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How Does Strategic Communication Shape Transdisciplinary Collaboration? A Focus on Definitions, Audience, Expertise, and Ethical Praxis

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Transdisciplinary collaboration offers great potential for meaningfully addressing complex problems related to climate change and social inequities. Communication shapes transdisciplinary collaboration in myriad ways, and interdisciplinary and rhetorical approaches to communication can help identify these influences as well as strategies to transform inequitable communication patterns. In this paper, we share results from an engaged and ethnographic research project focused on strategic communication in a large-scale transdisciplinary collaboration to develop environmental-DNA (eDNA) science for coastal resilience. In this context, definitions of eDNA, perspectives about communication, and constructions of audience and expertise shape the ways in which collaborators co-produce knowledge across disciplines and with diverse partners. Identifying relationships among strategic communication, knowledge co-production, and power enables the development of strategic collaborative practices, including asking questions as a means to identify and negotiate differences in definitions of eDNA and using participatory methods and anti-oppressive data management platforms for ethical praxis.

Keywords: strategic communication, rhetoric, transdisciplinary collaboration, epistemic authority, environmental DNA (eDNA), ethics

INTRODUCTION

Complex problems at the nexus of ecological, social, cultural, technological, and economic concerns require diverse approaches to collaboration (Blythe et al., 2008; Brown et al., 2010). There are several factors that intensify the complexity that occurs at this nexus, including the influence of context and local histories, cross-scale interactions, and diverse perspectives about the nature of any particular problem or solution. For example, climate change is occurring in dramatically

different ways depending on the sociocultural and ecological conditions of a place. The context specificity of climate change can make efforts to adapt strategies from one place to another difficult if not impossible. In an effort to tailor national-scale solutions to regional coastal environments, Leslie et al. (2015) argue for "strategic approaches, targeted to the needs and strengths of specific regions" (p. 5,982) that pay close attention to cross-scale interactions and social constructions. Collaborative approaches strengthen abilities to pay attention to how social, political, economic, and institutional factors interact with local ecological conditions. In addition to encouraging more bottom up and inclusive approaches to climate change adaptation, it is important to consider how dominant understandings of spatial and temporal scales are themselves constructed (McGreavy et al., 2021). What one collaborator may define as a pressing and urgent issue that invites a technical solution, another may identify as an issue linked to a longer-term colonial history that requires a different kind of "solution" entirely. The influence of cross-scale interactions as well as multiple constructions of problems, space, and time amplifies the need for individuals to engage in more relational forms of collaboration (Whyte, 2021).

Addressing complex problems like climate change through collaborative, science-based approaches can build capacities to understand the multiple dimensions of an issue and produce knowledge(s) that support action. Finding ways to bring diverse forms of knowledge together in knowledge co-production processes is a key commitment in these types of efforts (Tengö et al., 2014). Interdisciplinary and rhetorical approaches to strategic communication can lend insights about how to both study and shape such processes (Blythe et al., 2008; Herndl and Cutlip, 2013; Druschke, 2014; Graham et al., 2017; Suldovsky et al., 2018). Further, interdisciplinary scholarship on strategic communication calls attention to the myriad ways in which communication shapes information sharing, meaning making, and the formation of social difference and power (Holtzhausen and Zerfass, 2015; Heide et al., 2018; Ihlen, 2020). Finally, bringing interdisciplinary and rhetorical perspectives to strategic communication can also inform engaged praxis, emphasizing the value of listening and shared learning for ethical and inclusive transdisciplinary collaborations (Druschke and McGreavy, 2016; McGreavy et al., 2018; Suldovsky et al., 2018).

In this paper, we share insights and practices from an engaged and ethnographic study that focuses on how strategic communication shapes a large-scale transdisciplinary collaboration. The Maine-eDNA Project focuses on resilience to climate change and interconnected challenges, such as shifting livelihoods, harmful algal blooms, and changing species distributions in coastal ecosystems. This multi-institution project uses environmental-DNA (hereafter eDNA) science to address information needs associated with ecological changes in the Gulf of Maine. The Gulf is warming faster than many other areas of the earth's oceans (Pershing et al., 2015) and climate change is already having widespread impacts on coastal livelihoods and ecosystems (Maine Climate Council, 2021; Olson, 2021; Stoll et al., 2021). We start by introducing interdisciplinary and rhetorical approaches to strategic communication. We then describe the context and methodology for this work and share results from a series of semi-formal interviews (n = 15) and ongoing participant observations of project meetings (August 2020 through September 2021). Our qualitative results identify strategic communication patterns within this project, including how participants negotiate definitions and construct audiences and expertise in ways that both reinforce and challenge dominant approaches to science. We conclude by discussing the implications of our research for collaborative praxis. We highlight the importance of posing questions to promote reflexivity and using knowledge mapping and anti-oppressive data management to guide knowledge co-production. We also emphasize the value of centering questions about and as ethics to meaningfully address connections among language, knowledge, and power.

Strategic Communication and Transdisciplinary Collaborations

Within literature on transdisciplinary collaboration, scholars have identified how interdisciplinary and rhetorically-informed approaches to strategic communication can produce applicable knowledge about science-based collaborations (Druschke and McGreavy, 2016; McGreavy et al., 2018; Werder et al., 2018; Ihlen, 2020). Strategic communication serves "as a transdisciplinary, holistic, and inclusive field of knowledge," (Heide et al., 2018, p. 452) and can be understood as an umbrella term that weaves across multiple communication fields. These fields include public relations, rhetoric and technical, corporate, organizational, and management communication and each demonstrates nuanced yet important differences in what strategic communication means in theory and practice (Lock et al., 2020). Similarly, transdisciplinarity has diverse meanings; here we define it as the commitment to produce knowledge about complex problems in ways that build capacity to address them (Jahn et al., 2012). Knowledge co-production names the process through which transdisciplinarity emerges, with two main foci: (1) the communication practices that connect multiple forms of knowledge about a problem (Tengö et al., 2014; Norström et al., 2020); and (2) the guiding assumption that the ways in which we produce knowledge form social orders, such as identities, organizations, and discourses (Jasanoff, 2004; TallBear, 2013). Here we summarize three primary orientations to strategic communication that have influenced our work, including how we conceptualize strategic communication; key communication processes that matter in collaboration; and how constructing audiences and expertise connects with power.

