Faced with ongoing health and environmental crises, we must redefine urban landscapes as multi-functional spaces that not only improve physical and psychological health and support ecological sustainability, but also contribute to the beauty and identity of a site, encourage community engagement, and provide opportunities to pilot innovative management operations. The ***Nature HEALS (Health, Engagement, Aesthetics, Landscapes, & Sustainability)*** project will leverage University sheep to maintain valued landscapes on central campus and address the question: *how can science, design, and practice converge to inform the creation of accessible, multi-functional greenspaces that maximize cultural and environmental values?*

Historically, sheep have been critical in maintaining landscapes, including iconic ones such as those in Central Park and at the White House. Given growing recognition of the need for resource conservation, there is currently a resurgence of interest in introducing sheep to sustainable landscape systems. In addition to providing an environmental (and cost effective) alternative to conventional maintenance regimes, contributions of sheep to the urban landscape include: (1) enhancing place-based identity, (2) affording opportunities for education and engagement, and (3) promoting mental health and well-being. Nearly 40 years of research confirms that contact with nature is profoundly beneficial to human health and wellbeing.[1] Evidence also shows that human interactions with animals (including passive observation) produce similar benefits; positive effects include the potential to decrease loneliness and depression, reduce stress and anxiety, and provide a stimulus for exercise.[2,3] This has increased the number of health practitioners embracing the benefits of contact with nature and animals, resulting in prescriptions to spend time outdoors (a practice known as *Nature Rx*) and recommendations of therapeutic animal-assisted activities to patients suffering from stress, anxiety, and even loneliness.[4,5]

Incorporating sheep into an existing urban greenspace has the potential to offer multiple operational, environmental, and social benefits, but these metrics have never been quantified. At the operational level, sheep grazing landscape management practices have been shown to manage weeds and pests, reduce labor costs, permit operating access to inaccessible terrain, lower gas usage, and provide a cost-saving alternative to mowing. Environmentally, sheep can eliminate invasive plants and restore native grasses, reduce carbon emissions, introduce beneficial insects attracted to their waste products, and improve soil health without compacting the soil. Culturally, the addition of sheep to a greenspace can add pastoral beauty to a site, provide a sense of place, inspire urban agri-tourism, serve as a living educational tool, and promote mental health. Unfortunately, peer-reviewed evidence to support all these claims is nascent at best.

Through collaboration with a multi-disciplinary group of faculty, staff, students, and community members, the Nature HEALS project will address intersections of human and environmental health across five cross-cutting themes: (1) Health & Well-Being, (2) Regenerative Ecosystem Functions, (3) Beauty & Identity, (4) Education & Engagement, and (5) Operations & Maintenance. The research study will work across these five themes to (a) quantify the benefits of, and (b) propose best practices for designing, constructing, and operating urban-grazed outdoor spaces. The project will be grounded in co-produced knowledge that is convergent across ecology, design, public health, and operations.

Accomplishing the Nature HEALS Project

For this project, 25 campus sheep will be allowed to graze in a fenced 1-acre lawn area on central campus. An equally-sized adjacent lawn will serve as a control; it will be conventionally maintained by Grounds staff. Sheep will be transported to the site in a trailer and allowed to graze; at the end of the day, they will be transported back to the Sheep Facility. It is anticipated to take 2-3 days to "mow" the experimental half of the lawn. Two student-shepherds will supervise the sheep at all times. I have been working closely with Matthew Hayes, the Sheep Facility Manager, and Tyson Mantor, the Director of Grounds and Landscape Services. Both support the project and have agreed to participate in the research. The Animal Care and Use Protocol (#21902) I submitted has been approved by the Institutional Animal Care and Use Committee (IACUC). I am currently finalizing partnerships with academic departments and institutional entities to determine the specific qualitative and quantitative

metrics that will be included in the main study. This spring and summer we will pilot the logistics, feasibility, and efficiency of using sheep to mow campus lawns. The logistical data gathered this year will be utilized to launch the multi-disciplinary research project in the spring of 2022.

Enhancing Creative Academic Activity

The success of the Nature HEALS project relies on creative academic research collaborations between the social sciences and the natural sciences, input from students and community members, and operational partnerships with planning, design, and management entities. This transdisciplinary effort breaks down traditionally siloed approaches to human and environmental health, focusing instead on a whole-systems approach to developing innovative solutions and encouraging applied collective action. Specifically, the project will utilize engaged learning techniques to actively involve stakeholders with the design, implementation, research, and ongoing stewardship of the project. We will address the following five questions:

- *Is there a perceived mental health benefit from the presence of sheep on central campus?*
- *Does grazing landscape management ecologically enhance campus landscapes and support resource conservation?*
- *How does the Nature HEALS project aid in the creation of a sense of place and identity for the campus?*
- *Can information about the sheep experiment be shared in a novel and interactive way to engage the campus community as well as a broader external audience?*
- *From a fiscal and operational perspective, what benefits are associated with sheep grazing management?*

Advancing Innovation

Industry stakeholders have signaled that they are in need of academic partners to innovate and improve their environmental footprint. This designed experiment will use campus greenspace as a living laboratory to test, display, and provide data on the best practices, new technologies, social benefits, and cultural acceptance of urban grazing. Notably, I am currently in discussions with a New Zealand start-up to enroll the sheep in a pilot study testing electronic collars that guide and contain grazing animals without the need for fences. The sheep, which can be monitored through a remote tracking feature on a phone app, are trained to respond to the sounds and vibrations of the solar and battery-powered collar. The story of a land grant university utilizing its own sheep to test advanced technology, reduce its environmental impact, and simultaneously promote health & wellness on campus is easy to understand and culturally impactful. It is also physically, visually, and intellectually accessible to external outlets and the broader public. Partnerships and collaborations such as this will raise the profile of the university as a leader in sustainable agriculture, technology, and public health.

Advancing Scholarship at UC Davis

The Nature HEALS project dovetails with several ongoing campus initiatives, including Veterinary Medicine's ONE Health initiative, the campus-wide Healthy UC Davis initiative, and the Arboretum and Public Garden's Living Landscape Adaptation Plan. My project has been designed to provide unique opportunities for place-based research and can be used by other academics to test their own questions. Demonstration projects at other agricultural universities have investigated the potential of sheep to manage vegetation in the narrow aisles of solar farms, to improve soil health and reduce the need for tillage in crop plots, and to strip leaves (allowing grapes to get more sun) in vineyards. Researchers are also investigating the effectiveness of sheep to target the dry weeds and understory that provide fuel for wildfires. There are opportunities to design and craft interactive learning experiences for visitors at the site (interpretive signage) and virtually (web cams, podcasts, blogs) and to create public health programs that capitalize on the health and wellness benefits of nature contact. Our expectation is that this initial project will inspire the pursuit of numerous associated research opportunities.

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