PURM
Perspectives on Undergraduate Research & Mentoring

Undergraduates at Sea: Leveraging a Research Vessel Transit for Mentored Learning and Broadening Participation in Ocean Sciences

M. Kelsey Lane, Ph.D., Oregon State University (kelsey.lane@oregonstate.edu)
Leda Dowd, University of California, Los Angeles
Dakota Baxter, B.S., Millersville University of Pennsylvania
Jamie George, B.S., Coastal Carolina University

Introduction

Structured undergraduate research experiences increase students' persistence in Science, Technology, Engineering, and Mathematics (STEM) fields, strengthen sense of belonging, and clarify intentions to pursue graduate study (Linn et al., 2015; Lopatto, 2007; National Academies of Sciences, Engineering, and Medicine [NASEM], 2017). Research Experiences for Undergraduates (REU) programs provide stipends, mentoring, and a cohort-based model, and are especially powerful for undergraduate students who do not have access to research or specific disciplines like ocean sciences at their home institutions (Estrada et al., 2016; Russell et al., 2007).

Through National Science Foundation (NSF) funding, the Oregon State University College of Earth, Ocean, and Atmospheric Sciences (CEOAS) Ocean Sciences REU, has provided opportunities for paid summer research for undergraduates for 18 years. In the summer of 2025, NSF also opened a rare pathway to research vessel time and oceanographic sampling through an otherwise empty 5-day research-vessel transit from San Diego, CA to Newport, OR (Fig. 1) aboard the *R/V Sally Ride*, operated by Scripps Institution of Oceanography (SIO). This is a form of authentic fieldwork that is typically reserved for graduate students and faculty with existing ship access (Abdel-Raheem et al., 2023; Cooper & Lewis, 2017; Wang et al., 2024). As national discussions about reducing federally funded undergraduate research programs continue, the CEOAS REU program's *R/V Sally Ride* transit cruise underscores what is at stake: without this level of federal support, undergraduates from non-coastal, teaching-focused, or resource-constrained institutions are unlikely to experience ship-based research and science.

This article is a joint reflection from the REU program director, Dr. Kelsey Lane, and three undergraduate REU interns: Leda Dowd, a junior at the University of California, Los Angeles; Dakota Baxter, a senior at Millersville University of Pennsylvania; and Jamie George, a senior at Coastal Carolina University. We discuss the summer 2025 CEOAS REU program and the experiences of Dowd, Baxter, and George as they sailed on their first research cruise at its conclusion. We combine program-level data with individual perspectives to show how intensive research experiences reshape participant confidence, belonging, and career plans, and to illustrate what may be lost if federally funded undergraduate research opportunities are reduced.

Figure 1. *Map of the R/V Sally Ride 5-day transit from San Diego, CA to Newport, OR.*

Program and Funding Context

Since 2007, the CEOAS REU program at OSU has supported over 180 undergraduates in physical oceanography, ocean ecology and biogeochemistry, and marine geology and geophysics, with another 50+ undergraduates participating in the program from other funding sources (Table 1). Participation has steadily broadened: the share of REU interns from historically underrepresented groups rose from <5% in the earliest Corvallis cycle (2007–2009) to roughly 25–30% in 2010–2017 and >50% in 2022–2025. Nearly half (41%) of the interns have come from smaller colleges, community colleges, and non-research universities, many as first-generation college students. Long-term tracking suggests strong STEM persistence; of 231 past REU interns with known outcomes, 58% have enrolled in or completed graduate programs and 59% (not mutually exclusive) are working in STEM positions (Table 1). In short, over half remain engaged in STEM education or careers. Many now work as researchers, modelers, educators, and/or field and lab technicians, exactly the diverse workforce ocean sciences and the ocean-dependent sectors of commerce, energy, and food production that the broader economy requires (NASEM, 2025). Together, these trajectories suggest that when students have time, funding, and mentoring, more of them can see themselves as ocean scientists (Estrada et al., 2016; Linn et al., 2015).