Interdisciplinarity, Rhetoric, and Strategic Communication

First, in contrast with approaches that would position strategic communication as a singular and linear process of information sharing, an interdisciplinary and rhetorical orientation to strategic communication emphasizes a multidimensional approach. Strategic communication includes techniques that are deliberate, purposive, and goal-oriented (Hallahan et al., 2007; Rus, 2014) and yet also practice-based, relational, and collaboratively-constructed (Holtzhausen and Zerfass, 2015; Heide et al., 2018; Ihlen, 2020). Consistent with this

orientation, Holtzhausen and Zerfass (2015) identify a series of focal points for strategic communication, including attending to communication as both pragmatic and constitutive and focusing on processes of meaning making and audience constructions. Their approach points to the value of pairing strategic communication with engaged methodology in ways that allow communities of practitioners to develop a situated understanding of what strategic communication means (Holtzhausen and Zerfass, 2015).

In a call to connect rhetoric, science communication, and strategic communication, Ihlen (2020) demonstrates how working across disciplines and with communities of practitioners can also help "alert us to how knowledge is generated and socially constructed through communication" (p. 165). In this case, Ihlen (2020) focuses on the timely issue of vaccine hesitancy and how strategic communication can help trace how audiences and credibility are both constructed. Understanding audience constructions and who is seen to have credible knowledge creates the foundation for attending to how communication also constitutes power between people and within organizations (Blythe et al., 2008). For example, in their rhetorically-oriented critical action research, Blythe et al. (2008) found that asking questions about audience constructions allowed their team to understand power differences that shaped community negotiations of scientific and technical knowledge about an environmental remediation project. Similarly, Heide et al. (2018) argue for a more explicit focus on power in analyses of strategic communication "where taken-for-granted ideas, such as the notion of organizational goals, are examined and questioned" (p. 466). In his analysis of the taken-for-granted term "environment" Ross (2013) describes how this "seemingly innocuous word. . . carries multiple complex meanings dependent largely on audience interpretation and understanding, suggesting that rhetors should carefully choose their phrasing when attempting to motivate an audience to action in relation to environment-related communication" (p. 93). Thus, in addition to emphasizing the practical and technical elements of strategic communication, a rhetorical approach also highlights the constitutive or relational nature of all communication and the need to pay attention to the connections between language, knowledge, and power, especially in the context of science.

Asking Questions About Definitions

Relatedly, and as a second orientation that guides our study, asking questions about how key concepts are defined lends specificity to the focus on communication, knowledge, and power (Walsh, 2017). Focusing on definitions can help illustrate which ideas are considered important, shared, or contested within a communication situation (McGee, 1999). This is particularly important in collaborative approaches to science, as definitions can become commonplaces that collaborators come back to repeatedly to create and negotiate meanings (Blythe et al., 2008; Walsh, 2017). In this context, an approach like knowledge mapping can foster collaborative discussions by posing questions to help guide these negotiations (Wilson and Herndl, 2007; Graham et al., 2017). Scholars have also drawn from stasis theory to attend to how definitions shape arguments about contentious science issues. Stasis theory helps analyze how "sticking points" in arguments tend to center around definitions, as well as matters of fact, value, cause-effect, and action (Fahnestock and Secor, 1988; Walsh, 2017). In the case of climate change communication, definitions can serve as *both* commonplace and stasis, where "[Scientists] may indeed come to stasis and wrangle back and forth over whether a particular dip in the global temperature record should be defined as anomalous, for instance" (Walsh, 2017, p. 5). This pattern can create challenges in a collaboration because "If people are invoking the same term to imply differing definitions, then the task of reaching *agreed upon* stases becomes all the more difficult" (Blythe et al., 2008; p. 290, emphasis added). Thus, paying attention to and asking questions about definitions can point to repeated patterns, or touchstones, as well as sticking points that shape collaborations.

That definitions are subject to revision or debate also demonstrates their contingency (McGee, 1999; Lynch, 2011). Arguments about definitions can help participants find definitions best suited to establishing a context for their work (Schiappa, 1993). Debates over how a community uses particular words provide opportunities to strengthen knowledge co-production, increase understanding, and overcome conflicting interests or values in pursuit of collaboration (Schiappa, 2003). The practice of introducing and establishing definitions illustrates how rhetoric can be understood as the power to define, or the process through which definition comes to matter for how groups construct knowledge and authority (Zarefsky, 1998). The relationship between definition and power is shaped through collective negotiations that establish a basis for definitions and may also be collectively contested and justified over time (Clarke, 2005). Further, reflexive negotiation of contested definitions can help establish the purpose a term is expected to serve in a particular dialogic setting or science-based context (Lynch, 2011). For example, when Lynch (2011) works through the complex definitions that shape arguments about stem cell research, he highlights how contestations signal "that a given issue or object deserves attention: It should be selected and made a figure against the backdrop of other objects, issues, and actions" (p. 151). In contrast to perceptions that arguments about definitions detract from effective science communication, this perspective points to the value of argumentation about definitions, especially for research that intends to shape policy making.

Constructing Audiences for Science

Third and finally, there remains a need to consider relationships between communication, especially focused on negotiating definitions, and constructions of audience and expertise. This is particularly important in light of both the persistence of the information deficit model in science communication and the potential, yet still limited, value of message-centric communication (Cagle and Tillery, 2015; Suldovsky, 2016). Connections between perceptions of communication, audience, and expertise construct and reinforce the relative power of different forms of knowledge, also known as epistemic authority, in collaborations (Bucchi, 2008; Suldovsky et al., 2018; Ihlen, 2020). As Suldovsky et al. (2018) describe, such a focus "demonstrates the importance of attending to

specific discursive influences on perceptions about epistemic authority and subsequent stakeholder engagement" (p. 501). Interconnections between perceptions of communication and researchers' worldviews constitute a key discursive influence within science, especially in contexts that privilege post-positivist approaches. Post-positivism is a research paradigm often associated with dominant approaches to science that is based largely on a worldview that assumes a singular reality that exists independent of communication (Lincoln and Guba, 1985). This assumption reinforces belief in an objective observer who, by using empirical methods, has both the ability and the authority to describe that reality accurately *to* audiences (Druschke, 2014). These logics of objectivity and expertise thus reinforce a linear diffusion-based model of communication (Suldovsky et al., 2018).

