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Perspectives on Undergraduate
Research & Mentoring

Training the Next Generation of Natural Resource Scientists: Outcomes and Benefits of REU and REEU Programs

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Introduction

Undergraduate research and mentoring perform a critical role in preparing the next generation of natural resources professionals to address increasingly complex environmental challenges (Messenger et al., 2022). The field of natural resources focuses on the sustainable use, management, and conservation of environmental assets, such as forests, water, soil, wildlife, and fisheries. Natural resources integrates science, policy, and practice to balance ecological health with human needs. As biodiversity loss and competing land-use demands intensify, college graduates must possess technical knowledge, strong analytical skills, adaptability, and an understanding of how science informs management and policy. Engaging students in meaningful research experiences, guided by intentional mentoring, provides a powerful pathway for developing these competencies while broadening participation in the natural resources workforce (Burger et al., 2023). Within natural resources disciplines, undergraduate research experiences are particularly valuable because they can integrate field-based learning, interdisciplinary perspectives, and real-world management contexts (Millspaugh & Millenbah, 2004).

In this case study, we discuss our externally-funded undergraduate research programs in natural resources at a land-grant institution in the southeastern United States, outcomes of the programs, and how the programs have overcome challenges to successfully prepare young natural resource professionals, train faculty, graduate students, and undergraduate students as mentors, and help advance research in forestry, sustainable bioproducts, and wildlife biology. Specifically, we discuss outcomes of our programs, such as (1) improved student knowledge, skills, abilities, and self-efficacy, (2) increased career awareness and readiness, (3) research mentor growth and engagement, and (4) enhanced relevance of natural resources fields.

College of Forest Resources Externally-Funded Undergraduate Research Programs

The College of Forest Resources (CFR) at Mississippi State University (MSU) houses three departments centered on natural resources-based research and education. Approximately two-thirds of the student body are in-state residents, with most out-of-state students coming from the southeastern United States. As a public land-grant institution with a mission to improve communities and lives through education, research, and public service, the CFR has a goal to produce society-ready natural resource professionals to help ensure healthy natural communities are restored,

sustained, and valued while meeting long-term societal needs for bioproducts in Mississippi, the nation, and the world. In the CFR, we have worked to cultivate several undergraduate research programs and provide opportunities for our students (e.g., the CFR Undergraduate Research Scholars Program), as well as students from other institutions.

Our externally-funded programs include a National Science Foundation Research Experiences for Undergraduates (REU) program in the Department of Forestry and U.S. Department of Agriculture National Institute of Food and Agriculture Research and Extension Experiences for Undergraduates (REEU) program in the Department of Sustainable Bioproducts. These programs allow us to recruit and support external students from other colleges and universities around the nation, specifically targeting liberal arts colleges and other primarily undergraduate institutions with few to no research opportunities. Both programs run 10 weeks each summer and require that at least 50% of the participants come from outside of the home institution, necessitating a national recruitment effort focused on primarily undergraduate institutions. The REU and REEU programs recruit more talented students into forestry and natural resources-oriented careers and graduate programs and enhance the reputation and prestige of the CFR as student researchers present their results at conference(s), communicate with others about their summer research experience, and potentially publish their research. Other externally-funded research grants can be used to recruit undergraduate researchers as intermittent workers from outside of the university. Currently, we do not have internal funding mechanisms to support undergraduate researchers who come from other institutions, so external grants are essential to our continued support of students who are interested in natural resources but are not at Mississippi State University.

The unifying feature between the REU and REEU programs is a shared mentoring philosophy that emphasizes early belonging in research, scaffolded skill-building, and authentic participation in knowledge creation. For example, our mentors prioritize selection of undergraduate students who have not conducted research before and/or are from institutions that do not offer research opportunities, then work with the students to identify a suitable research project together. Our programs also have some unique features compared to other REU and REEU programs. A central focus on real-world natural resource challenges ensures that undergraduate researchers work on problems with tangible environmental and societal impacts, rather than abstract exercises. For example, the REU program centers on the ecology and management of resilient and adapted forest ecosystems, and students see how their individual projects contribute to this shared mission. Forest science is an inherently diverse field, so it bridges fundamental and applied science (Polinko & Coupland, 2021). Aiming to reach 32 undergraduate students over four years, the REEU program incorporated guided research and extension experiences for undergraduates within a traditional wood science technology collegiate program aimed at preparing students for careers within the wood products manufacturing, quality control, production, and natural resource materials processing fields. Collectively, our programs expose students in various fields of science to concrete, real world research problems, who otherwise might not be aware of the impact that research can have in addressing critical and urgent global problems in forestry and natural resources.