Table 1. *Year-by-year outcomes for participants in the REU program, showing numbers of alumni who have enrolled in STEM graduate programs and/or entered STEM careers (not mutually exclusive) from 2007-2024, along with unknown outcomes, known non-STEM careers, and total cohort size (n=231)*

Year	Enrolled in STEM Graduate School	Pursued a STEM career	Unknown	Known – not STEM	Total Cohort
2024	6	4	3	4	17
2023	5	9	1	2	17
2022	6	5	3	2	16
2021	6	8	5	1	15
2020	3	2	1	0	4
2019	11	10	3	0	15
2018	5	5	3	0	10
2017	8	10	1	2	16
2016	11	13	1	0	15
2015	6	8	1	2	13
2014	12	12	0	1	13
2013	7	8	0	0	10
2012	7	8	1	1	11
2011	10	7	2	0	13
2010	6	7	3	2	12
2009	11	8	0	1	12
2008	10	6	0	2	12
2007	5	7	3	0	10

The CEOAS REU program outcomes are important because the geosciences are a field that remains one of the least diverse in STEM: with a persistent lag in representation of students of color, LGBTQIA+ students, and students with disabilities, whose intersecting identities shape how they experience geoscience spaces (Barber et al., 2024; Behl et al., 2021; Bernard & Cooperdock, 2018; Dutt, 2020). In ocean sciences, going to sea is often framed as a rite of passage, but access to ship time is highly uneven (Wang et al., 2024). Time aboard University-National Oceanographic Laboratory System (UNOLS) and comparable vessels is constrained by funding, scheduling, and berths, and can function as a gatekeeping mechanism that concentrates authentic field experience at a small number of research-intensive institutions (Barber et al., 2024; Wang et al., 2024). It is also a space that has long suffered from a culture of exclusion and discrimination (Dutt, 2020) leading to a "diversity deficit" in the ocean sciences (Abdel-Raheem et al., 2023). Federally funded initiatives such as ship-based models like the Science, Technology, Engineering, and Math Student Experiences Aboard Ships (STEMSEAS) program show that intentional design can redistribute this opportunity space by underwriting travel and berths, pairing undergraduates with experienced and near-peer mentors, and embedding explicit learning goals into short cruises (Cooper & Lewis, 2017).

Our *R/V Sally Ride* transit was one such opportunity to utilize and capitalize on national oceanographic research infrastructure. It grew out of the long-running, NSF-funded CEOAS REU, which already emphasized mentored research, cohort building, and professional development on the OSU Corvallis, OR campus. During the summer, interns worked on lab or computational projects with faculty and graduate-student mentors and wrote up and presented their research results at the end of the summer. Then, the research cruise, sailing with REU Program Director Dr. Lane as Chief Scientist and two graduate students supporting multiple sampling projects in physical, geochemical and biological oceanography, offered a concentrated period where REU interns could see sampling

and underway data streams in the field (Fig. 1). The transit moved beyond the classroom, a sequencing that undergraduate-research literature identifies as especially high-impact for skill and confidence building (Lopatto, 2007; Mogk & Goodwin, 2012; NASEM, 2017).

Nearly every part of the summer program and transit—from intern stipends and airfare to berthage on a UNOLS vessel—depended on federal support and close coordination with NSF program officers, UNOLS schedulers, and SIO marine operations staff. Without that chain of people and offices, a single campus program could not have put undergraduates on this transit (Barber et al., 2024; Estrada et al., 2016; NASEM, 2017). In fact, the National Oceanic and Atmospheric Administration (NOAA) asked our team to deploy several biogeochemical Argo floats during the transit, adding a national observing-system contribution to the science mission Dr. Lane had planned. The research cruise was not an add-on, but a concrete example of how federally funded undergraduate research can repurpose national research assets so that undergraduates from many institutions can participate in ocean science at sea.

Once on the ship, the dynamic changed quickly, forging a deeper community and expanding from the research interns had been conducting all summer. While their nine-week campus-based projects taught them how to frame hypotheses, process data, and write up and present research results, the ship environment demanded real-time decision-making, and teamwork and adaptation to conditions no one could fully predict, working together as a cohort (Barber et al., 2024). Interns who had been working independently had to coordinate deployments with a bridge watch, a deck crew, and peers managing parallel sampling streams, all while the ship pitched in various sea states. The five-day cruise from San Diego to Newport aboard the *R/V Sally Ride* compressed key field lessons into one intense, continuous experience (Cooper & Lewis, 2017; Mogk & Goodwin, 2012; Wang et al., 2024).

The Summer 2025 CEOAS REU program included 15 undergraduates from a range of institutions including large public universities and smaller regional and private campuses. Most were rising juniors or seniors in geoscience or STEM-related majors. Over half were from groups historically underrepresented in the ocean sciences, including LGBTQIA+, first-generation, and students of color. This mix of institution types, class years, and majors meant interns arrived with varied prior access to research and oceanographic resources, which shaped how we created a mentoring network, both on campus and on the research vessel.

