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Coalition Science: Bridging Imaginaries Between Collocated Communities in the Polar Oceans

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ABSTRACT

Analysing ethnographic data from observations and interviews with polar scientists, this article builds on feminist techno-science, queer ecologies, and indigenous Science and Technology Studies (STS) to offer urgent critiques and useable techniques for creating more resilient and less harmful knowledge infrastructures. This article proposes 'coalition science' as a framework for multiple invested parties to share locations and produce knowledge together, complementing decolonial and feminist endeavours. The commitments of coalitions that we detail here reimagine communication pathways between scientists and other stakeholders who imagine and interact with the ocean in different ways. As this article demonstrates, when ocean scientists do attend to community engagement and co-design, they tend to invest in innovation rather than maintenance (what we call techno-scientific imaginaries). Feminist and indigenous theories of co-location and co-design push back against this asymmetrical attention to the new and help us see the urgent need to develop lasting coalitions as infrastructures continuously need repair. Coalition draws attention to new imaginaries based on justice, communication, and relationships. This article shows four critical moments that can put a coalition-centred imaginary into immediate practice.

Keywords: communication, science and technology studies, oceanography, imaginary, scientific practice

INTRODUCTION

The conversations and connections that led to this paper began in 2019, when Dr Stephanie Jordan planned to collaborate with polar scientists working in the Irminger Sea outside of Greenland and Iceland, as well as in the Northern Atlantic around Sitka, Alaska. The arrangement was designed to be symbiotic. Jordan would conduct ethnographic research to inform suggestions about feminist techno-scientific practices. The participants with whom Jordan conducted interviews were intrinsically motivated to learn more about feminist science studies because their laboratories were women-led and diverse, while their discipline, ocean science, has historically struggled to support practitioners and practices that challenged patriarchal norms (Jordan [Steinhardt], 2018; Lehman, 2018; Orcutt and Cetinić, 2015). Like many well-intended plans hatched during that fateful year, this collaboration was fundamentally changed by the COVID-19 pandemic. Jordan, now unable to visit sites themself, conducted Zoom interviews and remote observations using GoPro camera technology. The data set their scientist-participants shared with them brought into focus the difficulties of striving towards partnership with stakeholders who have different imaginaries. Cue another partnership: Jordan invited Jennifer L. Lieberman to collaborate on data interpretation using a feminist techno-imaginary lens. In this article, Jordan and Lieberman identify the tense and vulnerable moments when the desire to apply feminist principles and build community clashes with existing scientific practice. To understand these sites of friction – and to develop protocols that might ameliorate them in the future – we begin with a study of imaginaries and build an argument for protocols of *coalition* that might provide pathways forward.

Let us begin with the concept of the imaginary as it pertains to ocean science. Legal scholars have defined the imaginary of ocean science as the 'epistemological and ontological constellations that suggest a particular way of visualising, knowing and relating to ocean spaces' (Ntona and Schröder, 2020: 245). But, as feminist theory suggests, those constellations are defined differently based on standpoint epistemologies (Harding, 1991; Tallbear, 2014; Todd, 2016). Depending on who you ask, the *imaginary,* or shared understanding, of the ocean might include

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the history of Black death during the slave trade (Hartman, 2006); it might include art and literature (Gillis, 2013); or it might include technologically mediated data. Practitioners in ocean science, unsurprisingly, fall generally into this latter category.

Oceanographers typically understand mapping the ocean as a problem of instrumentation. Meanwhile, scholars from other traditions have demonstrated that an overemphasis on instrument-innovation has created several lacunae: (1) a tendency to overlook the necessary role maintenance plays in oceanographic knowledge-making (Jordan [Steinhardt], 2018) and (2) a lack of attention to the inequitable power dynamics among stakeholders who make different kinds of meaning with and about the ocean (Lehman, 2018; Liboiron, 2021), particularly salient in the extreme polar conditions of the Arctic (Itchuaqiyaq et al., 2023).

Feminist Encounters has already published an entire special issue that demonstrated how feminism can reshape understandings of innovation (Griffin, 2021; Berglund and Petterson, 2021). We take this work a step further by arguing that ocean science could benefit from shifting its focus from a techno-scientific imaginary driven by innovation, to a feminist techno-imaginary driven by maintenance, inclusion, relationality, and community building. The imaginary we introduce in the following pages offers a new way of seeing what scientists already do – as well as a restorative set of practices that could counter-balance historical patterns of exclusion. Typically, oceanographic practices have emphasised technology, science, and innovation while downplaying ongoing maintenance, as well as human and non-human participation; these practices are informed by what we call *techno-scientific imaginaries*. The words *emphasise* and *downplay* are the most accurate we can find to describe this, though they threaten to minimise how influential this paradigm is: credentials, funding, and status are conferred to scientists who exclusively adopt a techno-scientific approach. The lack of attention to human stakes has created challenges for women and other marginalised scientists who navigate hiring and promotion processes based on these norms (Bonatti and Crane, 2012; Orcutt and Cetinić, 2015). This article builds on feminist, decolonial, and science and technology studies (STS) scholarship that has sought to not only redress but also prevent harm that *technological imaginaries* can exacerbate among scientists, as well as co-located community members.