In our orientation, "audience" serves as a broad term that encompasses a set of related constructs that are often used in studies of collaboration, including stakeholder, decision maker, partner, end user, client, and so forth. Though there are multiple communication processes that construct audiences and expertise, we build from the above discussion of definitions to consider the related practices of naming and framing, all of which serve as rhetorical strategies whereby language is a process of material and symbolic action (Burke, 1966). Naming refers to the practice of articulating symbols and material entities, like naming some groups "decision makers," "lay publics," or "researchers," in ways that draw on and reinforce specific meanings and power relations. For example, McGreavy et al. (2021) explain how naming practices that emphasize decision makers as key audiences for the knowledge that a collaboration produces can shape the focus and direction of a project. When collaborations involve diverse groups with differences in social standing and power, such as between state agencies and Tribal Nations or between academic institutions and local communities, the ways in which audiences are named can reinforce, as well as challenge, colonial, or otherwise unequal power dynamics (Stuckey and Murphy, 2001; Endres, 2009). Framing is a related and broader strategy in which some aspects of reality are emphasized while others are not, a process that Burke (1966) also refers to as "terministic screens" (p. 45). In our use, framing refers to the communication processes through which some forms of knowledge and expertise are emphasized while others are not. For example, the use of metaphors, analogies, and related tropes that compare one thing to another are common framing techniques that can privilege some meanings associated with knowledge and expertise over others. Orienting in this way recognizes, as Burke (1966) famously remarked, "Even if any terminology is a *reflection* of reality, by its very nature as a terminology it must be a *selection* of reality; and to this extent it must also function as a *deflection* of reality" (p. 54). Thus, a focus on definitions, naming, and framing is not simply a matter of paying attention to the symbols we use to communicate but also those that are not included within discourse. This approach allows for a multidimensional and yet specific focus that can help guide analyses of what can otherwise feel like ambiguous relationships between communication, knowledge, and power.

Approaching strategic communication as a multidimensional process that attends to constructions of, interconnections between, and exclusions within definitions, audiences, and expertise provides a way of making sense of some of the complexity in collaboration. Further, this orientation points toward praxis commitments, which we define as emergent and problem-oriented practices (Ono and Sloop, 1992), that can help collaborators shape these constructions in more intentional, inclusive, and equitable ways (Blythe et al., 2008). As part of these commitments, an emphasis on knowledge co-production can invite attention to the specific practices through which multiple forms of knowledge are combined to shape emerging social orders (Jasanoff, 2004). Focusing on knowledge co-production also raises questions about how science *should* be conducted to promote more just and anticolonial social orders that can emerge within academic organizations and institutions of science (Van Kerkhoff and Lebel, 2006; TallBear, 2013). Along these lines, Suldovsky et al. (2018) recommend that collaborators should have early and ongoing conversations that focus explicitly on whose knowledge is prioritized to begin to identify and negotiate epistemic authority on scientific projects. As part of this process, demonstrated reflexivity, or open active reflection as part of a social process within teams or collaborative settings, can help create a space for clarifying key concepts (Thompson, 2009; Popa et al., 2015; Ihlen, 2020; Norström et al., 2020). It is also important to take time to figure out where each participant is coming from and how to co-construct definitions in ways that are "interesting, useful, and consequential for all" (Druschke, 2014, p. 5). Further, finding time to build trusting relationships (Endres et al., 2008), identify just ways of engaging with minoritized communities (Chen et al., 2012), and create equitable incentives for participation (Burke et al., 2016) can help collaborators develop consequential approaches to equity within a project.

RESEARCH QUESTION

In addition to the inherent complexity in the problems that many science-based transdisciplinary projects engage, large-scale collaborations also involve complex participation experiences, particularly when differences in power and issues of equity are foregrounded. Despite numerous studies that have produced important insights about how communication influences transdisciplinary collaborations, there remains a need to more fully develop an engaged approach that uses research-informed insights about communication to shape collaborative praxis.

Our **research question** thus asks: How does strategic communication shape transdisciplinary collaborations? More specifically, we describe how participants describe and negotiate definitions of eDNA, audiences, and expertise. We also provide examples of how we draw from research insights to inform strategic communication praxis and how an engaged research approach can make a difference in transdisciplinary collaborations.

An Ethnographic and Engaged Methodology

We pose this research question in the context of the Maine-eDNA Project, a 5-year $20 million National Science Foundation

(NSF) EPSCoR Research Infrastructure Investment Track 1 grant. The project's formal mission is to make Maine "the DNA Coast" and a leader in environmental DNA-based partnerships to support the resilience of coastal marine and freshwater ecosystems (https://umaine.edu/edna/). The project intends to take a transdisciplinary approach to develop eDNA science to build capacity to address complex problems, such as harmful algae blooms and fisheries declines. The project involves more than 100 participants including faculty, graduate, and undergraduate students, postdocs, and staff from nine partner institutions. Together, we are focused on building capacities for eDNA data collection; workforce development; and diverse partnerships across academic institutions, Wabanaki Tribal Nations, state and municipal governments, businesses, and non-profit organizations.

Environmental DNA is a relatively new application of genetic technologies to environmental monitoring and research and has experienced considerable growth in recent years (e.g., Ficetola et al., 2008; Bohmann et al., 2014; Deiner et al., 2017; Huerlimann et al., 2020; Veilleux et al., 2021). As such, definitions and applications are still in flux among both academic researchers and communities of practitioners. Indeed, this applies to the concept of eDNA itself. For example, it is common to use the term to refer both to the material studied and the technologies used to study it, leading to an almost tautological framing of "use of eDNA to study eDNA." There is also variation among practitioners in what organismal sources and approaches they consider to be subsumed within eDNA based on already-established fields with overlapping subject matter, such as "DNA barcoding" and "microbiomes." We explore the significance of this diversity of definitions in more depth in the next section.

We use an ethnographic and engaged methodology that draws from mixed methods data collection (Creswell, 2014) and a participatory modeling technique known as knowledge mapping (Wilson and Herndl, 2007; Graham et al., 2017). Our ethnographic methodology defines how we conduct ongoing observations in diverse organizational settings to observe how communication shapes this transdisciplinary collaboration through time (Rai, 2016; Lindlof and Taylor, 2017). When paired with an ethnographic methodology, an engaged research design can bring situated social knowledge to bear on addressing differences in perspective and power-related tensions that inherently shape efforts to link knowledge with action (Trickett and Espino, 2004; Van Kerkhoff and Lebel, 2006). This methodology involves showing up; observing; and, when permission is granted, audio recording diverse project meetings, including those of research and administrative leadership teams as well as project-wide annual meetings. In addition to methodological commitments to deep listening and paying attention to communication practices over an extended period of time, we also use a dialogic process of checking in to situate ourselves in this work and refine insights through time (Madison, 2006). Checking in supports our ability to share emerging insights back with teams and projects leaders to help shape collaborative praxis, which we do through both formal reports and presentations as well as informal invited updates.