Designing the Shipboard Learning Environment

We approached the at-sea component as a bridge from the summer's lab and modeling work to the realities of doing science on a moving platform. Over roughly 800 nautical miles in the California Current (Fig. 1), participants could watch the conditions they had been plotting in MATLAB or Python roll by outside the portholes. Our aim was for them to connect their data to the ship constraints and the technicians, engineers, and crew who make seagoing science possible (NASEM, 2025).

Effective inclusion in the shipboard workflow required extensive pre-cruise preparation. All REU participants (15) were invited to sail, but it was not required. A few did not join due to prior commitments; in total, 11 undergraduates participated. Two had previous experience at sea. Prior to sailing, Dr. Lane reached out to STEMSEAS staff to ask advice on how to set up the transit, informed by some emails and short conversations. We held a mandatory pre-cruise meeting that combined safety training with practical guidance about living and working at sea, including seasickness, shared berthing (staterooms hold two or more scientists), and the watch schedule. Interns received a detailed packing list and a chance to rank berth preferences so we could match cabin assignments to sleep habits, sensory needs, LGBTQIA+ student preferences, and access considerations. Treating these logistics as part of our mentoring was intentional; we wanted interns to see that their comfort and safety mattered just as much as the science mission.

On board, we progressed from observation to independent operation across our ocean sampling plan. For example, participants were first introduced to water column sampling with Conductivity Temperature Depth (CTD) rosette operations through supervised observation, then advanced to firing bottles themselves, and ultimately took charge of full casts. By the end of the cruise, several were running full CTD casts, including calling out depths, watching sensor readouts in real time, and coordinating with the winch operator like seasoned watch standers (Fig. 2). Similar progressions applied to other key operations: trace-metal sampling using a towfish system, collecting seawater samples with clean techniques, performing plankton net tows and examining plankton communities under a microscope, and operating the underway flow-through system for continuous surface measurements. For the final watches and deployments, participants chose which teams to join so they could lean into their interests and make sure experience with different instruments was spread across the group. Along the way they also got short introductory lectures by Dr. Lane, graduate students, and SIO marine technicians on plankton, trace metals in the ocean, and geophysical and hydrographic tools, including how we collect and start to process multibeam bathymetry and Acoustic Doppler Current Profiler (ADCP) data.

Some of the most important learning happened between deployments and outside formal watches. Shared card games in the lounge, meals squeezed into the mess, and quiet time on the bridge or in the lab created natural chances for participants to talk with marine technicians, officers, and crew (Fig. 2). These conversations demystified shipboard hierarchies and highlighted the diversity of roles onboard, from engineering to electrical technicians to merchant mariners. As interns saw how their individual tasks fit into the ship's broader mission, they began to understand themselves as part of a larger scientific effort, rather than isolated interns.

Figure 2. *Scenes from the transit, from upper left to lower right, abandon-ship drill emphasizing safety and shared responsibility; evening card game illustrating informal community-building; REU cohort and mentors on deck beneath the A-frame after a deployment; and interns monitoring the CTD console and near-peer mentoring during trace metal sampling.*

George noted that these informal interactions were often more influential than formal career panels: "Talking with the marine techs on deck about how they got into ocean work, or hearing the engineers explain the ship's systems during a galley break, made research careers feel real in a way that polished conference talks never did. I could see myself in their stories because they weren't trying to recruit me—they were just doing their jobs and letting us watch." These unscripted moments of mentoring helped participants see all the roles that make seagoing science possible and understand that many entry points exist.

Life at Sea: Co-ownership and Community in a Dynamic Environment

On this cruise, mentoring was treated as a core part of the cruise planning. Rotating leadership, embedded peer teaching, and gradual handoff of responsibility drew directly from our prior experience with undergraduate-research mentoring and frameworks that highlight the value of scaffolded ownership models (Shanahan et al., 2015; Walkington et al., 2019). We did not imagine mentoring as one-on-one conversations; instead, we tried to use it as the backbone for how decisions were made, how the to-do list was shared, and how interns came to see themselves as co-owners of our science objectives.