Previous scholars have taken important steps forward by demonstrating that maintenance is a crucial part of scientific practice (Houston et al., 2019; Jackson, 2014); we agree. We build on this work by weaving together feminist theory with observations of scientists to argue that *maintenance* must include maintaining relationships as well as equipment. We name this relational kind of maintenance, and the imaginary it espouses, as *coalition practice*. We observe nascent elements of *coalition* in our actors' recordings, when they are forced into communication with other university experts and non-academics who are located on or near their field sites. But our participant scientists also reveal frustrations that they do not have any training or institutional support to tend to work relationships with the ongoing care that they think they deserve. As researchers trained in feminist theory and science studies, we recognised these moments of friction as opportunities for change.

The recordings that comprise our current data set allow us to hear how scientists understand their own practices. One trend that became clear in our analysis was that our scientist-participants commonly named communication as a consistent cause of frustration. Despite working in the same waters, at times even physically side-by-side, stakeholders who have different – or even competing – imaginaries, struggle with basic interactions, even while acknowledging that their livelihoods could be much improved by coordination. Failures in communication regularly cause cascading problems. For instance, scientists might leave instruments in the ocean that affect fishing patterns; when they fail to communicate with local fishers during the project-design phase, animosity can grow between these groups. This animosity is further complicated by the fact that researchers rely on those very groups that they ignore in these scenarios. They request to borrow fishing vessels to calibrate equipment, or rely on local knowledge to interpret data. In short, practitioners who understand the ocean as an object of study may need to improve their work with local fishers, who understand the ocean in terms of extractive resources, as well as other coastal and indigenous peoples who all understand the ocean in entirely different ways.

Among the many things we learn from this data, we also notice trends in our participants' thinking about who or what might be a relevant accomplice in knowledge production about the ocean. The participants themselves acknowledge elsewhere that there are absences in their skills and training when it comes to coalition-building with non-academics, and that those absences can be a site of potential harm and erasure. The hegemony of innovation-driven technological imaginaries has encouraged and rewarded a focus on technological and scientific objects rather than human relationships, which takes time. For this reason, data collected after 2022 does not start from the perspective of university-led science; it focuses on amplifying voices from indigenous and coastal communities, small and commercial fishers, local historical institutions and recreational groups. Still, scientists are privileged actors in this space, commanding large grants and bringing cultural capital. When we start from the perspective of scientists, as our present data set does, we can identify moments of possible intervention. And it was here – in participant discussions about uncomfortable communication – that the concept of *coalition* emerged as an inclusive practice.

Coalition, at the moment of writing this paper, is an alternative techno-imaginary, salubriously informed by feminist science studies. Much has been written about what university scientists owe to the communities they study or rely upon; *coalition* rejects the paternalistic framework implied by that debt. Instead, it proposes some ongoing practices for maintaining both equipment and relationships, in ways that reduce harm whilst supporting inquiry. We make a distinction between *coalition* and its close kin, collaboration. Whereas collaboration describes a neutral meeting between equally interested parties, *coalition* is informed by social justice; it is not confined to one project; it begins long before deployment; and it can support the collision of different imaginaries, where conflict can be generative.

The case studies we discuss below demonstrate anxious and reluctant communication among groups. By illuminating just how interdependent these stakeholders are, we hope the concept of *coalition* will advocate for re-framing communication as an integral part of ocean knowledge production that can be built into techno-imaginaries that might be adopted by scientists in the future (and funded by future grant-makers).

This study begins by exploring the bias of techno-scientific imaginaries within ocean science. Next, it offers *coalition* as a potential framework for supporting scientific practitioners who are actively thinking about the need to work with people who understand the ocean in different ways than they do. It is our hope that shifting attention from over-funded innovation to *coalition* can demonstrate how ocean knowledge-making might persist while neither multiplying harms nor contributing to existing animosity among collocated groups.

METHODOLOGY

Theory and Literature Review

The explosion of environmental sensing (using robotics, sensors, modelling, and big data) has created a new social order in the scientific practice of studying oceans (Gabrys, 2016). Ocean scientists have recently used the concepts of 'Blue Growth' and the 'Burgeoning Blue Economy' to focus on technological futures that foreground innovation.[1] These initiatives are funded by such powerful institutes as the World Bank, and USA National Science Foundation, with good reason: improved ecosystem health and labour markets that use the water as a resource (be it energy, food, or transport) benefit from this framing. We attend to ocean science specifically because water infrastructures are historically tightly coupled with technological progress, such as cell phone towers built atop water towers in Zambia or the 'Telephone Cable Channel' that runs through a coral reef in a Hawaii nature preserve, as was explored by Lisa Parks (2015).

There are little to no institutionalised or financial incentives to challenge dominant techno-scientific imaginaries. Melanie Smallman has investigated why the techno-scientific viewpoint has become dogma, and argued that, at least in the context of the UK, an imaginary of 'science to the rescue' has influenced policymaking systems to the point that nuanced and critical approaches become inconceivable (Smallman, 2019). Some scholars and practitioners have attempted to address these issues within the techno-scientific model by advocating for approaches such as 'inclusive innovation' and 'pro-poor innovation.'[2] However, as Santiago Garrido and Ana Josefina Moreira (2017) have argued, attachment to large, private institutions has proven less effective at promoting inclusive development than advocates have hoped.