This methodology also includes the method of conducting semi-formal interviews ($n = 15$) using key informant and purposive techniques to invite participation (Lindlof and Taylor, 2017). These techniques allowed us to identify potential interview participants based on diverse positionalities in the project, including roles as faculty, students, and administrators; discipline; gender; race and ethnicity; and institutional affiliation. Interviews lasted an average of 73 min (range of 37–93 min) and were recorded and transcribed. Our iterative approach to thematic analysis involved multiple rounds of coding and triangulation (Corbin and Strauss, 2008).

Defining and Negotiating Meanings: eDNA as…

The following quote aptly summarizes how different and sometimes competing definitions of a concept shape collaboration: "What does eDNA mean? That's the…$20 million question." Asking what eDNA means is a valuable question because definitions feed into ongoing rhetorical negotiations around shared understandings of a situation as well as coordinated and policy-oriented action (Lynch, 2011; Walsh, 2017). For example, TallBear (2013) examines how a dominant and singular definition of DNA as gene "leaves us with an impoverished understanding of DNA" (p. 71), where definitions of DNA that draw from multiple forms of knowledge and perspectives (i.e., social, cultural, political, economic, etc.) would enrich what DNA comes to mean in any setting. In addition to limiting diversity, negotiations around definitions can also establish and reinforce power inequities, as some definitions align with dominant meanings and others fall outside the norm (Zarefsky, 1998; Clarke, 2005; Blythe et al., 2008). In this section we begin by tracing four primary ways in which participants in the Maine eDNA Project define "eDNA," including as a material entity, a tool or technology, an approach to science, and as a communication process. For each definition, we consider some of the associated meanings and how these patterns relate to power.

Material Entity

Many participants define eDNA as a material entity, the genetic material that is collected and analyzed to produce an understanding of patterns and processes in the natural environment. Highlighting the material nature of eDNA, one participant says: "eDNA, to me, is DNA that is within the environment. So that can be water, it can be in soil, it can be in the air, it can be in feces. So feces can be a vector for environmental DNA, like a tool for it to travel." Despite the clear material definition that this description implies, within this orientation there are also distinct nuances, especially related to assumptions about where eDNA is located. These differences are partially connected to a researcher's scale of observation and disciplinary training. Attention to scale influences differences in whether eDNA is defined as genetic material found in the external environment of the organism or that are still within an intact organism. At a broader geographic scale, participants define eDNA as genetic material that was shed from organisms typically too large or mobile to themselves be collected in an

environmental sample such as from air, water, snow, or sediment. At a finer and organism-focused scale, some participants define eDNA as also including genetic material that is still located within the bodies of living organisms that are collected in environmental samples. Of this distinction, one participant situates themselves in the following way: "Some people call that [genetic material within organisms] eDNA as well. I do not. I kind of restrict my definition of eDNA to what's found out in the external environment. I would call that other example something different." Importantly, this participant is not suggesting that the other definition is wrong but is instead marking the difference between definitions that are circulating on the project. Another speaks to the need to attend to the constructed boundary between macro and micro scales when they say "There's just so many shared techniques and I think it helps get peoples' heads a little bit into the idea that we shouldn't be having this artificial boundary between macro- and microorganisms." These latter two quotes point to another key pattern that has important implications for negotiating definitions within the project. As we describe more fully below, while participants describe their own definition of eDNA, they also acknowledge the "artificial" or constructed differences and the need for dialogue to continue to learn across those differences.

Creating spaces for dialogue, such as in the use of knowledge maps (Wilson and Herndl, 2007; Graham et al., 2017), can help identify the multiplicity of definitions and also how one definition can blur into another, such as how definitions of eDNA intersect with definitions of scale. However, mapping out different definitions also needs to consider the sets of meanings that guide how these definitions come to make sense in the first place (Lynch, 2011; Walsh, 2017), and especially how meanings connect with research paradigms, or the respective ontologies and epistemologies. The material definition of eDNA relies on and reinforces ontological assumptions about the nature of reality and epistemological assumptions about what constitutes knowledge. For example, the first quote above locates eDNA in the environment in ways that assume spatial relationships where the environment is composed of constituent parts, like air, water, soil, and so forth that can be measured and distinguished from the organisms within it. In this part-to-whole formation, material definitions mobilize binaries between parts of the environment as well as binaries that separate samples/organism, observer/observed, and interiority/exteriority. The concept of parts connecting into wholes is based on a systems ontology which is a common paradigm for post-positivist approaches to ecosystem and resilience-focused research (Walker and Cooper, 2011).

There is also an assumed temporality to environmental measurements, such that sampling for eDNA in the environment or within an organism can tell us something about the present in ways that connect with the past and potential futures. The logics that link eDNA as a material entity with how eDNA serves as evidence for present, past, and future conditions constructs a linear and singular temporality (Adam, 1998). Defining eDNA as a *reflection* of the past *deflects* the multiple definitions for what eDNA data could come to mean, including the multiple temporalities that *could be* constructed through eDNA (Burke, 1966). For example, a sample of water showing presence or absence of alewife chronologically reflects contemporaneous or past fish presence but is almost always perceived by those invested in the fish as evidence for possible recovery outcomes. In these future-oriented perspectives, cultural revitalization or Indigenous kinship-based relations to alewife serve as secondary considerations to recovery goals, if these considerations are included at all. Likewise, detection of harmful algae blooms might be interpreted through the lens of an impending shellfish closure. In this sense, while the processes that produce eDNA are largely contemporary or historical, the motivations for eDNA are often future looking, and orient to particular futures that run the risk of reinforcing existing and unequal power relations. This example helps show how definitions are consequential for how they deflect or foreclose multiple and Indigenous forms of time that are not based on linear sequences but instead attunements to place, space, community, ecology, Land, and myriad other forms of relationality (Liboiron, 2021; McGreavy et al., 2021). Further, material definitions of eDNA rely on a set of meanings that connect with post-positivist research paradigms. This attention to paradigms, and the relative dominance of some paradigms over others, can enhance efforts to grapple with connections between definitions and power, as we more fully describe in the next section.