From the outset, we framed the research cruise as something interns would help run, not simply observe. “We are the science party,” Dr. Lane explained. The mentors sailing along: Dr. Lane and two graduate students, could not accomplish the science goals alone, so every participant was an important team member. Early in the transit, the mentors and technicians modeled successful deployments and narrated decisions aloud, explaining why certain tasks were prioritized or plans adjusted in response to conditions or mileage constraints. As interns gained confidence, we shifted to asking what they thought should happen next or how they would sequence time-sensitive tasks such as filtration. Peer teaching became part of the fabric of the cruise: someone who had just learned to operate the CTD console or prepare the trace-metal towfish were often the ones walking the next person through those tasks.

Some of the clearest learning moments came through small, early mistakes and near-misses. Early in the transit, a set of seawater bottles remained on the bench during a hectic deployment involving multiple pieces of overboarding gear, and sat too long to be filtered. Instead of quietly tossing the samples and moving on, we stopped to talk through what had happened and then adjusted station roles so it wouldn’t happen again.

A different kind of turning point came when a late-forming storm and tight mileage constraints forced us to rethink plans for a NOAA Argo float deployment. Email delays over the ship’s satellite link meant that by the time we received approval for an alternate drop site, our window was very narrow. “The captain said yes, but we’d have to move fast,” Dr. Lane recalls. In a matter of minutes, the science party confirmed the float ID and metadata, coordinated with the bridge and deck crew, cleared deck space, and walked through the deployment checklist almost on the fly. Just days earlier, participants had only rehearsed that procedure on paper with a NOAA employee; now they were calling out each step, assuming the necessary roles, and making the deployment happen. In that short burst of activity, it became clear that they were no longer shadowing someone else’s operation. They were the science party making real-time decisions in changing conditions.

Differences in prior experience, identity, and home institution didn't disappear when we walked on to the ship. In fact, they can be amplified in intense learning environments (Abdel-Raheem et al., 2023; Wang et al., 2024; Bernard & Cooperdock, 2018). Social constructivist frameworks suggest that learners build new understanding from what they already know and have lived, and that cognitive apprenticeship works best when prior knowledge is treated as a resource rather than a deficit (Hunter et al., 2007). We tried to name and work with those differences and see that everyone had

valuable and interesting life experience (Behl et al., 2021). Some interns arrived with prior ship time or extensive lab experience; others were seeing the open ocean from a research vessel for the first time and realizing they got very seasick. Interns from smaller or non-coastal institutions sometimes worried they were "behind" peers from R1 campuses. To help address this, we paired interns with different experience levels on key tasks, rotated who was positioned as the "expert," and used daily debriefs to surface moments when interns felt heard or overlooked and how they wanted to support one another. Baxter reflected on this dynamic: "Coming from a small state college in Pennsylvania, I worried I was behind students from bigger universities. But the way the watch system rotated leadership meant everyone had a turn being the 'expert' on something, and I realized I brought skills and perspectives that others didn't have. By the end, I wasn't comparing myself to my peers—I was learning from them, and teaching them, too."

Data Sources and Approach

To understand what interns took away from both the campus and ship portions of the REU, we looked at their pre- and post-program reflections, anonymous surveys, focus-group conversations near the end of the summer, a few follow-up emails, and simple indicators such as later research or graduate enrollment. Together, these sources let us see how their confidence, sense of belonging in ocean sciences, and ideas about next steps shifted over the summer, including our student co-authors' experiences, speaking specifically to interns who joined the *R/V Sally Ride* transit.

At a program level, anonymous pre- and post-program surveys with parallel Likert-type items were completed by REU interns regardless of whether they sailed on the cruise. The quantitative results reported here reflect the full cohort rather than only the research vessel transit participants. Interns rated their knowledge and confidence in core research areas (research topic, field and lab methods, data analysis, and scientific writing) on a knowledge/familiarity scale (0-4). They also described their interest in continuing research in earth, ocean, and atmospheric sciences, and their likelihood of pursuing graduate study in the field on a Likert scale (0-6). Because responses were anonymous and the cohort size and number of responses modest (10 pre and 8 post), we treated the pre- and post-groups as independent samples and interpreted changes descriptively. For each matched item, we report the number of valid responses and the mean and median rating (Table 2). Our goal was to see broad shifts in the cohort, not to make strong claims about any single part of the program.

