with varying time and data requirements, that can be used to maximize the information content and relevance of ecosystem service assessments for migratory species based on available resources.

The Impacts of Heterogeneity on the Provision of Rangeland Ecosystem Services in Agricultural Restoration

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Much of the US rangeland extent has been degraded by historical management practices and disturbance events. Annually, millions of dollars are spent restoring degraded rangeland, often with little resulting return of native species or ecosystem services. The impacts and legacies of agricultural conversion can be particularly challenging but are a common space for restoration activities. Here, we assess restoration outcomes for forage diversity and invasive species control over five years in an agricultural old field in the front range of Colorado. The original experiment was designed to test seeded species selection outcomes, with three main seed mixes applied on site. We have found the species specialized to local climate conditions tend to have more success, both in establishment and forage provision, and in reducing the invasibility of the site by noxious weeds. As monitoring has progressed, however, temporal and spatial variability in the environmental conditions have become the clearest drivers of ecosystem service provisions and overarching restoration outcomes. Species with more general climate preferences have shown a wider spread success across space and time. Thus, the diversity of seeded species and their ability to respond to this variability has been a strength of the project, and we discuss this in the context of restoration decision-making in old fields regionally.

Evaluating the Spatiotemporal Trends of Predicted Land Surface Temperature in the Miami Metropolitan Area and Urban Simulation from 2002 TO 2040

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Temperatures are often higher in urban areas due to the abundance of impervious services with pavement and buildings that absorb heat. Urban heat can cause adverse impacts on ecosystem services. For example, higher land surface temperatures (LST) can impact cultural ecosystem services by reducing the usability of outdoor urban spaces and in so doing reducing the demand for urban tourism. Higher LST can also impact provisioning services. For instance, water availability can be affected through increasing evapotranspiration rates which can impact urban water availability.

We investigate LST for 2030 and 2040 in the Miami Metropolitan Area using several explanatory factors and historic LST data from 2002 and 2022. Key explanatory factors include normalized difference vegetation index (NDVI), normalized difference building index (NDBI), modified normalized water index (MNDWI), land use land cover (LULC), and distance to coast and roads. We also investigate the population density simulation and LULC changes. The Pearson Correlation Regression Test is used to assess the relationship between these explanatory variables and LST while the Artificial Neural Network (ANN) is used to determine the predicted LST as well as population and LULC movements. To examine how the time of day affects LST, Terra MODIS LST morning data is compared with Aqua MODIS LST afternoon data. The evaluation is conducted using a multi-scale view with results at the regional, county, and pixel levels.

Additional results will be available for ACES 2024 and will address how increased LST can affect urban ecosystem services, with emphasis on ecosystem services related to human health. My hypothesis is that LST will continue increasing in urban areas but will also extend into rural areas as well.

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The Ecosystem Service Gradient: An Integrated Approach for Describing Shifts in Ecosystem Service Production

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Ecosystem goods and services (EGS) are powerful concepts to use in the making and communicating of environmental management decisions because of the way they connect changes in the environment to changes in the stakeholders' experiences. But describing these EGS and the potential impacts that differing management scenarios could have on them is a complex challenge. To begin, it is rarely a question of presence or absence, but rather one of sufficiency – will the environment provide enough of an EGS to meet stakeholder demand or of high enough quality EGS to meet stakeholder need. Additionally, for stakeholders to realize the benefits they care about, EGS are best described as combinations of environmental attributes rather than isolated elements – for fishermen to recreate they need more than fish to catch, they also need water of sufficient quality for safe contact, the space to fish, and they would likely want some degree of aesthetic site appeal. To best describe how a management action could impact the single EGS of recreational fishing the constellation of individual attributes must be identified, their relative importance weighted, and the potential impacts to each described. Finally, this description should recognize that just as management actions may impact different EGS in different ways, those actions may impact different elements within an EGS in different ways. For example, a management action to put in a dock or fishing pier may provide increased space for fishing, while also leading to a reduction in water quality.

The Ecosystem Services Gradient was developed to describe the production and delivery of EGS in a way that encompasses this complexity. A Gradient is built by i) identifying relevant EGS for a specific management context, ii) identifying appropriate metrics, iii) using monitoring data and ecosystem service models to quantitatively describe EGS production under different scenarios, and iv) evaluating potential co-occurring benefits or tradeoffs across scenarios. The development of a Gradient is facilitated by a set decision support tools that have been released by U.S. Environmental Protection Agency (the Final Ecosystem Goods and Services (FEGS) Scoping Tool, the FEGS Metrics Report, the EcoService Models Library). Each of these tools uses the National Ecosystem Services Classification System Plus (NESCS Plus) framework, which provides a consistent approach for identifying and describing EGS and allows their results to smoothly integrate in the development of a Gradient.

Embodied Virtual Reality: The Impacts on Human-Nature Connection and Nature-Based Stormwater Solutions

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This study explores how immersive virtual reality, particularly through embodied experiences, can enhance the design and implementation of nature-based solutions for stormwater. Nature-based solutions, like bioswales and permeable pavements, are often underutilized in engineering design. This is because of barriers like perceived higher costs and strong norms and practices around traditional infrastructure systems. The public also tends to undervalue nature's role in the built environment leading to missed opportunities. This disconnect, between the benefits and implementation, highlights the need for better communication platforms, such as virtual reality, to facilitate conceptual design and the benefits of nature in engineering design.

Using a mixed-method approach, 102 undergraduate engineering students were given a case study about combined sewer overflow issues in Cincinnati, Ohio, and tasked with developing solutions to the stormwater challenges. Students were randomly divided into three groups. One group experienced the existing site conditions as a bird through an embodied virtual reality experience. The second group walked through the virtual environment as a human avatar and the control group received no virtual reality intervention. Data were collected through pre- and post-experiment surveys measuring connectedness to nature and their design solutions through think-aloud protocol. The results indicate that the group experiencing the site embodied as a bird expressed a stronger connection to nature compared to the other groups. The transcriptions and sketches from the design process also indicated greater inclusion of nature-based elements in the design solutions from the bird group and more emphasis on describing the connection between nature-based elements and the social benefits for the surrounding community.

This study demonstrates that small interventions early in the engineering design process can enhance the human-nature connection and elevate the use of nature-based solutions. Integrating embodied virtual reality experiences into engineering design helped promote a unique type of perspective-taking and led to the inclusion of more nature-based solutions. Future research is needed to inform how embodied experiences may affect other stakeholder groups and how these experiences shape real-world projects overtime.