Our programs also benefit from an engaged alumni network, including many individuals that now work for industry or state or federal government agencies, that offer enduring support, professional guidance, and access to unique research opportunities. For instance, one REU student worked on a project in collaboration with an alum who works for a local timber products company that provided access to research sites in exchange for advice on how to best promote native cavity-nesting bird habitat in pine ecosystems based on results from the project. Equally important is our triad mentoring approach, where faculty, staff, graduate students, and/or undergraduate students all contribute to a supportive learning community. Students who are mentored by both a faculty mentor and a graduate student or other near-peer mentor (i.e., triad mentoring) receive varied resources

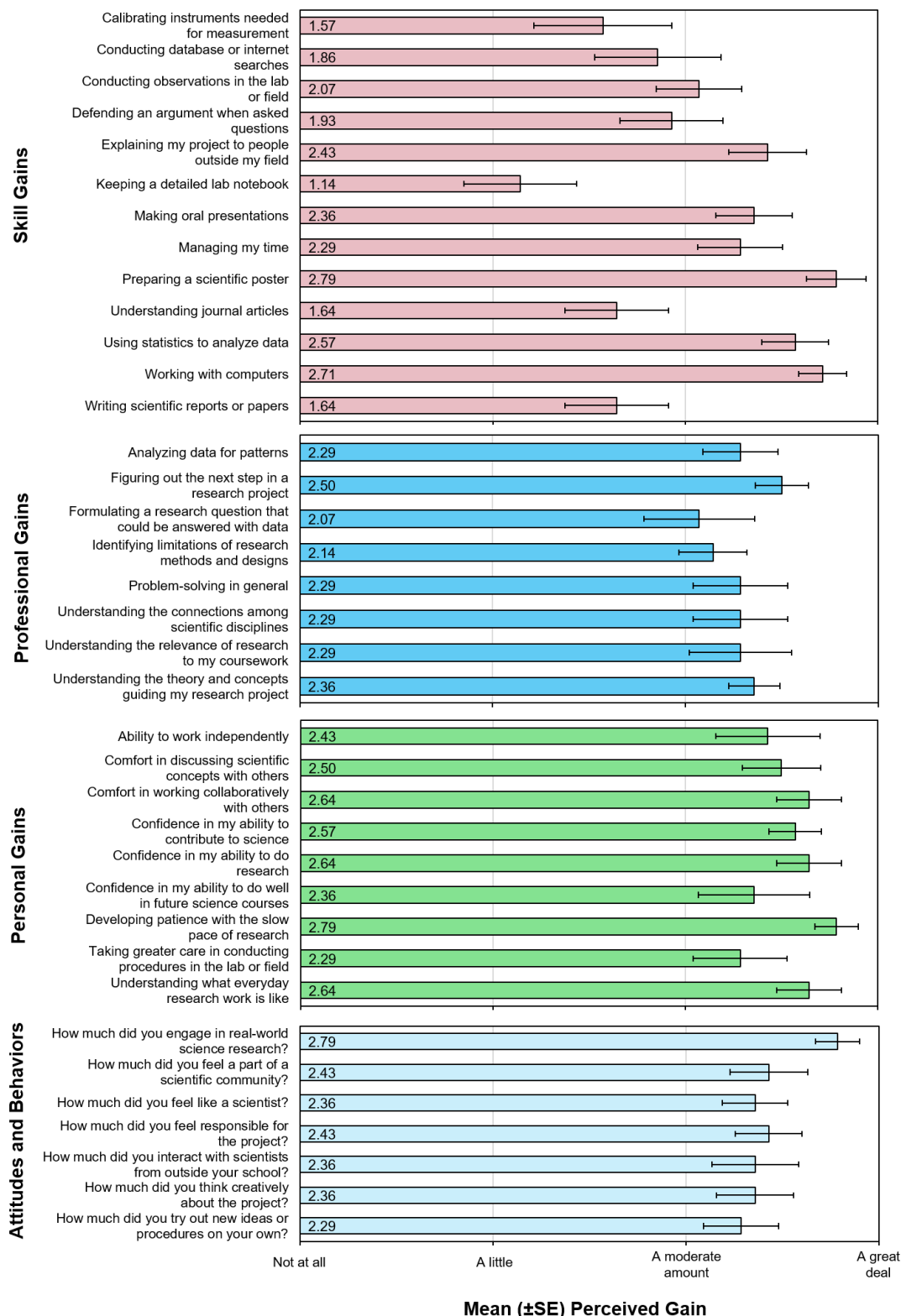
that more positively affect the undergraduate student (Aikens et al., 2016). This structure not only strengthens technical and research skills but also builds confidence, collaboration, and a sense of belonging within the field.