For this reason, we find that approaches that come from science and technology studies (STS) and feminism are better adapted to creating actual transformation. STS often works against the hegemony of a somewhat depersonalised techno-science. Scholars in these traditions have shown that infrastructures are prone to failure (Vaughn, 2016; Star, 1999); often contribute to ocean waste (Liboiron, 2021); harm or exploit local communities (Tsing, 2005); and/or represent a loss of financial investments when maintenance is undervalued (Jordan [Steinhardt], 2018; Jackson, 2014). The need for a maintenance-oriented solution to these varied problems becomes even more evident during times of societal stress, from political turmoil, the pandemic, or other factors (Finn, 2018). Some of the most exciting interventions have considered anti-colonial power dynamics. For instance, Max Liboiron has suggested that scientists should recalibrate not only sensors but also their commitments, which can be embedded into the ontologies and standard practices of oceanographic inquiry. Their laboratory, for example, has 'stopped using toxic chemicals to process samples, which means there is a whole realm of analysis [they] can't do' (Liboiron, 2021: 6). By demonstrating that prevailing scientific practices are tangled up in issues of inequity, these scholars call for a re-evaluation of what kinds of knowledge we could ethically create with, and about, the ocean.

The techno-scientific approach has contributed to what scholars have called the 'informationali[sation]' of the ocean, a process which has all of the allure and embedded neoliberalism of pressing the messy world into 'Big

[1] See, for example, https://openoceanrobotics.com/portfolio/the-burgeoning-blue-economy-with-ceo-of-open-ocean-robotics-julie-angus/ and https://oceanservice.noaa.gov/economy/blue-economy-strategy/.
[2] See, for example, https://projects.worldbank.org/en/projects-operations/project-detail/P072182.

Data' (Boucquey et al., 2019; Lehman, 2018). Ntona and Schröder (2020) have argued that this framework of creating knowledge about the ocean has led to a technocratic approach to distributing resources. In other words, the cultural cache of scientific and technological research leads to the idea that the ocean fundamentally *is* a site for resource acquisition. Christopher Lawrence (2020) introduced the concept of 'the imaginative exercise' to describe how an imaginary becomes 'modular' or transportable to different groups of stakeholders. We might say that the understanding of the ocean as both a resource and as information have been two such influential exercises, which have shaped the way academic researchers – and the institutions that fund their research – understand the ocean as an entity. Daniela Rosner (2020) has built on this approach by making the case that design in itself must be reimagined – through practice and storytelling or 'fabulation' – to work against silences and tacit knowledge that continually recapitulate technocratic power dynamics.

Richmond Wong et al. (2020) build on this Rosnerian approach in a way that resonates with our own work. They discuss how 'past imaginaries touch present-day infrastructures and technologies.' More important, they attend to the different orientations stakeholders may have to an imaginary or an infrastructure. The case studies we describe below demonstrate points of friction among imaginaries – most notably between university scientists who have a techno-scientific imaginary, and commercial fishers who have an extractive one. Silvia Lindtner's (2020) work has demonstrated how technologies can buoy up specific imaginaries. Academic scientists who recognise technology as constructive of imaginaries and identities have designed new labs that are founded upon anti-colonial, social justice-oriented approaches to knowledge creation which are built in. In addition to Liboiron (2021), mentioned above, these initiatives include the Environmental Data Justice Lab (located in Canada), which is co-led by Vanessa Gray (Aamjiwnaang First Nation), Michelle Murphy (Métis, Winnipeg), and Kristen Bos (urban Métis) as well as the Institute for Freshwater Fish Futures (also located in Canada),[3] which is led by Zoe Todd (Red River Métis). These examples do not oppose techno-scientific imaginaries; rather they demonstrate that innovation, maintenance, and scientific production can be practiced in ways that centre social justice priorities. For example, Giordano (2017) has demonstrated how feminist approaches to improve scientific understanding also help to attain social justice goals, they integrate alternative science paradigms from HIV/AIDS activists and the Black Panther Party, and the 'feminist science shop' tradition from the Netherlands. Notably, the Métis scholars cited above in varying ways emphasise water as a shared territory often seen secondary to land and yet the co-constitution of human life (and political history) is deeply connected to water and watersheds. These examples describe laboratories that were built from the ground up with STS, feminist, and social justice practices in mind; we see ourselves as a useful accomplice to this work by inviting existing laboratories to consider how *coalition* might improve or rewrite scientific practices and re-shape their imaginaries in salubrious ways.

Why Coalition?

One of the approaches that problematises the techno-scientific ocean imaginary focuses on maintenance and repair (Jordan [Steinhardt], 2018). Whilst the concept of this technoimaginary is oriented towards futurism, a Repair Worlds (Jackson, 2014) sensibility more accurately reflects scientific practice, as we will see in our case studies below. More importantly, an emphasis on repair inflects epistemologies with how experts create knowledge about the ocean. This perspective draws attention away from innovation, which can be over-emphasised. It serves as a foundation for reconceiving the technoimaginary altogether, as informed by feminist STS approaches.

While many of the texts we discuss in our literature review have adapted this maintenance-oriented approach, few if any have combined maintenance with the study of technoimaginaries. By attending to this nexus between fields, the interdependencies that are necessary to scientific production become more visible. For example, in practices of maintenance, we often find marginalised identities of people who are less powerful involved in the knowledge-building work of science. These people are often lower paid but nonetheless are essential positions which help maintain and interpret ocean data, whose names might never appear in a publication, on a plaque, or on a paycheque.