Tool, Technology, and Technical Process

Definitions that emphasize eDNA as a tool or technology focus on the technical process of taking samples of genetic material organisms leave in the environment and then studying these samples to better understand ecosystems. Where the material definition approaches eDNA as a thing or object, the technical definition emphasizes the practical details of going out into an environment, collecting samples, and processing and screening those samples to see what species are present. In these practices, participants focus on developing and applying assays that either characterize diverse biological assemblages (e.g., eDNA metabarcoding), or detect and quantify particular taxa of interest [e.g., Quantitative Polymerase Chain Reaction (qPCR)]. The relative foci define the component tools within eDNA as technology, as well what individuals perceive to be the strengths and limitations of the technology. Similar to the influence of constructs of scale in the material definitions, these technical practices, and who uses them to study eDNA at a specific scale, fold back into constructs for where eDNA as a material entity is located, and diverse attunements of scale, space, community, etc. This pattern begins to show how definitions on the project do not necessarily have clear boundaries. Instead, definitions overlap and blur together such that meanings sometimes align and other times contradict. The multiplicity of definitions and the ambiguity involved in what definitions are relevant in any particular context can shape science-based deliberations in myriad ways (Walsh, 2017).

Consistent with the pattern noted above where researchers identify how definitions are constructed, in this technical orientation to defining eDNA some participants note a need to be careful about how such a focus can "lock

out people." As critiques of technical solutions point out, technical definitions can reinforce assumptions about the nature of problems, whose knowledge counts, and how the world works in ways that can amplify power disparities and ignore the range of potential consequences of proposed solutions (Plec and Pettenger, 2012; Kuntsman and Rattle, 2019). The following participant describes how a technical definition of eDNA could contribute to these kinds of exclusions and power asymmetries:

> *You can imagine a scenario with a grant like this where the people in control of the technological measure side of the DNA things get to dictate how they get used. None of us know enough about how the things actually work or where they serve a technological performative control over the knowledge of things. So I guess I worry about that.*

The concern expressed here emphasizes individual agency and control, where having access to the technical knowledge of how to sample and what types of tools are required to address what types of questions privileges some forms of knowledge over others. The criticism of technological dominance in shaping project knowledge takes on an even greater significance when we move from concerns about individual agency to consideration of institutional power, and especially how academic institutions and dominant approaches to science intersect with colonialism (Whitt, 2009). One participant describes how "Technology-based data points can mobilize through colony institutions and artifact knowledge to disabuse Indigenous people or remove lands." This point calls attention to how approaching eDNA as "data" that can be collected through sampling technology is in fact a social-material construction that aligns with a particular worldview. Further, this participant points to how dominant approaches to science intersects with colonialism, as dominant science continues to be organized by assumptions about who can and should have access to land and water as Resources (Liboiron, 2021). A technical definition of eDNA emphasizes individual agency to collect eDNA as a material entity in ways that can reinforce anthropocentric, neoliberal, and colonial assumptions about who has the ability and the right to collect data and for what purposes, in this case the purpose of producing scientific knowledge to guide management. To begin to address this issue, a recent initiative by Local Contexts (localcontexts.org) shifts individual-level management of biocultural data to a collaborative approach through the creation and application of Biocultural (BC) Labels and Notices on data. As Liggins et al. (2021) describe, the BC labels signal "the right of Indigenous communities to define the use of information, collections, and data (including DSI) generated from biodiversity and genetic resources associated with their traditional lands or water" (p. 2,478). In this approach, Indigenous communities work with researchers to address management, cultural rights, and responsibilities for eDNA data and work to actively define how data and related eco-cultural knowledge should be described, shared, and archived and we return to this effort in the concluding section.

Science and Forensics

Definitions of eDNA as a science often combine the focus on eDNA as a material entity with the technological process to describe the kinds of questions and new knowledge that can be produced within this approach. The goal for knowledge tends to focus on producing new understanding about ecosystem processes over larger temporal and spatial scales than previous methods allow. This orientation also emphasizes methodological innovations, especially for the efficiency of data collection and the spatial and temporal extent of sampling. Further, the goal for eDNA as science prioritizes policy applications or technical solutions, and in particular, to address questions related to climate change. Mobilizing the definition of eDNA as genetic material left in the environment, this participant shows how this definition connects with their approach to science: "I define [eDNA] as the genetic signatures that organisms leave behind in their environment. And by capturing a sample of water and interrogating that water to find out what DNA is in it we can say something about who has been in the environment in recent time." The use of the term "interrogation" signals a related set of meanings for how eDNA is often defined as a *forensic* science. Approaching eDNA as a forensic science invites crime-based metaphors for characterizing ecological processes and events. This definition of eDNA frequently references popular television and crime shows, which further intensifies the link between eDNA, forensics, and crime. One participant offers an extended illustration of how they use crime scene analogies to explain eDNA to public audiences:

> *We went by and saw this school of fish and our first suspect was [a specific species] and then DNA came back and exonerated [this species]. Now we're trying to figure out: Who was it? Who was the culprit? And we think it's [an entirely different species]. So it's like a crime scene investigation.*

The value or potential utility of using crime scene analogies like this one differ based on the imagined audiences. For the participant communicating with a public audience, connecting with crime scenes provides a commonplace of understanding that could motivate a shared interest in the topic. In other cases, this approach is beneficial for helping natural resource managers conceptualize "how to handle" the samples they collect or the data they receive from the project. When communicating with donors, some participants note the importance of attention-getting tactics like comparing eDNA to a crime scene because they have experienced donors having "Very [. . .] short attention spans," and "so you need to hook them in really quickly." While participants value these kinds of comparisons, this approach also requires simplifying the complex problems of climate change and other environmental challenges into binary frames of innocent-guilty or problem-solution. The crime scene analogy may also be off-putting or threatening to those who have experienced biased, colonial, or state-based law enforcement. For example, clam harvesters face the threat of criminalization through environmental regulations related to water quality. If they dig in an area that has been closed due to fecal contamination or harmful algae blooms they can be prosecuted. Consequently,

while this project seeks to use eDNA to strengthen local communities' capacities to more accurately detect and reduce the negative impacts of these types of closures, explaining the methodology through crime-based analogies may intensify some stakeholders' legitimate concerns that these tools will be used to reinforce unequal power.

