

Title: Nature Based Solutions via Community-Engaged Research and Education

Abstract: Solutions to mitigate the negative impacts of climate change on local communities are urgently needed. However, stakeholders and decision-makers are inadequately integrated into the design of research and solutions intended to serve them. Similarly, we are not preparing the next generation of scientists to successfully collaborate across disciplines and stakeholder groups; undergraduate curricula often leaves-out training in collaboration, co-production, and real-world problem solving. To meet these needs, faculty from the EBIO Department and the City of Boulder propose a research and education program on interdisciplinary and community-engaged research and education. Together, we will create an undergraduate internship program centered on co-producing Nature-based Solutions: actions that conserve, restore, or better manage ecosystems in ways that provide co-benefits for climate mitigation and adaptation, biodiversity, and human-wellbeing. This pilot will strengthen connections between CU and local communities while enabling us to seek matching funds from partners and grants to grow this program.

Summary: As a result of global climate change, our society is facing some of the most complex and vast socioscientific challenges ever encountered (e.g., devastating wildfires like the Marshall Fire). Such challenges and the development and implementation of Nature-based Solutions (**NbS**) require scientists to work at the interface of science and society^{1,2}. These problems also require that we, as educators, equip our students with the knowledge and skill to address such problems *and* the ability to collaborate on sustainable solutions across diverse stakeholder groups. Yet, persistent challenges pose obstacles to developing effective solutions. First, stakeholders and decision-makers are often inadequately integrated into design, modeling, and implementation of research intended to serve them. As a result, proposed NbS often fail to inspire widespread uptake or broad societal impact. **A solution we will adopt is co-production:** an approach where researchers collaborate with end-users to develop research questions, design, products, dissemination, and implementation of findings³.

Second, CU undergraduates are often *not* formally trained in the full suite of skills needed to develop solutions to socioscientific climate challenges, nor are we recruiting a generation of scientists who, as a whole, will be well positioned to address these issues. While undergraduate curricula often discuss past solutions, undergraduates are rarely engaged in efforts to *create* actionable real-world solutions nor receive training in stakeholder collaboration³. Further, our field lacks the diversity needed to generate sustainable, creative, and equitable solutions⁴, often because we fail to attend to cultures and values of historically excluded groups. We can, in part, address these challenges by offering students opportunities to collaborate on science endeavors with clear pro-social goals. **Offering training in co-production is likely to attract and retain students from minoritized groups who tend to value pro-social goals**⁵.

To meet these challenges, we propose to launch an education and research program **with community partners** to increase a) the efficiency and efficacy of environmental solutions in Boulder, and b) the recruitment, retention, and job-preparedness of diverse CU undergraduates. We will develop and sustain a community-engaged undergraduate internship program focused on generating local NbS. This pilot phrase will:

1. Engage 6 EBIO students in paid internships for co-produced research with end-users as a pilot for EBIO's **Nature Based Solution Capstone Course (NBSCC)**.
2. Provide opportunities for graduate students to **work with local partners and to mentor undergraduate students** in participatory action research and curriculum development.
3. Develop curricula and a model for EBIO's **NBSCC** program focused on training in co-production, internships, and product development for end-users.
4. Establish a Community of Practice for undergraduate and graduate students with interdisciplinary interests working on applied projects (the **NBSCoP**).
5. Gather pilot data for fundraising and grant applications **to sustain and grow the program**.

Program components, leadership team, anticipated outcomes, and sustainability plan

Local projects generating NbS. We will focus on 3 ongoing projects, developing internships for 2 students within each project. Each project will involve students in co-produced research focused on solutions to local climate and environmental challenges.

Urban Heat in Boulder. As cities face frequent and prolonged heat waves, urban heat mitigation is an urgent priority. Vegetation offers a promising NbS to combat the urban heat effect by providing shade and enhancing cooling through evapotranspiration. Interns will collaborate with a graduate student expert and the City of Boulder's [Cool Boulder Initiative](#) to investigate the cooling potential of different types of vegetation and provide this information to City partners to inform decisions about planting and urban landscape management. **A pilot of this effort received the 2022 CU Boulder Sustainability Partnerships Award.**

Invasive species in Boulder. Species invasions are increasing worldwide, including in Boulder County. Invasions damage ecosystems, threaten biodiversity and cause annual losses of over \$46B and rising⁶. As such, Boulder City, County, and CO Parks & Wildlife's priorities include identifying and managing invasions⁷. We will work with students and city partners to identify invasive species management on which to collaborate (e.g., for [New Zealand mud snail](#)).