Recognising that the erasure of these participants is shaped by how we understand concepts like *scientist* or *phenomenon* or *object of study*. *In this article* we interpret the qualitative data below through a lens inspired by Karen Barad's (2006) work. Barad has argued convincingly that 'experimenting and theorising are dynamic practices that play a constitutive role in the production of objects and subjects and matter and meaning' (55–56). They use the concept 'agential realism' to describe how practices constitute different experiences of reality. While they use this philosophical framework to understand quantum physics (or more precisely particle/wave duality), we employ it to suggest that different analysts' practices construct different technoimaginaries and realities. Commercial fishers who understand the ocean in extractive terms construct it as a resource. The oceanographers who imagine that their sensors retrieve objective data construct a reality in which they 'discover' facts about an external object of

[3] https://www.landandrefinery.org/about.

study – the ocean. These parties cannot be said to collaborate, but much university- and institution-funded ocean science would not be possible without some degree of coordination across groups.

By proposing the concept of *coalition science*, we highlight the interactions and collisions that fall between the cracks of other disciplinary frameworks. We also demonstrate the stakes of invisibilising these relationships. Finally, we draw these marginalised interactions to the forefront to demonstrate the mutual benefits – and reduced harms – that can follow from attending to *coalition*. One of the essential insights of *coalition* is the self-awareness that scientists are just one constituency in a group of many. The first step to harm-reduction then, is in understanding how practices affect collocated people. Thus, the first step to *coalition* involves considering who will be affected by experiment design and inviting those voices into the design at the planning stage. While funders like the NSF promote interdisciplinarity with programmes like the 'convergence accelerator' grant, these institutions narrowly view knowledge producers in terms of university disciplines. *Coalition* would recognise – and offer institutional support for – the fact that engineers and scientists could benefit by working with 'lay experts' (Epstein, 1995), people whose expertise is not credentialed by university qualifications, but rather rooted in local knowledge or in standpoint epistemology. The transition to *coalition* will not be easy. Practitioners will need training about integrating voices from outside of the university into their experiments before deployment. People within and outside of the university will require fora or other kinds of infrastructure that can support the kind of shared hearing and listening that is required. As our cases will show, without this support structure, scientists are already struggling.

Data Collection

As we hinted at in our introduction, the data we discuss below was fundamentally shaped by the conditions of the COVID-19 pandemic. In collaboration with Arctic and Antarctic Specialist & Historian, Madison Hall, Jordan sent a weather-proof toolkit with a GoPro camera to the consenting laboratories to record observations where an ethnographer previously might stand. Jordan additionally performed interviews via Zoom with laboratory members and expanded the participant pool to other individuals who hold roles in deploying and maintaining sensors or observatories in polar regions throughout pandemic. The current manuscript is built on a data set of 20 hours of recorded remote observations, and over 20 hours of interviews with 15 participants working in and around the Arctic. *Participants in the below study are anonymised. All quotations, unless otherwise cited, come from anonymous interviews with polar ocean scientists.*

Lieberman became a collaborator after the data collection, and together both authors analysed the data. The transcribed interviews were analysed via grounded theory methods in the NVivo qualitative coding software. The concept of *coalition science* arose from an intersection of problems identified within codes: communication, collocation, peripheral actors, and ecological thinking. Due to the nature of our interviews, this paper focuses on scientific perspectives, though the *coalition* concept is more capacious. We see this as a first step towards creating a body of research that will consider how coalition affects the understanding of the ocean from a multitude of perspectives.

THE PATH FROM COTTAGE SCIENCE TO COALITION SCIENCE IS COMMUNICATION

Give a scientist a GoPro camera and they might surprise you. Several of our participants turned the lens on themselves in an echo of the reality TV 'confession cam.' These spontaneous reflections demonstrated how scientists narrated themselves in relation to their changing field. Participants described ocean science as a 'cottage industry' of 'little operations in many locations.' By 'cottage industry' and 'cottage science,' our participants mean that each institution consists of subgroups, each committed to understanding some part of the ocean. Historically, oceanographers have not been interested in 'the whole thing' as an object of study. Instead, physical, geological, biological, and ocean engineers specialise in particular geographies. Participants describe how 'soft money' organises the work of climate and ocean science, tying income to grant funding. This practice, which is common across academic STEM fields, places pressure on scientists to quickly build new endeavours that will continue to support their families, mortgages, and life plans. However, a transition is underway, in which longer term, more interdisciplinary, and more distributed efforts are being funded under research initiatives with titles such as 'eScience' or 'cyberinfrastructure.' As one participant noted, 'A shift is taking place now toward understanding entire marine ecosystems – and that ... is really complicated!' With the rise of the 'observatory model,' scientists could place satellites in the sky, sensors in the water column, robotics on the seafloor and gliders across the waves of multiple oceans to collect data in an ongoing and integrated form. This research model exceeds the capabilities of individual research efforts. And it imagines nobody but scientists will need to access these spaces. As these excerpted quotations already indicate, this expansion of the ocean scientist's purview relies heavily upon the techno-scientific imaginary. Grant funding demands newer, larger innovations now. In other words, funding and credentialing institutions continually displace the ongoing labour that makes on-the-ground science possible and interpretable.[4]