You Can't Do Just One Thing: The Case for a Watershed-Based Payment for Ecosystem Services Framework

Matthew Sheffer, Benjamin Banks-Dobson
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Agricultural land management has immense potential to provide myriad essential ecosystem services to human civilization, as evidenced by the positive impacts of indigenous agroecological production systems, and traditional organic systems. Agriculture now covers roughly 50% of the planet's habitable land, and we are facing ongoing ecosystem degradation and biodiversity loss across the globe. Therefore, harmonizing ecological restoration and agricultural production is essential to maintain a livable planet for future generations. When we think about agricultural land management through an ecosystem service lens, a common ecological maxim comes to mind: *"You can't do just one thing."* Implicit in this mantra is the notion that land management actions and activities do not happen in a vacuum, that ecosystems are dynamic and interconnected, and that specific actions towards singular climate or other ecosystem service goals can, and often do, have downstream effects, both intended and unintended, both positive and negative.

Current payment for ecosystem service efforts are often siloed, with programs and markets targeting specific resource concerns individually, without a holistic framework. This is compounded by the inability of currently available measurement, monitoring, reporting & verification tools and approaches to adequately assess outcomes and uncertainty at varying scales and across a suite of metrics. As a result, the collection of interventions that are either incentivized directly, via *payment-for-practice* programs, or applied within a *pay-for-performance* context (e.g. the voluntary carbon market), are short-sighted quick fixes that are minimally disruptive to the production systems that are a part of the root cause of the problem in the first place. These quick fixes, such as biogas generators, are often expensive, diverting scarce funding away from integrative agroecological solutions that have greater potential to address multiple resource concerns synergistically.

Therefore, it is critical that future efforts to develop or modify payment for ecosystem services programs apply a holistic framework that can adequately account for the full scope of impact in space and time, across a suite of benefits including soil health, carbon storage, greenhouse gas reduction, water management, and biodiversity enhancement. A watershed-based framework for payment for ecosystem service programs can help organize incentive structures in a way that accounts for the inherent connectivity and heterogeneity across landscape gradients that give rise to temporal and spatial dynamics of water, carbon & greenhouse gas cycles, and biodiversity habitat. The key components of such a framework must include incentive structures that integrate components pay-for-practice and pay-for-performance, where practices and systems are being incentivized on the basis of a holistic framework, and new, innovative measurement, monitoring, reporting & verification tools and approaches are being employed to monitor whole ecosystem performance over time, across the spectrum of local and global impact. This will allow for the evaluation of program success not only at field and farm scale, but outside the farm gate, into the larger landscape mosaic.

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Hotspot Analysis of Cultural Ecosystem Services and Grassland Bird Species Richness in the Upper Missouri River Basin

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The Upper Missouri River Basin (UMRB) is an expansive, sparsely populated agricultural and energy-producing region also supporting biodiversity and a range of recreational opportunities. The region is projected to experience widespread grass and shrubland loss on unprotected private land by 2050, which would reduce or degrade the preferred habitat for native grassland bird species. The study objective is to aid the targeting of conservation funding in unprotected areas (e.g., conservation easements) by prioritizing areas with (1) a high probability of grass and shrubland loss also identified as (2) supporting high biodiversity and (3) being valued by the public for conservation and recreation.

A region-wide survey of UMRB residents was conducted to identify public perceptions of values across the landscape (e.g., conservation and recreation). Respondents were asked to map points at locations across the region representing these values and to indicate their attitudes regarding various landscape activities. A principal component analysis distinguished two survey subgroups characterized by respondents' relative education levels and population size in their area of residence. The Social Values for Ecosystem Services (SolVES) GIS application was used to map social values associated with cultural ecosystem services (CES), conservation and recreation, for all respondents and for each subgroup. The maps illustrate the spatial distribution and relative intensity of these values across the landscape, based on their relationship to a suite of explanatory environmental variables (e.g., landcover, distance to water). The Getis-Ord Gi* statistic was then used to map hotspots for summed conservation and recreation values as well as for previously modeled bird species richness. The hotspot maps were then combined to determine the spatial coincidence of social and ecological value hotspots in unprotected areas. Projected losses in grass and shrublands were then calculated for each social-ecological hotspot combination.

Matrices of social and ecological value hotspots in the UMRB reveal that the value combinations for CES vs. biodiversity values (e.g., hot-hot, cold-hot, hot-cold, cold-cold) exhibit relationships that can inform the prioritization of conservation investment. Areas where conflicts between values exist can be distinguished from areas where values are more synergistic, which can better guide specific actions for preserving bird habitat and social values.

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Nature-Positive Urban Development and Regenerative Growth

OR

Mimicking Historical Ecology for Urban Ecosystem Service Targets and Metrics

Juliet Sinisterra
Spokane University District, CEO

Implementing a regenerative urban development framework that supports the biodiversity of life is critical at this point in history. Urban environments rely on healthy ecosystem services to thrive, such as clean air, clean water, and temperature regulation. Because 56% of the world's population now live in urban environments, urban design and development must contribute to the health, well-being, and sustainability of the ecosystems they impact.

As of September 2023, humanity has crossed six of the nine biophysical boundaries that allow life to thrive on Earth. According to the Nature-Positive movement (which consists of 27 of the world's largest nature conservation organizations, institutes, businesses, and finance coalitions), "connecting the nature-positive goal to equity and carbon neutrality recognizes the fundamental connection between human development and the health of nature and the deep connection between nature, climate, and Earth system stability." In the face of biodiversity loss, oceanic acidification, and climate change, how can we optimize urban development for life in the coming decades and support local ecosystems within our built environment?

The Spokane University District (UD)—as an innovative life sciences and energy district--aims to pioneer an urban development framework that is informed by nature, indigenous culture, and planetary boundaries, and that supports the long-term health of the district's ecosystem and inhabitants.

In 2023, the UD launched an ecological asset study led by Greene Economics that looked at how 12 ecosystem services that support the urban environment functioned from a pre-development state. How did nature maintain clean air, clean water, and rich soils? How does indigenous wisdom live in relationship with local ecosystems?

As a historically red-lined district that lies within a severely distressed census tract, the Spokane UD looked to implement the Just Communities protocol (formerly Eco-District certification) to inform a district conceptual plan and proof of concept scope to submit to the EPA concerning nature-based infrastructure that supports urban development through a climate and equity lens.

The final district conceptual plan and deliverables—based on the data and recommendations of these past studies—will inform land acquisition, shoreline restoration and access, stormwater runoff, brownfield mitigation, innovations in energy and waste management, potential land use code amendments, and development incentives.

The Spokane UD also aims to develop a replicable urban ecological development tool for municipalities in partnership with the City of Spokane and Avista Utilities. Presently, no formal standards of measure for carbon emissions have been adopted by the State of Washington, which focuses primarily on automobile and building emissions.