Interestingly, although forensic and crime scene analogies were used extensively early in the project, the onset of the COVID-19 pandemic shifted many conversations toward a more clinical analogy involving comparisons between eDNA science and detection of SARS-CoV-2 and its variants. This includes drawing on common molecular tools (PCR), the importance of controlling false positive and false negative tests, the limits of detection of assays, and real cross applications like the detection of SARS-CoV-2 in sewage water. Still, this clinical science analogy tends toward binary frames and the comparison runs the risk of reducing the kinds of complexities that climate change and many other environmental challenges present. Likewise, both the crime scene and clinical framings rely on the assumption that there is a singular reality that can be accurately observed and measured through the collection of material evidence, again reinforcing post-positivist approaches to science.

Communication and Social Construction

In addition to the above patterns, some participants also describe eDNA as a communication process. The following quote provides an illustrative example of how talking about definitions constitutes eDNA in this way:

> *Part of it is, it's asking for definitions… When terms come up like that, I was like, "When you say "sample," what do you mean?" That just opens it up to dialogue. Then, people question "Oh, okay. I was thinking about it this way and you're thinking about it that way. Let's see where we can go. I understand what you're saying now." I think trying to highlight when we need to define terms so [that] we can tease out where we might have differences.*

This characterization demonstrates how some participants recognize that definitions matter because they shape differences and also because the dialogic process itself actively constitutes what "eDNA" becomes. Not only does this orientation add to the diversity of ways in which eDNA is defined, awareness that some participants define eDNA as a communication process can help challenge dominant or singular assumptions about what eDNA *really* means (Lynch, 2011) and encourage reflexive constructions of shared definitions or agreed-upon stases (Blythe et al., 2008). This orientation is consistent with the reflexivity we note above when researchers recognize how definitions of eDNA are socially constructed. The recognition that eDNA is a communication process also aligns with embodied performances of communication, where researchers describe perceptions of communication that align with dominant patterns in science-based collaborations that emphasize a linear information flow. And yet, at the same time, they describe and demonstrate a more multidimensional embodied understanding of communication as well. Recognizing this pattern helps build capacity within our engaged research approach to strategically connect with and find ways to amplify these perspectives to challenge patterns of dominance and promote greater diversity in perspectives and equity in participation within the collaboration.

As this analysis helps show, definitions are not mutually exclusive. Defining eDNA as a material entity is not incommensurate with defining it as a tool, technology, science and/or communication process. Instead, tracing different definitions helps demonstrate that when collaborators define eDNA, they are not necessarily approaching this concept in the same way. Inattention to differences in definition can set collaborators up for getting "stuck" (i.e., negative stasis) in ongoing deliberations about what a project should focus on and what it comes to mean (Blythe et al., 2008; Walsh, 2017). More importantly, a lack of reflexive attention to these differences can also reinforce power disparities when some definitions are emphasized or prioritized more than others (Popa et al., 2015). While the critical perspectives about the intersection of technical definitions and colonialism and that emphasize the social construction of eDNA are not widely shared within the project, these perspectives are still present. Identifying the presence of these perspectives can help engaged researchers be ready to amplify these perspectives and promote reflexive attention to how eDNA is always more than any single definition and how language, knowledge, and power shape collaborations in complex ways. Where a focus on definitions helps identify important differences in meanings that constitute a project, layering definitions with how participants define communication, audiences, and expertise directs attention to how definitional work can help identify and challenge unequal power, especially for defining who participates in a project and in what ways.

Constructing Communication, Audiences, and Expertise for eDNA

The following quote frames the relative importance of attending to how communication, audiences, and expertise are defined on a project and how these definitions feed into one another. One participant sums this up by saying: "It starts with knowing who you're talking to, right?" We appreciate this sentiment and extend it by noting that in addition to knowing who one is talking to it is equally important to attend to how audiences are defined in the first place and how implicit definitions of communication, audience, and expertise are co-constituted in ways that shape relative power within collaboration (Ihlen, 2020).

Consistent with previous research on communication within transdisciplinary collaborations, participants often describe an information-centric and linear approach to communication similar to the sender-receiver or diffusion model of communication (Bucchi, 2008; Suldovsky et al., 2018). Communication is characterized as a "two-way" or reciprocal flow of information through verbal speech or media, such as writing and e-mail. One of the main objectives in this model of communication is effective messaging, tailored outreach, and getting past "jargon" to describe scientific information in simple and accessible terms. The emphasis on information sharing tends to center the role of researchers

or administrators as communicators who have a message they want to convey. Further, the goal frequently focuses on promoting mutual understanding of the project but where the terms for understanding, and especially as they relate to dominant paradigms, are not necessarily open for negotiation. The following quote represents this broad pattern:

> *I would define communication as an understanding of the content that's being communicated between both parties or all parties present. And I think the key there is understanding. And I think good communication is often, is very difficult to achieve because when you work in interdisciplinary projects, people feel more comfortable using words or terminology, so jargon, that others don't understand.*

Echoing this sentiment for audiences not directly involved in the collaboration, participants emphasize the value of describing the science in as simple terms as possible in ways that avoid getting into the details. Many argue that it is important to explain basic processes, such as collecting and analyzing eDNA, and focusing on the questions those scientific processes can help answer. Taking the time to explain the science was important for connecting with audiences, even if it "might not be scientifically the most accurate" or even if "[Identified audiences] probably still won't understand completely."

As demonstrated in the quote above, "jargon" as a frame often connects with linear or diffusion approaches to communication, where jargon is assumed to get in the way of effectively conveying information. The frame "jargon" can be deployed in distinctly uneven ways, where some forms of language or knowledges are deemed jargon and others that are equally technical are not. Further, calling some terms jargon makes assumptions that the knowledge associated with those terms should be accessible to others. As TallBear (2013) argues:

> …[Academic scientists] often refer to social theory as 'jargon,' as if they should readily understand what it has taken me and other social scientists and humanists years to master. I do not assume I should readily grasp all of the language used and data introduced in a technical presentation about the genome diversity of oak-tree populations in Northern California. (p. 122)

TallBear (2013) instead suggests that "We need precise languages to talk about precise ideas that have derived from specific histories of work, from the development of theories and methods" (p. 122). In this approach, the challenge in communicating across disciplines and with partners is not in getting past jargon but in how we define and produce knowledge about eDNA in ways that allow diverse meanings to connect on their own terms and within their respective meaning systems. Such a process would create opportunities for identifying and challenging dominant paradigms that set the terms for knowledge and understanding in the first place.