Since the techno-scientific imaginary was not changed by the development of this new trend, participants interpreted these trends not as a paradigm shift but, rather, as a change in common research practice. Our participants, like many ocean scientists, were forced to change from working alone towards reluctantly working with stakeholders they did not choose. One participant explained that the cottage industry of oceanography classically purported 'a very much individualistic and individual research' model, adding that now 'people are now coerced to work as a community.' The word *coerced* here indicates how this participant viewed the pressure (generally applied from external funding sources) to work in tandem with others. By *community,* this participant means working with other academic experts. As another scientist scoffed, 'It's partly in the way that people approach the natural world and the way they approach other people. A lot of ocean scientists have not had to work with other people ... Scientists are like all mouth and no ears.' This stunning quotation alludes to failures in communication that we will explore below. But coalition – between academics and non-academics – requires listening as well as speaking. In other words, ocean scientists in this new cultural economy must construct a more useful imaginary that values ears as well as mouths.

Another participant, a fellow scientist and lead principal investigator (P. I.), describes a similar clash caused by the friction between disciplinary imaginaries:

> Scientists are very egotistical, very self-centered people and sometimes they just don't realise that other people have good ideas! They need to listen more! And engineers just don't have an off switch! They just look at the world in a completely different way. Sometimes [engineers] are driven more by efficiency or cost-savings or getting things done more quickly, and it is hard for them to appreciate the science objectives. They're very different communities... It's almost like gender-sensitivity training or ethnic-sensitivity training.

The comparison to gender and ethnicity here draws attention to power dynamics. 'Gender-sensitivity training' and 'ethnic-sensitivity training' are the hallmarks of educational institutions which have enjoyed the ease of communication in a monoculture that appears disrupted by new voices. As this expression of frustration from a P. I. demonstrates, scientists can fail to work productively with engineers (and vice versa) because they can fail to value the perspectives, practices, and imaginaries held by one another. Participants recognise that they have to work with stakeholders with different kinds of expertise, but this frustration arises from the fact that they don't have sufficient resources to do so productively. The reference here to sensitivity training playfully alludes to the fact that institutions can provide support in cultivating respect across power differentials, and that this baseline work has not been completed in order to facilitate communication in interdisciplinary groups.

Interdisciplinarity, here, is not just a buzzword or trend. In some cases, scientists have elected to work in teams with practitioners from different disciplines to better understand complex problems from integrative perspectives. In other situations, including those described here, interdisciplinarity was foisted upon participants: scientists facing continued budget and staff cuts are pushed to work in larger teams for practical rather than theoretical reasons. Austerity initiatives in administrative practices have incentivised greater resource sharing, and pushed different kinds of specialists into uneasy communication. As one participant asserted,

> People have to collaborate at all levels from the technicians up to the university president ... and they don't like it because it's money! If they had to do it and there wasn't any money involved they would say 'yeah yeah yeah' and probably not do it.

In some cases, interdisciplinary collaboration is intentionally and mutually enriching, but, as this participant indicates, forced partnerships can be less productive.

Scientists in our data set fear that without community-building practices, they will continue to see harm and preventable breakdowns. One participant detailed a significant miscommunication between ocean scientists and NASA space scientists sharing satellite data. They explained that oceanographers developed major algorithms for satellite data-collection but had some different ideas about what to do with the data after it was gathered. One USA based participant said,

> NASA's [the USA National Aeronautics and Space Administration's] satellite mission is to do research. NOAA's [the USA National Oceanic and Atmospheric Administration's] satellite mission ... is long term

[4] Our emphasis on *ongoing*-ness calls up the temporality implied by innovation. For more on feminist temporality, see Juelskjær, M. and Rogowska-Stangret, M. (2017). A pace of our own? Becoming through speeds and slows – Investigating living through temporal ontologies of the university. *Feminist Encounters: A Journal of Critical Studies in Culture and Politics*, 1(1), 06. https://doi.org/10.20897/femenc.201706.

> operationals. ... The government mandated a convergence of DOD [the USA Department of Defense] and NOAA satellite acquisition and I think it was like throwing the NOAA bait into the wolves. Terrible cost overruns.

This quotation draws attention to the conflicts that arise over cost. The participant goes on to say, 'There isn't cross-funding between NASA and NOAA, though!' This participant had to navigate the nexus between two agencies that have different objectives, different imaginaries, different tools, and, perhaps the cause of greatest conflict, different pots of money.

The same participant went on to describe how oceanographers felt about these uneasy institutional affiliations:

> Everybody in the ocean community freaks out at the idea that NOAA would take over. One is please don't give me your dumb ass data delivery system when this one is awesome! And the other thing is that there are other nations that have colour systems.

The charged language here (*dumb ass* versus *awesome*) demonstrates the perceived attraction of the newest and best tech. Here is the allure of the techno-scientific imaginary: cooler, more colourful visualisation tools. Crucially, the draw of the presumably better data delivery system is not better data. The participant points out that, 'Anybody can send a sensor up and calculate radiants coming up green and blue but the sensors don't remain calibrated! The same number of photons and watts per meter squared don't generate the same photon counts!' The data set stays the same, but the bells and whistles of a recent innovation still lend to cross-agency conflict.