Table 2. *Pre-to post-program shifts in interns' self-reported research knowledge, interest, and graduate school intentions. Items were rated on a 0–4 scale (0 = no knowledge, 4 = expert knowledge or 0–6 interest/likelihood scale (0 = not at all, 6 = very much)*

Item (scale)	Pre-survey Mean (n=10)	Pre-survey Median (n=10)	Post-survey Mean (n=8)	Post-survey Median (n=8)
Knowledge in research topic (0-4)	1.7	2	2.6	3
Knowledge of fieldwork methods (0-4)	2.1	2	2.8	2.5
Knowledge of data analysis (0-4)	2.1	2	2.5	2.5
Would like to continue research in the fields of earth, ocean, & atmospheric sciences (0-6)	1.8	1	2.3	2
Likelihood of pursuing graduate study in these fields	3.2	4	3.6	4

Interns' self-ratings rose by one to two scale points across all items (Table 2). Pre-program medians clustered near "low knowledge" and post-program medians near "medium knowledge." The largest shifts were in research topic knowledge (mean 1.7 → 2.6) and interest in continuing research (mean

1.8 → 2.3); likelihood of pursuing graduate study also increased (mean 3.2 → 3.6). In open-ended comments, interns described how those gains translated into everyday changes—being less afraid of code, feeling comfortable asking questions at group meetings, and, for some, deciding that graduate school might be possible after all.

In keeping with PURM's emphasis on mentoring processes, we present these data as illustrative of how interns experienced the REU overall rather than as a causal evaluation of any single component. The short duration of the cruise, the small cohort size, and the fact that not all interns sailed mean that survey results cannot be cleanly attributed to the ship experience. For these reasons, we interpret these patterns as a grounded description of what this cohort learned in this REU, rather than as results that can be easily generalized.

Evidence of Impact and Constraints

Program-level Outcomes Across the REU

Interns had already made significant gains over the nine weeks on shore. Survey responses and open ended comments point to steady increases in technical confidence, especially coding and data analysis, and in interns' sense that they could see a place for themselves in ocean sciences. Several interns highlighted steep learning curves but emphasized that the sustained, nine week structure allowed them to move from intimidation to competence, consistent with evidence that duration and intensity predict learning gains in undergraduate research (Linn et al., 2015; Lopatto, 2007; Russell et al., 2007). One intern who arrived with "essentially no coding experience" described leaving with "a solid foundational understanding of ocean modeling" and a sense that a more math- and physics-intensive career path now felt "within reach." Another noted, "I really enjoyed my research project this summer because it allowed me to work with ocean modeling frameworks, which is something I had heard was very rarely done at the undergraduate level. While the learning curve was rather steep…I feel that the project allowed me to quickly build coding/programming skills."

Interns also described changes in their identity and sense of belonging as scientists. Several commented that the program gave them their first experience of feeling "immersed" in a research environment rather than simply taking another class (Estrada et al., 2016; NASEM, 2017). One intern contrasted a prior semester-long research credit—"just another class I was taking"—with the REU's full-time immersion, which "felt like an actual job" and allowed them to connect deeply with and feel ownership on a project. Another reflected, "This was definitely one of the most enriching learning experiences of my life, and it's made me really hope to have more research opportunities in the future."

Program participation also broadened interns' sense of career possibilities, even when their specific interests shifted from before the program to after. Interest in continuing research in the specific subfield started fairly low, and while it increased, remained modest relative to other items. In conversations, several interns described the experience helped them calibrate their interests and expressed concerns around funding stability and long-term job prospects in academia. Interns reported entering with uncertain or narrow plans and leaving with clearer intentions to pursue graduate study or new interests in areas such as physical oceanography, geophysics, or environmental engineering. Overall, they described the experience as an "incredible motivator" that made graduate school and research careers feel more attainable. They cited explicit conversations about research ethics, a workshop on demystifying the graduate school application process, or the discussions on career paths as well as informal mentoring (Shanahan et al., 2015; Walkington et al., 2019). One intern noted, "This provided me with wonderful insights into how scientific research can be performed, and what working in a positive lab environment with a good mentor can be like. I think this will definitely affect how I look for academic and professional opportunities in the future."

Research Cruise Impacts

The 5-day *R/V Sally Ride* transit offered a concentrated, ship-based extension of the summer's campus-based research, giving undergraduates a rare chance to see how oceanographic data—such as CTD profiles, ADCP current measurements, and underway flow-through data--are collected and used to make decisions in real time. In exit surveys and follow-up reflections with student co-authors, they framed this shift from observer to active participant as central to feeling like "real scientists," especially when they navigated small mistakes, rough weather, or last-minute plan changes as a team.