Outcomes and Benefits of REU and REEU Programs in Natural Resources

There are many positive outcomes associated with undergraduate research programs, ranging from benefits to the undergraduate students conducting research to growth of mentors and the field of natural resources at-large. Engaging in undergraduate research bridges the gap between classroom activities and practical application, enabling students to deepen their disciplinary knowledge (Elgren & Hensel, 2006), develop critical research skills (e.g., critical thinking, data analysis, communication), and strengthen transferable “soft skills” (e.g., adaptability, teamwork, time management) that are increasingly expected by employers (Easterly et al., 2017; Thompson et al., 2003). As a result of participating in our summer undergraduate research experience, all Forestry REU students felt that their research skills and overall confidence in their ability to do research improved (Figure 1). Of the professional gains, students reported the largest improvements in their ability to figure out the next step in a research project and understand theory and concepts guiding their research, with the least improvement in their ability to formulate research questions. Students reported the largest personal gains as increased patience, confidence, comfort in working collaboratively, and understanding of research work, with the least personal gain in taking care in conducting research procedures. One student stated, “My mentor increased my confidence in my ability to succeed in higher education and was great about guiding me through mistakes without correcting the mistakes themselves.” For skills, students reported a large improvement in their ability to develop a research poster compared to the start of the program, while keeping a lab notebook was reported as a skill that was not as developed over the course of the program (Figure 1). Attitudes about forestry research were largely positive and improved over the course of the program, with some students in the REU program reporting that they have unchanged or newfound positive perceptions of plants. One student reported, “From hating plants, I now tolerate and kind of like them.” Conducting undergraduate research has also been shown to foster students’ self-efficacy, allowing them to see themselves as capable contributors to knowledge rather than mere consumers of information (Carpi et al., 2017). Within our REU cohorts, 43% of students reported feeling “a great deal” like a scientist and another 50% feeling “a moderate amount” like a scientist. Only one individual only felt “a little” like a scientist,” which demonstrates that most of the students felt like they were capable contributors by the end of the program (Figure 1).