While battles wage about who collects and controls data, miscommunication becomes a part of scientific practice. This P. I. said, 'You might pose the question of our culture, though, with the way the agencies survive and exist funded by the federal government: does our federal government encourage a reward for cooperation? I don't know. It's not clear.' Relatedly, another P. I. on the same project noted that 'breakdown[s in communication involved] a lot of people not knowing what they don't know!' *Not knowing what they don't know* has led to significant growing animosity between not only scientific groups but also groups outside of a formal scientific research institute. As we will touch on below, non-scientists hold expertise that is not only valuable in its own right but also essential to the production of scientific knowledge about the ocean.

In the examples above, scientists grappled with the extra- (or non-)scientific pressure to work in teams for institution or academic reasons. Scientists can also feel pressure from ocean-stakeholders without such affiliations. As one co-P. I. and project manager grumbles,

> In our offshore site [] at the head of a canyon, that is a great fishing spot. And it is right at the border of a reserve. So the way people fish that area is that they go right up to the boundary and they fish along the edge, which includes trawlers and recreational people [who] use our buoy. They kind of go out to our buoy and then start fishing. They are asking us to move it out of the area and then into the area that they aren't explicitly allowed to fish.

This participant demonstrated the reluctance of performing work for fishers outside of the efficiencies of the scientific project. Hesitancies and feelings of incompetency to communicate with fishers in particular are well vocalised by scientists. Our participants consistently frame fishers as recipients of their expertise via university research but are traditionally not a part of the process of defining where instruments will be dropped, what kinds of data will be collected, for how long, and so on. In fact, in this era of scientific research, primary investigators often assert, without corroboration, that non-academic communities will benefit from project data. For instance, one P. I. explained the value of their work by asserting, 'Colleagues in even the fishing industry [could use our data] because that kind of observatory could track fish migration patterns! Or earthquakes and how tsunamis evolve! OR how storms effect the circulation of the ocean in real time!' In this example, there was no evidence that fishers asked for this kind of knowledge; the speaker was informed by their own imaginary of condescension of what commercial fishers *might* need. Indeed, a keynote speaker Jordan observed during a prior field research trip stated that their research 'could be useful for resource managers like fisheries or those interested in harmful algal bloom elements.' The conditional tense (*could*) suggests the importance of rhetorically gesturing towards impact without verifying, in coalition, what fishers actually want or need.

One participant even noted how little oceanographic research is actually used by non-academics, claiming that citizen scientists that look at hydrophone data and 'digital fishers' could use their data but 'You have to be really dedicated to want to store and download the data from these sound experiments because the files are so big.' In other words, the potential beneficiaries of data might have difficulty accessing the data. And the scientists know it.

Yet, while funders like the USA National Science Foundation might look favourably on projects that demonstrate interdisciplinarity by including experts from different disciplinary fields on the grant, they do not require non-academic names to be listed among the investigators on any given project, even when the project claims to have non-academic impacts or applications. The assertion that scientific research benefits non-scientists, like fishers, is a speculative techno-imaginary that uses an *empty vessel* understanding of science communication that has been shown to often engender both animosity and lost effort (Baker, 2019).

In the above examples, participants were forced to consider other perspectives. They did not intrinsically value the input of their forced collaborators, even within a single-university setting. And they definitely did not have the training to communicate in mutually respectful ways. In other words, the above examples talked about talking, and the frustrations that arose from having to do so, when talking did not seem like scientific labour. In the examples below, communication was required by the very nature of scientific practice. In order to calibrate and retain equipment, talking and listening, mouths and ears, would both be essential.

Calibration Requires Community

Particular sites of maintenance are especially ripe with opportunity for developing sustained community engagement. Here, we focus on calibration as one such site. Scientists often work with distributed instruments – instruments that are at sea which communicate with computers at home institutions, for example. The precise calibration of instruments is essential to the creation of scientific knowledge about the ocean. In an above example, the participants involved in USA based organisations such as NASA/NOAA data collection pointed out how unruly sensors are by noting that they 'don't remain calibrated!' While this participant preferred a higher-tech data delivery system, this problem of calibration remains. Innovation cannot erase the need for maintenance. But the techno-scientific imaginary encourages practitioners to identify progress in the form of new tools even as these heritage problems remain.

Calibration is nontrivial. As one P. I. and laboratory lead explained, 'if your sensor is not well-calibrated you can miss or misinterpret the signal.' They continued with a specific example, noting that, 'oxygen sensors have a known issue where they decrease in their sensitivity over time and drift downward, so you can confuse that drift downward with a net respiration signal.' To determine whether a signal was missed, misinterpreted, or naturally decreasing, scientists need to consult every available data point – ranging from existing models to conversations with charters and local fishers about migration patterns. In this way, calibration becomes a force that pushes scientists to communicate with collocated communities. This pressure can engender similar frustrations to those we saw above. According to one participant, 'NSF [National Science Foundation USA] is facing this crisis that they're now paying more money to support operations and maintenance than they are paying for science!' Three things become explicit here: (1) the techno-scientific imaginary of this participant, who cannot visualise the maintenance of necessary machinery as science; (2) the fact that a 'maintainers' or 'repair worlds' mindset has started to influence funding; and (3) that funding bodies *can* be influenced. There are utilitarian reasons maintenance might be funded more now than it once was. Austerity and long-lived systems that represent huge financial investments that would be lost without calibration and maintenance are certainly good incentives. These grant programmes might also have been influenced by research about maintenance as a scientific practice. In either case, it is precisely in this moment of change where we believe a reframing towards coalition might be useful to practitioners. We will discuss that possibility in our conclusion.