For some participants, the cruise significantly broadened their disciplinary identity. Dowd, a geology major, noted that sailing "not only broadened my interests beyond land-based work into oceanography and marine geology, but also gave me a unique chance to gain hands-on experience that would not have been possible within the scope of my major." She added, "I was able to meet other geology students with interests in oceanography and learn that there is significant overlap between the fields, something I would not have explored without this program." Seeing the overlap between fields helped Dowd reimagine geology and oceanography as connected pathways rather than separate tracks (NASEM, 2017).

For George, whose initial exposure to CEOAS' REU program came the previous summer, the 2025 transit deepened and redirected an emerging commitment to deep-sea research. He described the cruise as providing "an invaluable first-hand experience with the positives and negatives of data collection and research at sea," noting that while the trip was constrained to one week, it was long enough to give him "a much more developed sense of being a 'real scientist' and being able to envision myself in this field in the future." Hands-on work with plankton tows was especially impactful, connecting the internship project to the kinds of organisms he hopes to study in deep-sea ecology. The momentum from the cruise extended into the following spring: George presented his REU and ongoing research at the 2026 Ocean Sciences Meeting in Glasgow, Scotland, marking his first international scientific conference and translating his ship-based experience into a visible step toward a research career in deep-sea ecology.

Baxter's experience illustrates how ship time can reshape opportunity for undergraduates from smaller, non-coastal institutions. Coming from a state college in Lancaster, Pennsylvania, he had limited access to marine research or nearby oceanographic infrastructure, and many of the REU options he initially explored had been scaled back due to budget constraints. When a last-minute CEOAS REU position opened, he undertook his first-ever plane trip to reach Oregon and joined a cohort whose research access would have been unimaginable at his home campus. The *R/V Sally Ride* transit provided his first authentic oceanographic field experience, allowing him to connect classroom knowledge to the lived realities of deck work, instrument deployment, and collaborative problem-solving at sea. Baxter emphasizes that without federally funded undergraduate research vessel programs, he "would never have had the chance to bring my classroom knowledge to life at sea," underscoring how STEM REUs can open doors for undergraduates far from the coasts and smaller institutions. Reflecting on the broader stakes, he noted, "As budget cuts threaten REU and similar opportunities, these losses reach far past individual undergraduates. They narrow the pipeline for diverse talent," particularly for participants from under-resourced institutions and historically excluded groups (Barber et al., 2024; Wang et al., 2024). Baxter's experience illustrates, at the individual level, what Abdel-Raheem et al., (2023) describe structurally: that restricted access to research spaces and unequal distribution of opportunities are among the core barriers perpetuating oceanography's diversity deficit, and that without intentional federal investment those barriers fall hardest on participants whose home institutions cannot replicate the lost access.

Taken together, these stories point to a set of cruise-specific impacts that build on, rather than duplicate, the broader REU outcomes. Participants described how the ship forced them to practice technical skills over and over under real constraints, e.g., fatigue, weather, time pressure, sea sickness, etc., until running a CTD cast or prepping a net tow felt like something they could do for a research group in the future. They also began to imagine themselves as the kind of scientists who go to sea, even if that had never been part of their picture of "someone like me" before. Just as importantly, undergraduate students from smaller, regional universities, and non-coastal campuses came away feeling that large research vessels were not reserved for a narrow slice of institutions; they had stood watch, made decisions, and done the work, and could now see those ships as places where they, too, belonged (Barber et al., 2024; Wang et al., 2024).

Constraints and Limitations

We also recognize important constraints that limit what an opportunistic research vessel transit can and cannot do. The cruise was brief and involved a smaller subset of the REU cohort, limiting generalizability. Strict safety protocols, unpredictable weather, and vessel operations requirements sometimes curtailed participant autonomy or forced changes to planned activities. Time for data analysis at sea was limited, and much of the processing occurred back on shore after the summer program had ended. These realities are intrinsic to seagoing work, and we treated them as learning opportunities about uncertainty and trade offs rather than as flaws in the design. When weather forced us to abbreviate a sampling station, we discussed trade-offs in sampling plans; when mileage constraints limited overboard science, we toured ship spaces with crew and Dr. Lane and others held short workshops on research topics; when analysis time was tight, everyone practiced the kind of sample triage that working oceanographers face routinely. Framing constraints as inherent to the work, rather than as failures, helped interns develop adaptive thinking and realistic expectations about research careers.