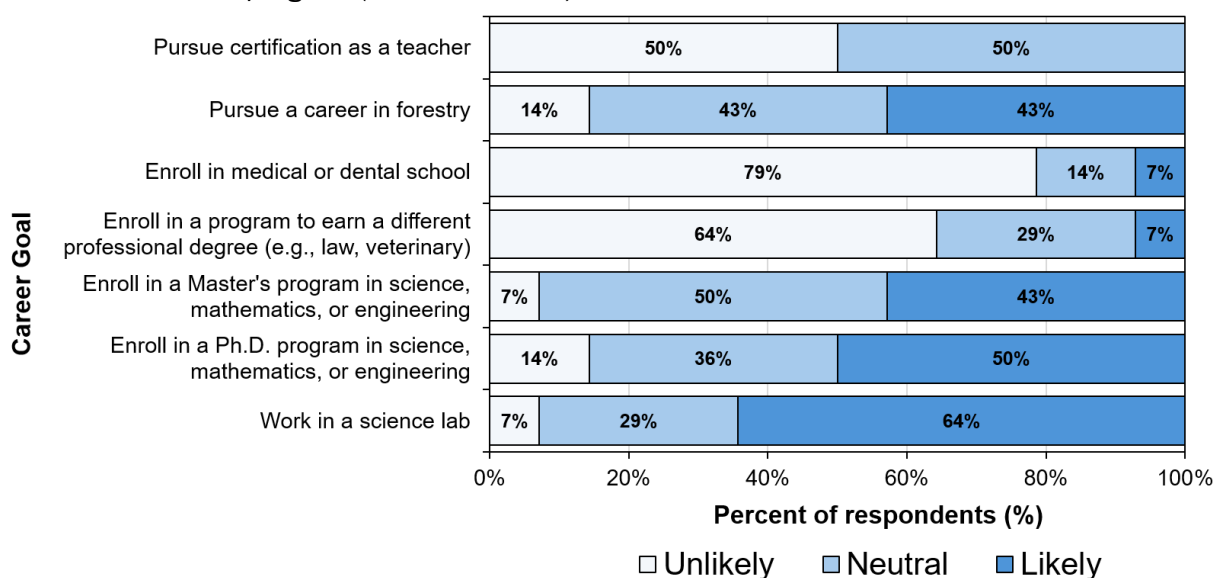
As undergraduate researchers receive individualized guidance, socioemotional support, and encouragement from their mentor(s) to overcome challenges and achieve tangible outcomes, they develop a stronger sense of ownership over their learning, more awareness of the field, and greater confidence in pursuing advanced education or professional goals (Haeger & Fresquez, 2016; Hanauer et al., 2012). Undergraduate researchers are exposed to the natural resources professional landscape as they connect with faculty, postdoctoral fellows, graduate students, other undergraduate researchers, and industry or agency partners who can serve as mentors, and they build social and human capital through networking (Cooper et al., 2021). For students in the Forestry REU program, approximately 43% reported that they want to pursue careers in forestry after participating in the summer research experience, with the remaining students wanting to pursue a career in ecology or natural resources, more broadly (Figure 2). Around 93% also reported wanting to attend graduate school or pursue a professional degree. For example, one Forestry REU student stated, “I’m excited to look for graduate school opportunities and reach for as high as I can because I believe that I can accomplish what I put my mind to with enough work and diligence, especially after having this experience.” When asked if they thought the REU experience changed the likelihood that their mentee would attend graduate school, approximately 73% of mentors strongly agreed or agreed (Figure 3). Some mentors disagreed because their mentees started the program with an

Figure 1. Student perceptions of skills, personal, and professional gains and attitudes and behaviors as a result of participating in the 2024 or 2025 REU program (n = 14 students)