Although participants might be hesitant to classify maintenance and communication work as *science* in itself, they still recognise that their work would be impossible without these practices. As a project manager for a USA national observatory said: 'This winter has been very rough ocean [sic].' Other participants corroborated this impression. The project manager continued to explain what those hazardous conditions meant to their scientific research:

> I guess ... last year there were a couple of big storms, but the previous two years we had nothing. Those first two years were the first years we put stuff out for [institution redacted] and so … it was fine! But both this winter and last winter we lost the buoy for our water profiler in the Washington offshore site, and both times we got into the coastal current and it went straight up to Vancouver Island. The first time, December of 2015, there was a University of Washington student cruise on the Thompson, which is a big ship, and so they just happened to be halfway up Vancouver Island, and they just picked it up. And then this last time the same thing happened. Similar storm. And so we had the people from the Bamfield Marine Station because the previous year it passed them before the seas were safe enough for them to go out and get it. And they're used to dealing with tough seas. I mean it was 40 foot seas for days. It was tough. I don't see how the Thompson was out there with students … I can't imagine.

In this example, atypical ocean conditions led to the potential loss of expensive and vital equipment. These instruments were recovered because of the happy coincidence that an unrelated expedition from Bamfield Marine Station in Vancouver, Canada, and student-led research cruise were near enough to retrieve the device. Years of grant funding might have been lost without an awareness of other stakeholders who made use of the ocean – even in circumstances that this researcher 'can't imagine.'

This participant was able to seek assistance from other research vessels rather than having to liaise with non-scientists. In the quotation above, they registered no hesitancy or difficulty communicating. But, much to the chagrin of some scientists, communicating with non-scientists can also become a necessary part of the job in these extreme circumstances. In the above quote, research vessels happened to be available because of nothing more than kismet. In the examples below, researchers had to work with non-scientists and found that experience much more difficult. One participant explicitly discussed how difficult this work was because of her introverted personality. Another engineer corroborated this issue, saying:

> We have this continuing problem of shipping things up and down the coast so that we can get to the moorings or more likely when something goes adrift. And so we need to go get it. So we have these relationships with people that we ... We haven't found any tribal boats that have the ability to pick up what we need to pick up. So we have one boat in West Port that we use a lot that is a recreational fishing boat that he's rigged it up so he can do some of our work. We tried to get this other fishing boat but, man, it was slow and not ... It hadn't had scientists aboard. It would have been hard socially to do what we needed to do. It was just unlike anything we had done before. And they make you know, they do better by going to do their work. Whereas the recreational guys we pay them to go out to sea for a few days we are paying equal or more than they would make taking a group of guys who are coming in to fish for a day. Whereas if it's a commercial boat, the kind of boat that can lift up our stuff, they can do better going to fish for a day.

This comment mentions in passing some of the physical limitations of partnering with indigenous communities (the size of 'tribal boats'). Boat size is not the only documented impediment to collaborations between indigenous and scientific communities, though that fact has been well-explored elsewhere (Lauter, 2013; Little Bear, 2017). The above comment does not reflect on a willingness or unwillingness to work with indigenous people. In this case, the engineer maintained a relationship with a recreational fishing boat in order to retrieve equipment. Both the relationship and the instrument require maintenance that are essential to the creation of scientific knowledge about the ocean. The engineer describes social difficulties in coercing local fishing people ('It would have been hard socially to do what we needed to do.') Again we see the theme of a technical expert feeling unprepared for the social and communicative labour required of them.

This passage also points out a tension occurring between an extractive imaginary of the ocean and a techno-scientific imaginary. The interviewee points out that commercial fishers 'can do better going to fish for a day', which is a point mentioned twice in the above passage. While relationships with fishing people could benefit scientists, in some cases scientific funding has proven unable to make this relationship mutually beneficial. Where imaginaries clash, tensions arise.

Unlike in the first example, where lost equipment was retrieved by scientists, this example demonstrates the difficulty scientific practitioners may have even in communicating with non-scientists. Consider, for example, the stuttering way this interviewee mentioned the difficulty of working with a boat that 'hadn't had scientists aboard.' In these moments where communication fails, the real value of (and need for) coalition becomes all the more apparent. These relationships, as this engineer notes, are absolutely essential. Yet, scientists and technologists are not prepared to cultivate mutual relationships with collocated people. Because they are immersed within a techno-scientific imaginary, they expect that non-scientists will share their aims and will therefore offer help. However, as this example shows, the help scientists require is not readily given by all collocated groups.

These examples are typical. They demonstrate that people who operate from a techno-scientific imaginary *expect* that they will need to cultivate ongoing relationships with other collocated groups. Even as they privilege the moment of innovation, deployment, or discovery, they recognise that ongoing relationships underpin all of their work. Yet while ocean scientists might acknowledge that community resources are a reality of scientific maintenance, they resist relationship-maintenance work for a host of reasons. Some may disregard opinions that do not align with their techno-scientific imaginaries. Others may simply find the need to communicate with non-experts stressful or unscientific.