What Is at Stake Without Federal Funding

Time aboard a UNOLS research vessel remains scarce, constrained by operating costs, schedule pressures, and limited berths, and access is often concentrated at a small number of research-intensive institutions (Cooper & Lewis, 2017; Wang et al., 2024). Without dedicated federal support, undergraduates at geographically distant campuses have few realistic pathways to experience ship-based science, even as authentic research experiences are known to support persistence and broaden participation in STEM (Estrada et al., 2016; Lopatto, 2007). Programs like the CEOAS REU and ship-based models such as STEMSEAS demonstrate that intentional design, specifically underwriting travel and stipends, coordinating berths, and embedding explicit learning goals, can broaden access to ship-based science rather than leaving it to geography, resources, and chance (Cooper & Lewis, 2017; Wang et al., 2024; Zaniewski & Reinholz, 2016).

Our student co-authors' experiences underscore what is lost when such funding disappears. George notes that his time aboard the *R/V Sally Ride* "completely transformed my identity and core interests in relation to marine science," shifting his trajectory toward deep-sea research that his home institution's coastal-focused offerings could not provide alone. George links his two summers of REU participation and the cruise directly to the strength of his graduate-school and scholarship applications, emphasizing that "without these two summers of experience, I would not have been able to access deep-sea sciences" or prepare competitively for that field. Dowd similarly describes the transit as opening oceanography and marine geology as viable directions within her geology major, pathways she "would not have explored without this program."

For Baxter, a student who took his first-ever plane trip to reach Oregon for the REU (see above), federal funding was not an abstraction: 'As budget cuts threaten REU and similar opportunities, these losses reach far past individual students. They undermine efforts to build a strong, equitable

STEM workforce. Dowd also framed the personal stakes clearly: “The current lack of federal funding for the sciences initially dissuaded me from pursuing academia. I had heard too many stories about funding, budget and program cuts, and how these issues can make a career in the sciences nearly unattainable. Without the opportunity to participate in a federally funded research program and to surround myself with peers who shared similar fears, I would not have had the courage to even consider a research-focused career. However, support from my mentors and peers showed me that a career in the sciences is not only possible, but deeply rewarding and now more needed than ever.”

More broadly, our long-term tracking of the CEOAS REU suggests that sustained, federally supported undergraduate research can yield high rates of STEM persistence, graduate enrollment, and employment even as ocean and climate sciences continue to lag in representation (Bernard & Cooperdock, 2018; Dutt, 2020). When ship-based components like the *R/V Sally Ride* transit are layered onto that foundation, they not only provide rare technical experiences, but also a chance to change who can credibly imagine themselves on the deck of a large research vessel or in a graduate program in oceanography (Barber et al., 2024; Wang et al., 2024). In an era of contested science budgets, Baxter, Dowd, and George’s stories highlight that cuts to undergraduate research funding do not fall evenly. They close doors first for college students whose home institutions cannot replace those opportunities, and in doing so, weaken the future ocean-science workforce (NASEM, 2025).

Practical Guidance for Replication and Adaptation

The shipboard experiences of the 2025 REU cohort offer practical guidance for others seeking to build undergraduate learning into opportunistic research-vessel transits. Other REU programs, particularly those near ports accessible to research vessels, may be able to take advantage of transits or other shipboard opportunities. The CEOAS REU program was recently funded for more sea time through Oregon Oceangoing Research Vessel Program.

First, near-peer mentoring was crucial. Graduate-student mentors, only a few years ahead of the undergraduates, provided practical guidance and support by normalizing struggle, sharing their own first-cruise stories (Zaniewski & Reinholz, 2016). Dowd reflected that having near-peer mentors on board “made it a less intimidating and more welcoming environment to try new things, make mistakes, ask for help, and ultimately learn a lot.” She elaborated: “I loved having Ilana and Ben on the cruise with us. It gave me the chance to talk to them about the real pros and cons of pursuing a PhD and scientific research, which inspired me to further explore the career path.”