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Local Determinants and the Wealth of Wildlife

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Valuation is critical to measuring the contribution of natural resources to society. Our study addresses the critical issue of how local factors influence the valuation of natural capital, using the specific example of elk and mule deer populations in Wyoming. By employing a current natural capital valuation technique developed by Fenichel and Abbott (JAERE, 2014) and Kirkland (ERE, 2024), we further examine how geographic, ecological and anthropogenic factors contribute to variations in the shadow values of these wildlife resources. This analysis is particularly pertinent given the growing recognition that natural capital and other forms of capital are not always perfect substitutes, especially in environments experiencing significant resource depletion and ecosystem stress. For a given context, a resource stock's shadow price will also be sensitive to the extent to which resource management authorities make decisions along a non-optimal pathway (Fenichel and Abbott, JAERE, 2014). This decision pathway is often referred to as an "economic program" (DasGupta and Maler, EDE, 2000) that will vary with the cultural and social context surrounding each resource's governance authority.

Natural capital valuation methodologies have evolved with the goal of increasing estimate precisions and recognizing that context around resource governance matters in real-world settings. However, these applications have focused primarily on informing sustainable growth strategies that seek to track resource extraction and accumulation that may be obscured by traditional metrics of economic growth. Herein, we have argued that natural wealth accounting at ecosystem and subnational levels is important where local contexts inform the opportunity cost of resource extractions. This is particularly important for regions where wildlife and human activities intersect closely. Our research highlights the necessity of considering these local factors to develop effective policies aimed at sustainable development. Such accounts may serve as a tool to inform judicial discretion that is often exercised by courts and other legal entities when issuing fees and penalties. The proposed approach ensures that effective conservation investments and technological innovations that increase the effective value of natural resources to society will be reflected in the legal structure that protects those resources.

USDA-NRCS and the Bipartisan Infrastructure Law

Astrid Martinez *Presented by:* ***Ralph Smith***
Conservation Planning and Technical Assistance Division Director, USDA-NRCS, Washington, DC,USA

NRCS received a significant amount of supplemental funding to invest on rebuilding our crumbling infrastructure. NRCS watershed programs help communities bounce back from natural disasters and prepare for future ones. This includes communities that we've historically underserved. The Bipartisan Infrastructure Law provided $918 million for watershed programs administered by NRCS. This included $616 million in 238 projects in 49 states for Watershed and Flood Prevention Operations and Watershed Rehabilitations and $278 million for 29 Emergency Watershed Protection projects,

NRCS, in cooperation with local sponsors, will use Emergency Watershed Protection (EWP) program BIL funds to implement much-needed aerial seeding — a successful post-wildfire conservation practice that helps reduce soil erosion, restore ground cover, and establish native plant species.
NRCS has set aside $70 million of BIL funds for covering 100% cost share of Floodplain Buyouts in Limited Resource Areas where structural projects to reduce threats from additional flooding are not cost effective and/or beneficial.

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Making Navajo Cultural-Benefits-Knowledge Available to Inform the Glen Canyon Dam Adaptive Management Program

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The Navajo Nation is collaborating with the Glen Canyon Dam Adaptive Management Program (GCDAMP) to create a resource monitoring program based on cultural-benefits-knowledge to direct management decisions of Glen Canyon Dam operations. Since the early 1990s the Navajo Nation has worked to revive its knowledge of and relationship with the Grand Canyon through its Colorado River Monitoring Program. Though it was originally intended to be an archeologically centered program, it has become clear through associated ethnographic work that an expanded spectrum of cultural knowledge is necessary to meaningfully contribute to management and decision-making. The GCDAMP is a program based on Western sciences, law, and their associated instrumental values and practices which often struggle to accept diverse forms of knowledge. The benefits of the Western systems must be recognized, but it is also essential to introduce Navajo cultural-benefits-knowledge to improve adaptive management and realize social and environmental justice initiatives. Navajo concepts such as *hózhó* (translated as beauty and balance) introduce context-specific values to a program limited by abstracted scientific methods and processes. Cultural-benefits-knowledge has existed for thousands of years but has been marginalized through colonization, the Navajo Nation's Monitoring Program seeks to elevate its contributions to the management of the ecosystem by strategically reproducing traditional knowledge in forms that retain their cultural integrity and effectively inform decision-making in the GCDAMP. In an attempt to move from theory to practice, we will attempt to operationalize knowledge derived from Hoelting et al.'s critical interpretive synthesis of environmental management literature to introduce a systematic monitoring protocol based in both enacted and translated forms of traditional knowledge.

Linking Restoration Efforts to Ecosystem Services: The Case of Freshwater Mussels in Clinton River, Michigan

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Native freshwater mussels are among the most imperiled taxa in North America. Once prevalent in the landscape, anthropogenic stressors such as habitat alteration, contaminants, and climate change have led to steep population declines. Such declines have altered habitat functionality through the loss of ecosystem services they provide, such as water quality improvements, sequestration/processing of nutrients, stream stability, and diverse food web structure. Our project is designed to restore mussel assemblages and their ecosystem services, as well as provide systematic habitat assessments for locations of variable land usage. The urban Clinton River watershed in Michigan was chosen as pilot locations with varying water quality issues supported historically diverse mussel communities. We seek to re-establish diverse representative mussel assemblages and evaluate the resulting impacts on water quality within this urban stream system.

Disentangling Sources of Water Quality Variation in Property Sale Models

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Economists frequently use hedonic property sale models to represent the effects of water quality on housing markets and evaluate the potential social benefits of policies that may improve water quality. While previous studies have estimated property sale models for different types of waterbodies and a wide range of water quality measurements, little attention has been paid to the source of water quality variation used to identify the effect. However, the source of water quality variation is crucial in policy evaluation. When the expected benefits are contingent on future homebuyers responding to improvements in water quality over time, temporal variation may be the preferred source. But constraints in data availability and limited temporal variation often lead researchers to rely on spatial or spatiotemporal sources of variation instead. The open question is how does the source of water quality variation impact estimated effects in property sale models.

In this study, we test how different sources of variation impact hedonic estimates for different types of water quality measurements in lakes, rivers, and coastal waters throughout Massachusetts and Rhode Island. For water quality, we pair remotely sensed water clarity data and enterococci measurements from the EPA BEACHES program with E. Coli and dissolved Oxygen measurements from state monitoring programs. We match water quality measurements to property sales using a novel method that isolates spatial and temporal sources variation by averaging observations throughout the study time frame (2014-2020) or across fixed spatial units (e.g. census tracts) respectively. We compare these results to traditional spatiotemporal matching where each property sale corresponds to a spatially and temporally explicit water quality observation.