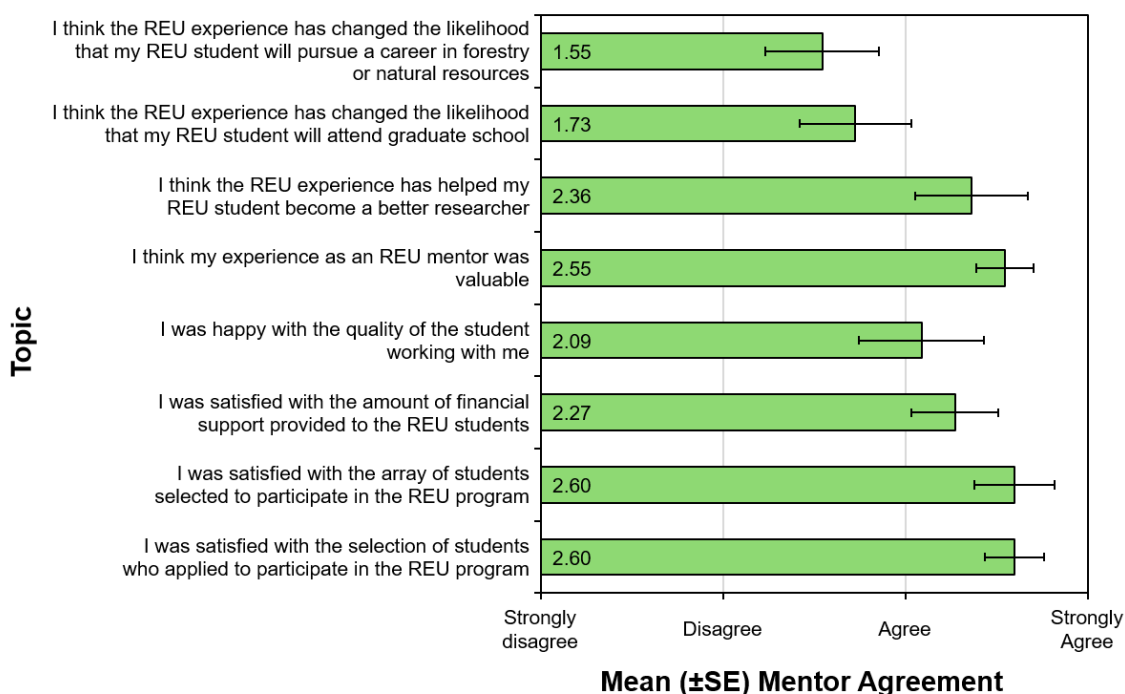
interest in graduate school, so their interests did not change by participating in the program. A similar trend was found when mentors were asked about mentee interest in pursuing a career in forestry or natural resources. When students see how mentors apply scientific knowledge to solve complex environmental problems involving social, economic, and policy factors, they gain clarity about their own interests and strengths. As evidence of this, one REU student expressed, “My research introduced me to new economic and environmental issues that the world is facing right now. I also learned how to view my field of study through a forestry and outreach lenses instead of a purely academic approach.” This exposure to complex problems and interdisciplinary factors better prepares students to pursue careers or advanced study within the diverse and evolving field of natural resources (Coker & Davies, 2002; Kinkel & Henke, 2006).

Figure 2. Comparison of student intention to pursue different career goals following completion of the 2024-2025 REU program (n = 14 students)



Many mentors engage students in undergraduate research because they found the experience to be edifying and metamorphic when they were students. However, they also benefit from undergraduate research in several other direct and indirect ways, including greater connection to students and pride in their success (Potter et al., 2009), enhanced interest in learning practices and guiding other mentors (Hall et al., 2018), and improved research productivity and satisfaction (Laursen et al., 2010; Vandermaas-Peeler et al., 2015). Faculty who served as undergraduate research mentors in the Forestry REU program reported positive experiences, such as: (1) “Seeing the students learn, grow, become better researchers, and develop a passion for their research over the course of 9-10 weeks [was the most beneficial aspect of the program],” (2) “Great opportunity to develop research potential in a promising student,” and (3) “It was enjoyable to have a student with limited forestry experience, to expand their horizons and give them a chance to explore a new field.” Approximately 55% and 45% of mentors strongly agreed and agreed that their experience as an REU mentor was valuable, respectively. Furthermore, 82% of the mentors felt that the undergraduate research experience helped their mentee become a better researcher, with one mentor expressing, “Seeing the growth of the student within one summer of work was very rewarding.”

Figure 3. *Mentor satisfaction and views on student impacts (n = 11 mentors)*



Finally, there are many tangible benefits of undergraduate research for programs and institutions, ranging from increased student and faculty retention to promotion of an innovation-oriented culture (Morrison et al., 2019). Through research projects, students and faculty can foster partnerships with government agencies, non-profit organizations, industry stakeholders, and local communities, which can strengthen program relevance within a discipline or region (Osborn & Karukstis, 2009). These research experiences and collaborations can also help colleges adapt their programs to workforce demands and emerging technologies while producing more professionals with practical experience and specialized skills (Easterly et al., 2017). Programs also increase their relevance by showcasing student-driven research outcomes and community impact, reinforcing their value to the public and positioning themselves as essential contributors to environmental solutions. For example, all students in the REU and REEU programs are required to present on their individual research projects at a scientific conference with some students also publishing their research results in refereed journals. These tangible outcomes can not only help increase faculty research productivity, but they also strengthen relevance of and attraction to our programs. This is especially important for our sustainable bioproducts program, which, as of 2014, was one of only 17 active undergraduate programs in this field across the United States and Canada (Armstrong et al., 2014). Across the four years of the REEU program, 33 students participated, with 27% female representation and 50% of participants from underrepresented demographics in STEM fields. By inviting students from other programs to learn about our wood science program through the REEU program, the Department of Sustainable Bioproducts was able to recruit two students who later elected to pursue graduate programs in the department. Often, participation in these undergraduate research experiences introduces students to fields of study they did not know they could pursue or programs they did not know existed, which can draw students back to pursue graduate studies, thus increasing institutional recruitment capacity.