Despite the unsurprising presence of message-based, linear, and diffusion-oriented perceptions about communication (Suldovsky, 2016), we also regularly observe other definitions of communication circulating as well. Like definitions of eDNA, definitions of communication are diverse, overlapping, and contradictory, and the following quote provides a representative example: "I mean I'm being a biologist here and thinking about senders and receivers and signals and things of that nature. But it's not just a sender and a receiver. It needs to be both directions for communication to occur, otherwise it's just signaling. People are just sending stuff one way, it's not really communication. Communication requires reciprocal information transfer." On one level, this perspective aligns with a diffusion model of communication. Like jargon, the concepts of senders, receivers, signals, and so forth imply a linear transfer of information. Yet, on another level, the perspective also begins to show how it would be overly reductive to indicate that linear definitions of communication were the only meanings circulating.

There are two distinct patterns that we have noticed consistently. First, the frequent emphasis on reciprocity points toward a more dynamic and relational orientation to communication than an information-centric approach would imply. Reciprocity as a relational commitment works to transform the more linear meanings associated with information transfer. And where this quote makes a nod to a more relational approach, many others linked ideas of reciprocity with commitments to dialogue and listening, as seen here: "And for me…that communication starting as early as possible and listening and learning as early as possible is pretty critical to the overall success of the project. It may take a while and it may require extra effort, but it's been invaluable." Second, when the participant situates themselves as a biologist, as in "I mean I'm being a biologist here," they *perform* a reflexive orientation to communication (Thompson, 2009; Popa et al., 2015), one that positions themselves as a communicator and where they are trying to define communication in more expansive terms than the discourses of their disciplinary training may allow. This demonstrated reflexivity becomes a means through which more diverse definitions of communication can become articulated, both in terms of the overt definitions (i.e., stating what communication means) and the embodied and relational performances of communication.

These diverse perspectives about communication and audience layer with constructions of expertise in ways that open up and constrain possibilities for collaboration. Participants frequently describe how they reserve technical terms or formal science associated with eDNA for scientific audiences. Instead of focusing on the technical and scientific aspects of the work, participants describe how they center research or application-focused questions in their communication with "non-scientific" audiences. As one participant explains, "I think it's really about the questions. So we walk them through the range of questions that can be identified." Using a similar question-focused communication strategy, the following participant helps show the constitutive relationship between questions and audience constructions, which we quote at length because the perspective is uniquely illustrative:

> *Yeah, if you're talking to a mussel farmer, you say "Do you wish you knew when the seed set was coming in in advance so you knew when to get your ropes in the water?" I'm trying to think from [a biologist's] perspective. If you're talking to a lobster fisherman,*

then you want to say "Don't you want to figure out where those Stage 2 larvae are going, and are they eating Calanus finmarchicus [a species of zooplankton]? Are they following them out to sea? Is that why we are not seeing them around here?" Or [one non-profit fisheries leader] was really excited thinking about looking for [a shellfish species] off of Downeast using eDNA because that fishery has been closed for a little while, I think, and they think the stocks are rebounding. And there's not a concerted effort to go out there and survey them with trawling. And knowing that those trawling surveys are destructive in the first place. "Isn't there a non-destructive way that we can sample and figure out what the standing stock looks like?"

Asking questions becomes a relational process that positions audiences in terms of their roles and relative interests in eDNA topics and reinforces material and tool or technology-based definitions of eDNA. This approach reinforces specific definitions of eDNA, in this case as a material entity or tool and technology. It also defines audiences in terms of the eventual applications of these tools and not in terms of the specific knowledge they would contribute or the ways in which they may define eDNA or issues of environmental change. However, this perspective also demonstrates reflexivity in how this participant imagines what specific audiences would want to know about the kinds of questions that, in this case, lobster fishermen, would ask. Asking questions paired with reflexive consideration of audience interests can promote connections across differences in knowledge, as project researchers work to describe their science in more relatable terms and in ways that start with and center audience questions. Thus, a focus on questions—where questions come from, who is asking questions of whom, and how questions can disrupt or challenge patterns of dominance in definitions, communication, and expertise—emerges as significant communication strategy within transdisciplinary collaborations.

CONCLUSION: ENGAGED PRAXIS FOR MORE STRATEGIC COMMUNICATION

This research contributes insights about how a focus on definitions, audience, and expertise can produce knowledge about some of the complex and multidimensional ways that strategic communication shapes collaboration. Further, this focus lends specificity to identifying and potentially challenging unequal power within science-based transdisciplinary collaborations. In the Maine-eDNA project, participants described multiple definitions of eDNA, including as a material entity, tool or technology, science, and communication process and each of these definitions connects with different meanings related to spatial and temporal scales as well as ontologies and epistemologies, where systems ontologies and post-positivist research paradigms were frequently articulated. Definitions of eDNA layer with definitions of communication, audiences, and expertise in ways that align with previous research that demonstrates the dominance of linear and diffusion-based models of communication and the relative epistemic authority of post-positivism in science-based contexts (Bucchi, 2008; Suldovsky et al., 2018). However, we also observe important differences as compared with previous scholarship, especially in terms of the diversity of definitions and consistent performances of both reflexive and relational approaches to communication.

What accounts for these differences and, more importantly, how do these patterns shape transdisciplinary collaboration? There is no single explanation. As we hope to have shown, communication influences collaboration in ways that exceed any single perspective or ability to observe and describe. There are also contextual details that matter and that shape the ways in which we might compare one collaboration to another. For example, many researchers on this project have been involved in related large-scale transdisciplinary collaborations, some of which were also funded by NSF, and they reflect on what they have learned from those previous experiences, and especially from communication challenges. Another contextual factor is the relatively new nature of eDNA research itself, where definitions are not as entrenched as in more established fields and where the lack of shared and singular disciplinary agreements may invite reflexivity as team members work toward situating their own perspectives about eDNA.

However, this research helps identify opportunities to more carefully and critically attend to how specific communication practices shape knowledge co-production for more diverse and equitable transdisciplinary outcomes. We conclude here by highlighting three ways in which this engaged approach to strategic communication is shaping collaboration, including question-focused strategies that promote reflexivity, using knowledge mapping to identify and negotiate differences in definitions, and using questions about/as ethics for identifying and shifting relationships between language, knowledge, and power.