We find large differences between spatial and temporal sources of water quality variation that vary by waterbody and measurement type. Our model results demonstrate temporal variation estimates for clarity and enterococci in coastal waters are approximately half the size of spatial variation estimates, while the spatiotemporal estimates fall in between. However, water clarity estimates in lakes are not sensitive to the source of water quality, implying spatial variation may be suitable alternative for temporal variation. Overall, these results support new methods for isolating temporal variation in property sales models for policy evaluation.

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Acknowledging Native Land Ethics & Uses (in South Central Puget Sound, Washington)

Jeffrey Thomas
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This report explores the Native community engagement and visioning strategies which the *Tahoma Indian Center/TIC* (Tacoma, WA, USA) used for framing the ecocultural aspects of its' proposed 2024 Washington State "Native Health Equity Zone" pilot project. Census data indicates there are more than 56,000 persons (representing >300 tribal nations) who identify as Native within the overall City of Tacoma/Pierce County area. The TIC is dismayed that repressive adverse policies still underlie the prevailing local Native health disparities, and that many local Natives still live under the poverty level, and that the TIC community is ranked as being most impacted for each of the states' 19 health and environmental "overburdened community" indicators.

Typical public health (and urban context) literature snubs Native connections to the land being sources of their resilience and well-being and/or Natives needing to reinforce their resilience through positive interactions with land and nature too – rarer literature stresses that Native peoples' lives are sustained by their relationship with natural environments and these relations are known to be an important determinant of their health.

Current literature expounds resilience as being ones' ability to cope (with stress, adversity, change, misfortune) and the community's capacity to provide the resources individuals need to sustain their wellbeing too - and expounds the necessity of honoring Native needs to maintain connections to nature and their needs relating to nature, that non-human connections help Natives cope every day, and that public health interventions need to address local native connections to land and nature (and the social inequities they are experiencing).

A historiography of the terms *ecocentric* and *ecocultural* reveals Puyallup Timber, Fish & Wildlife coining/development of each term during 1993-1994, and the outside elaboration of ecocultural health (2011) and ecocultural identity (2020) concepts by others later on.

This report illustrates that the Tahoma Indian Center both picked and used practical ecocentric and ecocultural concepts to frame the basic local Native health equity zone approaches it proposed for pilot project funding. Their framing proposes elevating nature as a Native community health and wellbeing solution because nature offers calming serenity feelings which attending support programs can't, Native interactions with nature animates meaning-making processes (and emotional shifts to positive calming experiences), and that Nature supports their facing/coping with daily struggles. This report argues that local natural spaces need decolonizing (where Natives don't feel safe, or that they belong) as a population-level form of intervention.

This report aims to girder TICs work to address health disparities, conduct environmental health and justice assessments, energize community and trusted leaders' engagements, partner with other trusted messengers and public health entities, and/or develop policies emphasizing TIC health equity frameworks and community needs.

Exploring Cumulative Environmental Factors on Health Outcomes with Tribal Nations in the Great Lakes Region

Kathleen Torso[1] *and Danelle Lobdell2*

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Scholars and Indigenous leaders have highlighted the need to further examine cumulative environmental injustices, stemming from impacts to the air, water, land, sociodemographic, built, and other culturally specifical factors, on health outcomes for Indigenous Peoples. Within the United States, Tribal Nations of the Great Lakes Region, maintain an ever-growing concern over the impact of cumulative environmental factors on their community. Within this region, cumulative environmental factors are often associated with historical and present-day resource extractive industries including mining, logging, and oil. The potential for open-pit iron mining, expansion of crude oil pipelines, and growing agricultural activities continue to threaten the environmental quality of Tribal land and water withing this region. Tribal Nations rely on the environment for harvesting, gathering, and hunting traditional foods as well as surface water and groundwater as primary drinking water sources. Beyond that, Tribal Nations also depend on their environment for cultural ecosystem services, or the non-material benefits of spirituality and cultural connection, gained through their interaction with nature.

In response to this collective call, United States Environmental Protection Agency scientists are partnering with a Tribal Nation of the Great Lakes Region to explore potential associations between cumulative environmental factors on community-level health outcomes. Through shared roles and responsibilities, partners will assess these potential associations through an exploratory sequential mixed-method design, guided by a decolonizing transdisciplinary perspective which seeks to braid Indigenous and Western knowledge systems. This type of mixed-method design begins with the collection of qualitative data, which builds to quantitative data, and lastly the interpretation of both data sets. The results of this study will act as a building block to strengthen the existing capacity of the Nation in addressing this challenge by providing information, training, and tools to support public health planning and decision making. This presentation will describe the study design, how the design addresses the cumulative impact objective of the partnered Nation, and the collaborative process this research team has undergone to foster an equitable research partnership.

Disclaimer: *This presentation does not necessarily reflect EPA policy. Mentions of trade names do not constitute endorsement.*

Building Urban Resilience to Climate Change with Nature, Community- and Infrastructure Based Solutions a Mixed Methods Study in the Gulf of Mexico. Ciudad del Carmen, México as a Case Study

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The Gulf of Mexico (GoM) is a semi-closed sea shared by Cuba, Mexico, and the USA. These countries have managed the GoM individually while implementing cross-border efforts to manage it jointly. However, no project focuses on building resilience to climate change (CC) from a transboundary perspective. Cities can face the effects of CC by adopting actions that allow them to strengthen their resilience. Among the existing actions, nature- (NbS), community- (CbS), and infrastructure-based solutions (IbS) have been incorporated into urban agendas with encouraging results.

This work aims to evaluate urban resilience in the context of CC in coastal cities in the GoM with direct attention to the Mexican case study in Ciudad del Carmen. To carry it out, it has proceeded through analyzing planning and management urban ordinances (content analysis, CA), semi-structure interviews, and observation notes (thematic analysis, ThA) that focus on NbS, CbS, and IbS actions from 2002 to 2024.

The research is structured using a mixed methods methodology. It has a conceptual model (CM) complex nested design - mixed methods multiple case studies explanatory sequential design (ExplanSD) - with emphasis on quantitative rather than qualitative methods in ExplanSD (QUAN → qual).

The results for the Mexican case study are from the CM: 1) It was tested in selecting the case study and analyzing it. Of ten potential cities, only one was selected through the CA and analyzed in depth using both CA and ThA. From the CA and ThA: 2.1) Mangrove restoration financed by the federal government and implemented by various local actors has been the most used NbS over time; 2.2.) Mangrove conservation by local actors, NGOs and local government, is another NbS that has been applied for several decades. From the ThA: 3) Since there is a significant economic disparity in the city's population, the CbS have a large area of opportunity to be applied to reduce climate-associated risks, strengthen climate outreach, and reduce poverty traps; 4) The SbI have caused a greater degree of risk exposure because they have accelerated the coastal erosion of the Island, which is why the redesign of the piloted road infrastructure and coastal protection structures is imperative. Since the methodology has been tested, it can be replicated in the selection, analysis, and subsequent comparison of the case studies in the United States and Cuba.