Second, “know before you go” preparation session(s) helped align expectations, set up community guidelines, and enact salient mentoring practices in advance (Shanahan et al., 2015; Walkington et al., 2019). The pre-cruise meeting engaged interns in strategic pre-planning, set clear, well-scaffolded expectations, built community, and outlined the technical skills needed during the transit. By explicitly addressing issues such as shipboard culture, seasickness, berthing assignments, and communication norms, we were able to reduce avoidable stressors and create more room for learning, which is an approach consistent with broader recommendations for inclusive field and shipboard experiences (Cooper & Lewis, 2017; Wang et al., 2024). This design choice also reflects Abdel-Raheem et al.'s (2023) call to treat interns’ prior knowledge and lived experiences as resources rather than deficits: by rotating who held the "expert" role and pairing participants with different backgrounds on shared tasks, we worked to ensure that institutional prestige or prior sea time did not determine whose contributions were valued on the ship.

Finally, structured reflection helped transform the transit into a developmental experience. Dr. Lane led watch debriefs and daily check-ins that helped interns connect hands-on work to broader scientific objectives and to questions of inclusion, confidence, and belonging (Linn et al., 2015). Follow-up emails, Zoom chats, sharing photos, and letters of recommendation extended mentoring

beyond the week at sea. For the REU interns, this transformed the transit from a simple data-gathering trip into a rich professional-development opportunity, echoing prior work on high-impact undergraduate research and field experiences in the geosciences (Cooper & Lewis, 2017; Mogk & Goodwin, 2012). Participants left with practical skills, deeper scientific context, and valuable professional networks, empowering them to imagine themselves in oceanographic careers and advancing the REU's mission to recruit and train the next generation of scientists.

Conclusions

This Dialogue shows how an opportunistic, federally supported research-vessel transit can expand access to ship-based ocean science and deepen undergraduate learning. The CEOAS REU program's long record of diversifying participation and supporting STEM persistence shows what sustained investment can accomplish, and the *R/V Sally Ride* transit illustrates how extending that investment to ship-based experiences opens pathways that would otherwise remain closed to undergraduate students from smaller schools far from the coast.

Baxter, Dowd, and George's reflections make clear that these opportunities are not interchangeable with campus-based research. The mentoring strategies we employed translated established frameworks into a seagoing context, but the setting itself did the pedagogical work of showing participants what ocean science entails and who gets to do it. As federal support for undergraduate research faces reductions, we risk narrowing the pipeline at precisely the moment when ocean and climate sciences need broader participation (Bernard & Cooperdock, 2018). Programs like the CEOAS REU demonstrate that intentional design, adequate funding, and authentic field experiences can make the hidden curriculum of seagoing science visible and accessible (Cooper & Lewis, 2017; Wang et al., 2024). As George put it: "The time I spent aboard the Sally Ride made me feel like I had found my career and scientific niche and inspired me to pursue work involving large research vessel in the future." That is the kind of trajectory federally funded undergraduate research makes possible, and the kind that disappears when the funding does.

Acknowledgements

We thank the captain and crew of the *R/V Sally Ride* for making this transit a safe and productive learning environment, with particular thanks to marine technicians Mason Schettig, Sandra Hermann, and Harpoon Seabring for their patience and generosity with the science party. We are grateful to the individuals and offices who made this opportunity possible: Elizabeth Rom and Lindsay Martin at NSF; Hannah Delapp and the Marine Operations staff at Scripps Institution of Oceanography; Elizabeth Steffen (NOAA PMEL) for coordinating the Argo float deployments; and Jonathan Lewis at STEMSEAS for advice on structuring the transit as an undergraduate learning experience. Graduate student mentors Robert (Ben) Freiberger and Ilana Farrell were essential to the success of the cruise, and we thank non-sailing colleagues Dr. Kirsten Buck, Dr. Maria Kavanaugh, and Kelly George for providing sampling equipment and expertise. We also acknowledge Katherine Voss and Ed Amonsen, who brought tremendous enthusiasm to the ship.

We are grateful to the amazing community of REU participants in the summer 2025 cohort, including Alder Chu, Suzanne De Visser, Joseph Egan, Thomas Freiling, Annalise Gregory, Tessia Hoffman, Kasey Ingram, Ella McKee, Sebastian Moreno Comstock, Yvette Lin, Sophia Nowers, Samuel Whitmire, Zechariah Webb, and Amanda Williams; and mentors including Jack Barth, Kristen Buck, Salvatore Caprara, Christo Buizert, Amrapalli Garanaik, Rosie Gradoville, Jim Lerczak, Peder Nelson, Henry Pitts, Alyssa Shiel, Charles Seaton, Joe Stoner, Greg Wilson, and Aaron Wolf. This program was supported by NSF (OCE 2242815) and Oregon State University Foundation funds.

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