Pose Questions to Create Spaces for Reflexive Attention to Rhetorical Constructions of Definitions and Knowledge

Our engaged and ethnographic approach to strategic communication in this science-based context centers a strategy of continuously posing questions. A shared and consistent focus on addressing questions together helps promote active consideration of how core concepts, like definitions of eDNA, are rhetorically constructed and reflexive awareness about the multiple ways in which eDNA can be defined. Questions thus function as a type of genre, an identifiable space of social action within the collaboration (Miller, 1984), that promotes specific types of interactions, such as the consideration of how one's own perspective relates to or differs from another. The practice of asking questions together occurs in myriad ways, including most notably in the context of conducting the interviews described above. In addition to helping us gather evidence to address our research questions, posing interview questions about definitions, communication, the type of knowledge that someone brings to a project, and experiences with collaboration creates a space for more actively considering the diversity of possible perspectives and how something like a definition is socially constructed. The reflexive space that interview questions create is evident in many of the quotes throughout the analysis.

Taking a question-focused approach also served as a main objective for the formation of a working group focused on communication and collaboration. This group, which involved all of the co-authors on this paper as well as other collaborators, met on a monthly basis for two years. Unlike other teams on the project, such as those that focus on project administration or biophysical research, this working group intended to create a space to address shared questions, engage in open-ended dialogue, and consider and discuss what we were learning from the interviews. The diverse participation in this group helped to foster recursive consideration of questions and insights throughout the project, and we observed many instances where conversations we had in this working group were then taken up in other project meetings.

Use Knowledge Mapping for Question-Focused Knowledge Co-production

We brought the above commitment to asking questions to a knowledge mapping approach to create space to talk about different definitions of eDNA and the knowledge we each contribute to the project. Drawing from previous work on how knowledge mapping creates spaces for rhetorical constructions and negotiations across difference (Wilson and Herndl, 2007; Graham et al., 2017), we noticed how the embodied activity of working together on knowledge maps created opportunities for participants to visualize and create linkages between multiple definitions of eDNA. Knowledge mapping provided space to consider different perceptions about eDNA and fostered discussions about how a transdisciplinary approach invites us to consider ethical issues associated with linking knowledge with action. Occurring in parallel with interviews, both efforts coalesced into a consistent focus on what an ethics of eDNA and, more broadly, an ethics of transdisciplinary collaboration would mean.

Center Questions About/As Ethics as a Strategy to Address Language, Knowledge, and Power

The practice of asking questions created space for focused discussions about ethics, and what an ethics of eDNA would mean for this project and for emerging eDNA science more broadly. The frame about/as ethics refers to the two distinct orientations to how we understand the practice of asking ethics-focused questions. First, project dialogue *about* ethics sought to identify ethical research commitments that included but also transcended formal research regulation in the Institutional Review Board (IRB) and Institutional Animal Care and Use Committee (IACUC). In the context of a transdisciplinary collaboration, there are myriad ethical issues that are related to the under-specified and yet crucially important considerations of mutual beneficence and justice (Lynch, 2019). For example, some of the research efforts on the project include citizen science and partnerships with Natural Resources Departments in Wabanaki Tribal Nations where ethical issues related to data management and ownership intersect with questions about how eDNA is defined and whose knowledge is prioritized. The graduate student-led pilot project on Biocultural (BC) Labels with Local Contexts and ENRICH (https://www.enrich-hub.org/) mentioned in the analysis above seeks to amplify relational and reflexive commitments to communication. In addition to setting up a platform to actively challenge dominant definitions of eDNA, this effort creates further opportunity to ask questions such as: who or what form of knowledge counts and what are alternative ways of defining eDNA? Further given the complexities in communication and across differences and in relative power, what are our responsibilities to each other and within this place?

Related to these latter questions, we also approach ethics *as* a commitment to centering questions in the project as a whole, a commitment which includes but goes well-beyond ethics as a prescribed set of principles. Active participation in our engaged research serves as one example of this project-wide commitment and the questions we ask in the context of this engaged approach have intensified the more deliberate and extensive focus on an ethics of eDNA in the project. For example, as part of our focus on definitions, one of our interview questions asked about the kinds of visual images participants use to communicate about eDNA and this question created an opportunity for a participant to raise a concern about the ethical implications of using the double helix as a visual image in light of the relationship between DNA research, colonialism, and eugenics (Whitt, 2009). Sharing this and related insights in multiple project meetings promoted project-wide efforts to use questions about/as ethics to intentionally grapple with the intersections between language, knowledge, and power, which coalesced in a series of presentations in project meetings; a half-day ethics workshop that invited speakers with diverse perspectives about Indigenous ethics, applied biomedical ethics, and environmental ethics; and incorporating a consistent focus on ethics in the two graduate courses on the project.

In closing, when paired with an engaged and ethnographic methodology, an interdisciplinary and rhetorical approach to strategic communication can help study patterns and shape collaborative praxis. In large transdisciplinary collaborations, such as the Maine eDNA Project, the myriad ways in which communication shapes knowledge co-production processes can, at first, seem overwhelming and impossible to meaningfully address. As critiques of the diffusion model help show (Bucchi, 2008; Suldovsky et al., 2018), it is not desirable nor arguably even possible to control communication within science-based collaborations. However, attention to definitions, perceptions of communication, audience, and expertise can help identify the types of questions that can be paired with specific techniques, such as using knowledge mapping and anti-oppressive data management platforms, to foster a shared commitment to strategic communication as ethical praxis.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because they are IRB-protected qualitative data.

Requests to access the datasets should be directed to bridie.mcgreavy@maine.edu.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by University of Maine Office of Research Compliance, Institutional Review Board for the Protection of Human Subjects (IRB). The patients/participants provided their verbal informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

BM led the writing and co-led the research design, data collection, and qualitative analysis. KH contributed to all aspects of the writing and co-led the qualitative analysis. JS-M contributed to the data collection. JS-M, JR-M, MTK, and DR contributed to the writing, research design, and qualitative analysis. HL co-led the research design, data collection, qualitative analysis, and contributed to the writing. MTK, HL, BM, and DR obtained funding for the research (#OIA-1849227). All authors contributed to the article and approved the submitted version.

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