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Caminos for Success: An Overview and Lessons Learned

***Bob Edward Vásquez**, and Gloria P. Martinez-Ramos*
Texas State University, San Marcos, TX USA

This presentation provides some background and a description of CAMINOS For Success, a USDA-funded project designed to engage and empower STEM students to raise their professional aspirations. The CAMINOS fellowship enhances the education of graduate students with mentoring and coaching; a data analytics and career institute; a research competition; a USDA site visit; and a trip to present their research at the conference of the American Association of Hispanics in Higher Education. Insight into lessons learned during the first year will be discussed as well as the process for adjusting the plan for subsequent years.

Protecting Rangelands in a Changing Climate: Using a Heritage Cattle Breed to Maintain Ecosystem Function under Livestock Production

***Kari E. Veblen*[1,2]*, Maria K. Stahl*[1,2]*, Tal Avgar*[3]*, Michael C. Duniway*[4] *Juan J. Villalba*[1,2] *Sasha C. Reed*[4]*, Eric T. Thacker*[1]*, Matthew Garcia*[4]*, Matthew Redd*[5]

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The Colorado Plateau, USA is an iconic western dryland landscape, home to dozens of national parks and monuments as well as several UNESCO World Heritage Sites. this richly diverse environment is also a hot-spot for climate change. This threat poses significant risk to the future of livestock production, a key economic activity in this region. We are testing a novel climate adaptation strategy for livestock producers, the use of Raramuri Criollo (RC) cattle, a heritage breed adapted to the arid rangelands of Mexico, as an alternative to conventional breeds such as Red Angus (RA). RC cows are 300-500 lbs lighter than RA cows, with previous studies in the Chihuahuan Desert finding that RC range farther from water, eat a broader diet containing more shrubs, and navigate more rugged terrain than conventional breeds. We are determining if these behavioral differences also occur—and whether RC traits may be advantageous in the face of a changing climate—on the Colorado Plateau at the Dugout Ranch, located in San Juan County, UT. Preliminary results suggest that in the dormant season (Nov-Feb), RC traveled farther, explored larger areas, and spent more time grazing and less time resting ($p < 0.05$) each day than RA. However, these differences were not significant during the growing season (Mar-Apr). Additionally, based on the results of a habitat selection function, both breeds avoided areas far from water in the growing season, but RC to a lesser extent than RA ($p < 0.05$). We are continuing to investigate how movement behaviors differ across seasons and are using DNA metabarcoding of fecal samples to examine whether these traits are associated with different diet preferences. Further, we are monitoring metrics such as calf and cow weights at birth and weaning to determine how movement traits might translate into beef production efficiency. Finally, we are using both field-based and remote sensing approaches to weigh these potential differences between RC and RA cattle against their impacts on range condition, and the production of ecosystem services therein.

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Midwestern USA Farmers' Perceptions of Distributive Justice in Voluntary Soil Carbon Markets

***Chloe Wardropper**, Ashley Colby, Jane Gross, and McKenzie Johnson*
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Voluntary carbon offset markets have emerged over the last decade to allow firms to compensate land managers for carbon sequestration, including paying farmers for practices that sequester soil organic carbon. While agricultural soils have the physical potential to offset up to ten percent of US greenhouse gas emissions, the social and economic viability of voluntary carbon markets in agriculture is uncertain. Little research has assessed the barriers and opportunities to participation in these markets across farmers with different demographic backgrounds. Minoritized producer groups in the US likely face barriers to accessing offset markets, including limited information, high transaction costs, and high levels of uncertainty. Drawing on the concept of distributive justice, which concerns the allocation of resources and opportunities, our study asks: 1) Who benefits from and is impacted by the existence of voluntary carbon markets? And 2) How do perceptions of inclusion and equity affect farmer interest and participation in voluntary carbon markets? Drawing on 35 interviews with Midwestern farmers and key informants, we find that active recruitment into carbon markets has focused narrowly on large-scale conventional row crop farmers who are demographically homogeneous. Farmers outside this farm type and demographic group are cautiously skeptical but open to participation in voluntary carbon markets. They are especially interested if participation would provide adequate financial incentives for practice adoption and co-benefits to the farm operation such as resilience to extreme weather conditions. Concerns about participation across all farmers interviewed include financial loss if measured carbon sequestered is less than expected, and minoritized farmers mentioned concerns about programs not tailored to their background and operation. This study illuminates the practical concerns different types of Midwest farmers have regarding carbon markets and offers insight into the process and barriers to realizing just transitions within payment for ecosystem services markets.

Evaluation of Publicly Accessible Nature-Based Solutions Databases as Sources for Evidence of Effectiveness

Katie Warnell *& Lydia Olander*
Nicholas Institute for Energy, Environment & Sustainability, Duke University

Nature-based solutions (NBS) present opportunities to simultaneously tackle both the climate and biodiversity crises by supporting carbon sequestration in ecosystems, enhancing community resilience to climate hazards, and providing high-quality habitats for diverse species. However, uncertainty around the performance and reliability of NBS continues to be raised by engineers, local decision-makers, grant-makers, and the insurance industry as an obstacle for widespread implementation of NBS at scale. This uncertainty indicates the need for comprehensive and accessible data on NBS projects and outcomes that could be used to develop engineering standards, assess projects' cost-benefit ratios, and incorporate NBS into insurance premium pricing.

We evaluated 27 publicly accessible nature-based solutions databases to understand what information they contain, what types of nature-based solutions are included, their geographic scope, and data organization and accessibility. While there is a large amount of information on nature-based solutions projects and publications in these databases, it is not sufficient for the purposes described above. Existing databases have inconsistent structures and differ in the details they provide about projects, making it difficult to compare across projects or approaches. Many provide limited information beyond project type, location, and a short description. While there are several relatively simple changes that could improve these databases, there are limits to what can be achieved given missing data on baseline status, project design and construction, and project effectiveness.

In this session, we will share results from our evaluation of existing databases and our ideas for improving the collection, organization, and sharing of effectiveness data from nature-based solutions projects. There will be multiple opportunities for attendees to provide their input at ACES and beyond.

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Order Out of Chaos: A Dashboard for Forest Accounts

Katie Warnell

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The United States recently announced a strategy to develop natural capital accounts, which track the condition of natural ecosystems as well as the values they provide to society. Forests, as a critical part of the nation's natural assets, offer a variety of services such as timber, pollination, recreational opportunities, and carbon storage and sequestration. Although there is abundant data on forest extent, condition, and values, is it scattered across many sources, formats, and levels of aggregation. Forest accounts provide a framework for consolidating this data and making it more accessible to decision-makers and researchers.