Aridity, fire risk and the rewetting of landscapes. Much of the Western U.S. faces increasing drought and aridity, leading to greater risk of catastrophic fire. The water that does fall as rain quickly rushes off the land due to erosion and channelization. Procedures from as far back as Southwestern indigenous cultures can slow drainage of water and allow it to infiltrate soil, boost vegetation, buffer temperatures, and provide fire-safe refugia for wildlife. Interns will collaborate with a graduate student expert and community leads at Cal-Wood Education Center and Wildlands Restoration Volunteers to identify key restorative actions of different structures (e.g. Beaver Dam Analogs) that create climate-resilient wetlands in water-scarce habitats.

Undergraduate intern recruitment and participation. We will recruit 6 undergraduate students (2 per project) to a) become active collaborators engaged in data collection, analysis, and generation of reports to support project goals, b) reflect upon, analyze, and report upon the structure of the internship program to inform development of our NBSCC, c) participate as members of the NBSCoP and actively develop their professional networks, and finally d) present their work to stakeholders in a stakeholder-requested format at an end-of-project symposium.

Anticipated outcomes. Students will obtain increased knowledge and skill in co-production and

generation of NbS, science identity, intentions to persist in the major, and future scientific community engagement. The program will result strengthen partnerships with the City and other community organizations and spark new interdisciplinary research that engages undergrads.

Graduate student recruitment and participation. We will recruit 3 graduate students to lead **1)** project management, study design, and stakeholder coordination **2)** curriculum development, and **3)** program evaluation. The first two graduate students will mentor undergraduates. The students will benefit from mentorship of the project leads and foci will align with their professional goals (e.g., in non-profit work, academia, or education). These grad students will be members of the NBSCoP, benefit from the network, and achieve outcomes aligned with their dissertations.

Leadership team. Dr. Dee will coordinate the projects and research with the partners. Dr. Corwin and Dr. Bilinski will design the internship program, Dr. Bilinski will lead implementation and Dr. Corwin lead evaluation. Dr. Suding will contribute to all aspects as well as fundraising. Brett KenCairn (City’s Climate Initiatives) and Dr. Abernathy will lead from the City of Boulder. Collectively, the leadership team has >70 years of experience related to this proposal.

Cross-CU Advisory Board. We will recruit an advisory board of experts in co-production, culturally-relevant practices, NbS, and internship programs at CU. We will meet with the board pre and post implementation for input on program design and evaluation. Board members will include V. Sinha (School of Education), L. Aurthurs (GEOL), A. Carrico and J. Harter (ENVS), S. Marder (RASEI), K. Rowell (RIO), B. Anacker (Boulder Open Spaces & Mountain Parks).

Sustainability and Impact: *This project will increase student retention and success, community engagement, and interdisciplinary research.* It will also provide an important pilot that will contribute to a broader effort to secure funding for a new interdisciplinary Initiative on NbS at CU. As in this proposal, this Initiative will focus on two branches: 1) community-engaged scholarship and interdisciplinary research for NbS and 2) education to develop socioscientific problem solvers. A central feature of the Initiative will be a far-reaching multi-departmental capstone program with undergraduate internships (the NBSCC) in which students collaborate with local stakeholders to gain job-relevant skills and produce NbS. This proposal will provide the proof-of-concept needed to ensure we can accomplish this goal and gain extramural funding.

The City’s Climate Initiative proposed (\$10,000-50,000 per year) in matching funds and fundraising support for donors if this proposal is funded. In addition, multiple funding programs exist to continue and grow this work, e.g., NSF Centers for Research and Innovation in Science, the Environment and Society (CRISES) and USDA AFRI.

Budget: We will hire 6 undergraduates for \$20/hr for ~20 hours per week for 8 weeks (\$3,000 per student; \$18,000 total). We will pay stakeholders and advisory board members for their participation (\$2,000) and graduate student summer salary (\$18,000). We will dedicate \$2,000 to host a public-facing event showcasing the work. Total = \$40,000.

References: **1.** Scheufele, D. *Public Understanding of Science* 31, 297–304 (2022) **2.** Dressel, M. *Humanit Soc Sci Commun* 9, 241 (2022) **3.** Keeler, B. *et al. BioScience* (2017) **4.** Asai, D. *Cell* 181, 754–757 (2020) **5.** Allen, J. *Transl Issues Psychol Sci* 1, 331–341 (2015) **6.** Diagne, C. *et al. Nature* 592, 571–576 (2021) **7.** [City of Boulder Research Priorities for 2024.](#)