Undergraduate Research Program Challenges and Solutions

Despite the recognized benefits and positive outcomes, cultivating an impactful undergraduate research and mentoring program in natural resources presents distinct challenges (Vandermaas-Peeler et al., 2015). For example, external funding to support undergraduate research can be inconsistent and, in some cases, perceived to be deficient. Although 82% of REU mentors were satisfied with the amount of funding provided to support student research, another 18% were not satisfied, possibly due to the desire to have summer salary or other compensation for their mentoring efforts. The success of our REU and REEU programs has been leveraged by a broad portfolio of assets, including people, infrastructure, and internal and external funding, across multiple research programs. Facilities and equipment investments are planned with dual teaching-research use, maximizing return, and lowering barriers for undergraduate student involvement. Field and laboratory supplies, University-owned forest land, laboratory spaces, and greenhouses are intentionally shared across programs that support undergraduate research. For example, the Department of Forestry maintains field equipment for its summer field program that is also used by those conducting field-based undergraduate research.

Faculty also often balance heavy teaching, research, and service responsibilities, and student projects can be constrained by seasonal fieldwork, funding limitations, and other logistical complexities. Moreover, students enter undergraduate research programs with different backgrounds, levels of preparation, and career aspirations, necessitating flexible mentoring approaches. For example, approximately 27% of REU mentors felt like their mentee did not have sufficient experience in natural sciences to support their research and/or was not well-prepared to conduct research. This response may be a result of mentors selecting students who are freshmen in college who have not had extensive coursework beyond general education courses or students who do not have prior research experience. Because of these differing levels of preparation, mentors take a student-centric approach to mentoring, offering customized guidance and support based on mentee needs (Haeger & Fresquez, 2016), with some mentors opting to use the CARES model to create an optimal mentoring environment (Weber-Main et al., 2019).

This individualized approach to mentoring undergraduate researchers can result in other challenges, ranging from reduced time for scholarship and mentoring graduate students, to poor perception by upper administration of undergraduate research toward promotion and/or tenure (Evans, 2010; Vandermaas-Peeler et al., 2015). Some mentors can feel that they are treated as lesser scholars or are branded as teachers because they mentor undergraduate students, which can impact professional identity (Hall et al., 2018). Administrators in the CFR, and Mississippi State University at-large, support faculty who engage in undergraduate research activities and are working to improve recognition of these faculty, and to possibly develop new promotion and tenure standards that value faculty who participate as mentors of undergraduate researchers (Morrison et al., 2019; Schultheis et al., 2011), beyond the traditional metrics of research productivity. This support from the institution, as well as enthusiasm and curiosity of undergraduate researchers and the scholarly outputs of presentations and publications, can reinvigorate some mentors' passion and sense of fulfillment. Institutional cooperation for undergraduate research through a supportive culture and other financial incentives can also drive faculty interest in engaging as an undergraduate research mentor (Osborn & Karukstis, 2009).

Conclusion

As a land grant university in an Established Program to Stimulate Competitive Research (EPSCoR) state, we rely on external grants, such as our REU and REEU programs, to expand capacity and enable innovation. Our undergraduate research programs in natural resources demonstrate how a focus on real-world problem solving, strong connections, and triad and individualized mentoring can transform student growth and career readiness while strengthening the field. Despite funding and

logistical challenges, structured support, collaborative mentoring models, and institutional commitment enable meaningful outcomes. These programs not only prepare skilled professionals but also enhance research innovation and the long-term relevance of natural resources disciplines.

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