This presentation will introduce pilot forest accounts for the Western United States, presented in an interactive Tableau dashboard. The dashboard enables users to explore forest accounts data through tables, graphs, and maps, offering various levels of detail from the entire study area down to individual National Forests. The pilot accounts highlight the challenges and potential solutions in integrating multiple datasets to build out natural capital accounts, as well as the types of questions these accounts can help answer.

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What is the Value of a Forest?

Travis Warziniack[1], *Jennifer Costanza*[2], *Rebecca Flitcroft*[3], *Chris Mihiar*[2], *Claire O'Dea*[4], *Sonja Oswalt*[5], *Jeff Prestemon*[2], *Kurt Riitters*[2], *Eric White*[6]

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This talk synthesizes recent assessments on the state of US forests and leverages forest health data to better measure ecosystem service values from forests, with a goal of developing forest natural capital accounts by 2027. It builds on the recently released Resources Planning Act (RPA) Assessment and advances the implementation of the National Strategy to Develop Statistics for Environmental-Economic Decisions, which outlines plans for an all-of-government approach to increase understanding of the economic value of the Nation's environment and natural resources in order to provide linkages with the current national economic accounting system. To the degree practical, US natural capital accounts will follow standards set out in the United Nations System of Environmental-Economic Accounting (SEEA).

Forests make up 34 percent of the coterminous United States, sequester 45.5 billion metric tons of carbon every year, and are the source of 39 percent of the U.S. water supply. However, we find that though total forest land area increased slightly over the past decades, there was a net loss of 15 million acres (6.4%) of interior forest cover due to land use change and forest disturbance between 2001 and 2016. In recent decades, forest area burned by wildfires in the U.S. have doubled, and forests are increasingly susceptible to insect damage and storms, affecting their capacity to sequester carbon, produce timber and non-timber products, sustain aquatic and terrestrial ecosystems, and provide the quantity and quality of water upon which the nation depends. These stressors point to a potential future where forests are unable to regenerate as they once did and highlight the need to include measures of forest condition in assessments of economic value.

Waterfront Reconnection: Linking Ecosystem Restoration to Community Revitalization

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The Great Lakes Area of Concern (AOC) program was established to address beneficial use impairments in aquatic ecosystems caused by historic anthropogenic degradation and habitat loss. These impacts disconnected communities from waterfront ecosystems. The "R3" paradigm frames the potential impact that AOC program actions can have for their communities: environmental Remediation can facilitate ecosystem Restoration, which can spur community Revitalization. Revitalization is defined as equitable and sustainable policies or interventions that promote human well-being and healthy ecosystems. However, measurable human well-being outcomes associated with restoration of AOCs are variable, and when observed, can take years to manifest following environmental work.

In a case study in the St. Louis River Estuary, we explored the benefits from and barriers to blue space experiences by employing a survey of 532 residents and 42 semi-structured interviews with participants. Our qualitative results suggested that remediation and restoration must be paired with reconnection efforts, or actions to reestablish connections between the community and waterfront spaces to facilitate potential human well-being benefits (i.e., revitalization outcomes). Reconnection efforts identified by participants included waterfront amenities like universally accessible transportation, trails, bathrooms, drinking water, rest areas, and safety amenities. In addition, public communication and education is needed about current ecosystem health, basic skills to safely access the waterfront and waterbodies, and opportunities to deepen relationships with waterfront places. These efforts can help shift perceptions about environmental quality and the desirability of visiting waterfront areas and may help increase public support for further revitalization efforts. The limited nature or absence of reconnection efforts for some AOCs and AOC projects may explain delays in associated revitalization benefits.

Our results support funding for and prioritization of amenities, communication, and education to reconnect communities with waterfront ecosystems. Reconnection can be considered an additional "R" to the paradigm: Remediation and Restoration, paired with Reconnection, can lead to community Revitalization. Only through explicit reconnection efforts can beneficial use impairments be fully addressed to support waterfront revitalization and human well-being benefits associated with healthy aquatic ecosystems.

The views expressed in this abstract do not necessarily represent the views or the policies of the U.S. EPA.

Sustaining Rural Livelihoods, Livestock Grazing, and Sage-Grouse Habitat in Western Sagebrush Systems

Perry Williams[1], *Corina Mathews-Sanchez*[1], *J.D. Wulfhorst*[2], *Brandon Linhart*[2], *Jeffrey Mosley*[3], *Katherine Lee*[2], *John Ritten*[4], *Jonathan Dinkins*[5], *Lance McNew*[3], *Jeffrey Beck*[6], *David Dahlgren*[7], *James Sedinger*[8], *and Christian Hagen*[5]

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The sagebrush biome is a vital landscape in the western United States, providing significant economic, ecological, and societal benefits, including livestock forage, wildlife habitat, and carbon sequestration. Despite its importance, only half of its historical range persists, posing challenges for rural communities and conservation efforts.

We examine the balance between rural livelihoods, livestock grazing, and greater sage-grouse habitat within the sagebrush ecosystem. The sage-grouse has been a focal point of conservation efforts, with the U.S. Fish and Wildlife Service deciding in 2015 not to list it under the Endangered Species Act due to extensive conservation measures. However, the regulatory landscape may pose real or perceived threats to ranchers' livelihoods and ecosystem health.

To address these challenges, we developed a framework that integrates wildlife conservation with cattle production, evaluating the regulatory impact on sage-grouse population dynamics, rural economics, and community well-being. This framework assesses the impacts and uncertainties of livestock grazing on vegetation and sage-grouse habitat, providing insights into sustainable practices across a climate gradient that affects both grazing and ecosystem function.

Our holistic approach highlights the need for integrated strategies that address the economic, ecological, and sociological dimensions influencing rural communities that depend on sagebrush ecosystems. By balancing livestock production with habitat conservation, we aim to evaluate how sustainable ranching relates to effective conservation of sage-grouse habitats.

Longleaf for All: Working with Historically Underserved Landowners to Strengthen a Legacy of Resilience

Tiffany Woods[1]*, Shelby Diehl*[1]*, Jamelle Ellis*[2]*, Herbert Hodges*[3]*, and Brian Branciforte*[4]

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Longleaf For All, led by the National Wildlife Federation and founded within America's Longleaf Restoration Initiative, engages with historically underserved landowners, professionals, and students to create positive change across the longleaf range. This panel focuses on the collective work being done with historically underserved landowners and communities to address challenges, such as access to resources, legal counsel, financial markets, and outreach, and optimize opportunities for owning forested land through longleaf pine restoration. Our goal is to demonstrate the potential to engage in existing and emerging markets for forest ecosystems by highlighting the ecological, economic, and cultural advantages and resiliency of longleaf pine.

Panelist Biographies

Tiffany Woods has over two decades of hands-on experience in forestry, prescribed fire, landowner engagement, and community resilience, and is the co-founder and co-lead of Longleaf for All.

Shelby Diehl has more than three years of non-profit communications experience, with an emphasis on climate solutions, natural resource management, and storytelling.

Jamelle Ellis has over 20 years of experience in the environmental field, with engineering and science roles in academia, private, and public sectors focused on environmental contaminant delineation, exposures, and human health impacts.

Herbert Hodges, a retired military veteran, educator, and landowner from South Georgia, is Longleaf for All's first Landowner Mentor.

Herbert Hodges, a retired military veteran, educator, and landowner from South Georgia, is Longleaf for All's first Landowner Mentor.

Brian Branciforte has worked in the natural resource field for two decades and recently joined the U.S. Forest Service southern region focusing on ecosystem services, landscape conservation, climate mitigation, and underserved forest landowners.

Expanding Ecosystem Service Considerations in Olympic Coast National Marine Sanctuary

Katie R Wrubel*, Kevin Grant, Jenny Waddell*
Olympic Coast National Marine Sanctuary, Port Angeles, WA, USA

Olympic Coast National Marine Sanctuary (OCNMS) is a 3,188 square mile area of the Pacific Ocean off the coast of Washington state designated in 1994. The sanctuary protects thriving intertidal zones, kelp forests, and deep-sea communities. The sanctuary also lies within the boundaries of the legally defined usual and accustomed fishing areas of four federally-recognized tribes with reserved treaty rights: Hoh Tribe, Makah Tribe, Quileute Tribe, and Quinault Indian Nation (collectively referred to as the Coastal Treaty Tribes). OCNMS has recently completed a sanctuary Condition Report and Climate Vulnerability Assessment to inform an update of our management plan. Condition reports are used by NOAA to assess the condition and trends of resources and ecosystem services within national marine sanctuaries. Climate Vulnerability Assessments qualitatively describe and evaluate how vulnerable a given resource is to the cumulative impacts of climate change and non-climate stressors in order to inform and improve management approaches. OCNMS has worked closely with the Coastal Treaty Tribes, and other partners, on these assessments, and has expanded not only the sanctuary's considerations, but the whole sanctuary system's considerations around ecosystem services to better recognize Indigenous Knowledge and the reciprocal relationship that many Indigenous People have with the environment. As Indigenous Peoples have been an important part of the ecosystem since time immemorial, it is vital to understand these relationships and multiple worldviews for effective collaborative management.

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Integrating Soil Carbon and Greenhouse Gas Monitoring into Regionalized Ecosystem Service Evaluation

***Yushu Xia*[1]*, Xuesong Zhang*[2]*, Anthony Aufdenkampe*[3]*, Matt Sheffer*[4] *and Terry Nipp*[5]

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Soil provides numerous ecosystem services such as supporting animal and plant growth, nutrient cycling, and water retention. There is a growing interest in evaluating soil ecosystem services related to climate regulation through the monitoring of soil carbon sequestration and greenhouse gas (GHG) emissions. Considering that soil carbon and GHG emissions vary not only with management but also with soil and environmental conditions, it should be investigated how recommendations for climate smart agricultural practices can be customized for different regions using monitoring tools and datasets. This presentation will first review the current boundaries used for summarizing modeling results, together with alternative methodology that can be used to establish regional soil monitoring units. This will be followed by a discussion of spatial variability in soil carbon and GHG emissions, as well as their main driving factors reported at the regional scale. Data availability across different regions will also be examined in order to identify gaps that need to be filled to derive Tier-2 (emission factors) or Tier-3 (model-based) estimates of SOC stock changes and GHG emissions. Finally, we will outline the steps needed to improve models and decision support tools to facilitate regionalized stakeholder engagement activities.

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The Final Ecosystem Goods and Services (FEGS) Document Reader: A Tool to Extract, Identify, and Prioritize Ecosystem Services and Their Beneficiaries from Documents

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An essential step to effectively setting environmental management goals, designing projects, and characterizing outcomes is identifying key stakeholders and understanding what ecosystem services benefits are important to them. The FEGS Document Reader is a deep learning, text mining tool designed to accelerate the process of identifying and prioritizing ecosystem services when existing information in the form of written documents is available. The FEGS Document Reader classifies the relative frequency of ecosystem services terminology in documents uploaded by a user and provides an assessment of: i) the relative importance of different ecosystems mentioned in documents; ii) the types of users, or beneficiaries, who use or care about those ecosystems; and iii) the most relevant ecosystem services attributes important to those users.

The FEGS Document Reader is designed to work with the National Ecosystem Services Classification System Plus (NESCS Plus) and the Final Ecosystem Goods and Services (FEGS) Scoping Tool. These two tools use manual input from users, often through working directly with decision-makers and other stakeholders, to identify and classify ecosystem services and assign weights of their relative importance. Though not intended to substitute for thoughtful stakeholder engagement, the FEGS Document Reader can provide a preliminary assessment of priority ecosystem services, serving as a starting point for more efficient or targeted stakeholder engagement to refine that classification and prioritization. Additionally, because the FEGS Document Reader is based on a highly structured corpus of keywords, the tool can facilitate a fast and consistent approach for comparing documents, for example to evaluate regional, contextual, or temporal differences in ecosystem services preferences.

The FEGS Document Reader was applied to identify key ecosystem services user groups and how they may benefit from coastal ecosystem restoration. Identification and prioritization of ecosystem services forms the foundation for communicating and refining locally relevant restoration goals and targets, for designing and implementing restoration projects that reflect what the community cares about, and for assessing and monitoring project outcomes in terms of accruing benefits to local communities.

Great Lakes Coastal Resiliency: Supporting Community-Centered Processes to Build Consensus and Prepare for Future Climate Scenarios

***Nicole Zacharda*[1], *Jim Luke*[2], *Stevie Adams*[3], *Bridget Brown*[4], *and Chiara Zuccarino-Crowe*[5]**

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Through significant U.S. federal investment in the Great Lakes Restoration Initiative and state initiatives, federal and state agencies and Indigenous Nations are partnering with local governments and conservation organizations to build a resilient Great Lakes basin capable of withstanding the highs and lows predicted by our region's climate models. Of particular significance for the five Great Lakes, highs and lows include water levels, leading to a key partnership between the states and U.S. Army Corps of Engineers for a 6-year Great Lakes Coastal Resiliency Study. Meanwhile, local partners are working to sustain regional coastal processes and ecosystem services through equitable shoreline management approaches and reuse of dredged sediment. Attendees of this session will gain an appreciation for the collaborative spirit of Great Lakes partners aiming to restore and protect the largest freshwater ecosystem in the world.

Panelist Biographies:

Ms. Zacharda is celebrating 25 years of water policy work, spanning a career with Michigan's environmental agency and now serving as program manager for water and resilience efforts at the region's interstate compact agency.

Jim Luke is the Great Lakes Restoration Initiative Program Coordinator for the U.S. Army Corps of Engineers (USACE). As the GLRI Program Coordinator, he manages and coordinates a large portfolio of GLRI projects involving USACE that includes sediment remediation, habitat restoration, invasive species, non-point source pollution, construction management, and technical assistance.

Stevie Adams is a Senior Climate Adaptation Specialist with The Nature Conservancy in New York and is part of a team that works to protect and restore floodplains and coasts to help human and ecological communities adapt to climate change. She is a Certified Floodplain Manager with the Association of State Floodplain Managers and co-chairs the Training and Outreach Committee of NY's state chapter, the New York State Floodplain and Stormwater Managers Association.

Bridget Brown is the Chief Operations and Programs Officer, Great Lakes and St. Lawrence Cities Initiative. In this role, Bridget leads the Cities Initiative's municipal support programs around coastal resilience, water equity, water quality and climate action. The Cities Initiative's coastal resilience programs have provided engineering and financing support to over 100 U.S. Great Lakes coastal communities since launching in 2021.

Chiara Zuccarino-Crowe is the Great Lakes Regional Lead for NOAA's Office for Coastal Management. In this role she coordinates a team to support program partners' needs in enhancing the resilience of the region's coastal areas and communities, while providing resources, tools, and services to help protect and restore coastal ecosystems and sound economies. She has focused on Great Lakes issues in interdisciplinary government, non-profit, and academic settings for over a decade.

Accessing Urban Forest Inventory and Analysis: A Spectrum of Tools for Every User

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The USDA Forest Service Urban Forest Inventory and Analysis program is a strategic-level, continuous inventory and monitoring system that combines traditional National Forest Inventory and i-Tree Eco protocols to monitor urban forest resources and their structure and function. Data collected through this program provide a wealth of information on the status and trends of urban trees and forests over time, including the services they provide, their health, and future risk from insects and disease, and can be used to inform urban forest management and policy at local, regional, and national levels.

The data collected through Urban Forest Inventory and Analysis is extensive and requires a complex database to manage. Making this data accessible is critical for empowering cities and other stakeholders to strategically manage their urban forest resources and strengthen urban forestry advocacy efforts. A broad spectrum of users ranging from policymakers to researchers presents a challenge for effective data delivery, requiring a broad spectrum of tools for data access. With the DataMart, FIADB API, Urban Forest Stats, My City's Trees, and written reports, there is a way for every kind of user to leverage Urban Forest Inventory and Analysis data.

These tools range in complexity and flexibility. The DataMart, which places the full database in user's hands, provides maximum flexibility but is also very complex and has a major learning curve. Removing some complexity while also maintaining a relatively high degree of flexibility, the FIADBAPI provides users a mechanism to query the USDA Forest Service's database in a structured way. Urban Forest Stats allows users to retrieve information from the API without having to understand how to structure the queries. Designed to be easy for anyone to use, My City's Trees summarizes important elements of the data and is updated annually. Finally, the written reports are static and updated the least frequently but are also the easiest to digest and understand.

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Integrated Watershed Modeling and Accounting of Terrestrial and Aquatic Carbon Budgets

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Managing agroecosystems to mitigate greenhouse gas (GHG) emissions is essential for achieving the global goal of reducing climate change risks. The current carbon accounting approaches often include soil organic carbon change and net ecosystem exchange between land and the atmosphere, but do not consider the lateral carbon fluxes that leave the agricultural field and enter the aquatic ecosystems. Here, we introduce the Soil and Water Assessment Model -Carbon (SWAT-Carbon) that is capable of simulating the coupled terrestrial and aquatic carbon cycles. The SWAT-Carbon model converges carbon cycling algorithms and knowledge from multiple widely used ecosystem and water quality models, including SWAT, EPIC, DayCENT, QUAL2K and CE-QUAL-W2. In addition, numerous new algorithms were also developed to link the terrestrial and aquatic carbon cycling processes represented in those existing models. We provide examples demonstrating the SWAT-Carbon model's performance with regards to carbon balance of terrestrial ecosystems (e.g., crop and forest), response of photosynthesis to CO2 fertilization effects, freeze-thaw cycle, land-river lateral carbon fluxes, and fate of carbon in aquatic environments. The results illustrate the importance of accounting both terrestrial and aquatic carbon fluxes for designing effective agricultural practices to reduce GHG emissions. The open-source SWAT-Carbon is expected to serve as a useful tool to support more comprehensive assessment of diverse climate-smart agricultural practices to ensure effective climate adaptation and mitigation.

Mapping Flows of Nature-Based Outdoor Recreational Services at Large-Scale BASED on Crowdsourced Date and Multimodal Learning

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Cultural ecosystem services (CES) are intangible non-material benefits provided by nature, which involves direct outdoor interactions with the natural environment. Crowdsourced geotagged social media data and deep learning have emerged as promising tools that augment existing approaches to improve our understanding of human-nature interactions and mapping of CES. However, to date, studies focus on automated image classification for CES research typically focus on a single data modality. Few studies have simultaneously leveraged both text and image content to classify and map CES at large spatiotemporal scales. This study aimed to quantify and map outdoor recreational services using a combination of crowdsourced image and text data from the photo sharing platform Flickr. Flickr data across the state of Florida from December 2013 to December 2019 were retrieved, which provides images and text attributes such as geospatial coordinates, tags, titles, and description. We applied a novel multimodal vision-language model based on zero-shot learning to classify and map recreational services at the landscape level. Space-time clustering analysis was used to identify hotspots of outdoor recreation, considering both the spatial and the temporal context of services flows. Additionally, a quantile random forest classifier was developed to examine important landscape characteristics, environmental and socioeconomic variables that drive recreational services flows and to spatially explicitly predict the recreation potential based on important features. Our findings show how emerging crowdsourced data, coupled with new developments of large vision-language models, offer the opportunity of processing fine scale and comprehensive information about CES. By identifying areas and time periods with high and low CES flows, as well as factors correlated with users' preference for nature-based recreation, our results hold great value for informing management interventions on ecosystem services provision, especially in locations with limited onsite visitation data.

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