Toward a Framework for Coalition Science

We might describe ocean scientists as working in a distributed ecology of knowledge. They leave instruments behind during field work and return to institutions (that generally share and advocate a techno-scientific imaginary) to make sense of their data. Their sensors and sense-making occur on different sites. Once they have left an instrument in the water, communication with local community groups becomes essential to scientific knowledge production. When researchers are not present, local fishers or other community members might need to recover instruments that have gone adrift or even help make sense of data that might seem anomalous. Without local knowledge, it might be difficult to determine when unexpected data from ocean instruments suggests poor calibration, or when it registers a local phenomenon. In other words, ocean scientists must work with others, including non-scientists or 'lay people', not only to maintain equipment (which is essential in itself) but also to interpret data. The necessity for coalition can be amplified by extreme conditions which are common in the polar regions we discuss, but which may also include unanticipated events such as lockdown during COVID-19 or more regular occurrences, like rough weather.

The construction of university-based research relies upon a speculative imaginary of the recipients of value. For example, rather than cultivating a community partnership with people who fish for a living, practitioners imagine a hypothetical fisher and expect that their research will benefit them. Despite the barriers that a techno-scientific imaginary erects between scientists and non-scientists, these collocated groups could help construct experiments or shape the knowledge those experiments yield. By 'construct' we mean help scientists determine where to place sensors and how often to retrieve data. As long as scientists control the physical and temporal parameters and success metrics of an experiment, they will yield knowledge that primarily makes sense and brings value to stakeholders only in the university space, rather than creating transformation and enduring coalitions or knowledge for application beyond the university.

The field of science and technology studies has a long history of looking at tensions like the ones our participants describe. Science, in operational practice, rarely looks like the idealised scientific practices the public (or people who aspire to be scientists) imagine (think of the scientific norms Robert Merton identified in 1973 versus the practices Bruno Latour and Steve Woolgar observed in 1979). But when communication and coalition are categorised as non-science, scientific practitioners can feel frustrated and even expensive research endeavours can fall into jeopardy.

We invoked Barad's notion of agential realism here, because it illuminates an important lesson about how experiments are crafted. According to their own summary of Bohr, 'we are a part of that nature that we seek to understand.' In other words, attempts to understand 'the ocean' create a separation between the scientific object (ocean) and the researchers. This dichotomy has a very long history,[5] but that fact does not mean it is the only way of understanding ocean science as a methodological practice. As our examples have shown, scientists and engineers yearn to be better prepared for the realities of their work – including preparation for communication and the working-together-ness we call *coalition.*

We believe that a set of practices for mutual community engagement based on feminist and post-colonial theory could offer such preparation. Gloria Anzaldúa (1987) tells us that being in coalition is akin to family, and adrienne maree brown (2017) discusses strategies for building such kinship-like connections. Groups in coalition might still be in competition some of the time. There might be collision or collusion in coalition: favourites and outcasts. Coalition science is built on a foundation of these beautiful connotations. It resists the binarism that haunts our own language when we label scientists and set them against non-scientists or lay-people; coalition pushes back against this tendency to create and police borders and invites stakeholders to work together on growth. Necessity and circumstance create the conditions where communication is unavoidable, but feminist STS give us the framework to recognise this fact as an opportunity. By nurturing a shared investment, we might begin to make visible connections between communities around a shared point of concern. Coalition is not empathy: it is not purporting to understand the struggles of another. Instead, it is a process of active listening for another to explain how they can thrive and support scientific work, and, reciprocally, how this coalition-minded kind of science can produce welcome and community-identified interventions. Coalition involves building alliances, even when they are uncomfortable, in an attempt to improve the conditions in which we all live and, in this case study, the oceans we all share.

Defining the Commitments of Coalition

As it is coming to be defined, *coalition science* holds commitments to the following four tenets. First, coalition is a **new imaginary that emphasises the relational. Second,** coalition requires **both mouth and ears**. Third, coalition looks to **breakdown, maintenance and repair as an opportunity for re(infra)structuring**. Finally, coalition **takes harm seriously** and is proactive about harm reduction.

Our first tenet, that coalition emphasises the relational, illuminates the fact that not all partnerships are, well, partnered. Everyone approaches their work and their world from different subjectivities, and from different imaginaries. Understanding that collocated groups might not share the same values, power, or imaginaries is an important first step to creating less harmful and more productive scientific practices towards understanding the ocean. To emphasise the relational is to illuminate the contexts in which science-in-practice takes place. *The relational* refers to dynamic inter- and intra-actions that change over time. This framework demands that we move from the chronotype of understanding science in a snapshot (as the innovation mindset does) to understanding science as ongoing practice that involves cultivating relationships that change over time.

[5] See, for example, Daston, L. and Galison, P. (2010). *Objectivity*. Princeton, NJ: Princeton University Press.

Our second tenet involves the mouth and ears – by which we mean developing practices at all stages of the scientific project with awareness that communication is bi-directional. Active listening is just as important as speaking. Communication might never create a commensurate cohesive community between these many ideologically opposed groups.[6] Taken together, participant interviews and observations suggest that opening new, ongoing communication channels might defend against larger-scale harm and blowout that only exacerbates chasms between these interested parties. For example, university scientists operate in an imaginary which is at odds with the indigenous and the local fishers' perspectives. When these groups respectfully work together, they can do more than react to problems (for example, from the above examples, calibration, miscommunication, or lost equipment) and can begin to create generative knowledge together. Indigenous peoples' expertise is often bought off in an ad hoc way and then abandoned; these exploitative and transactional practices need not, and should not, be typical. Focusing on bi-directional communication can help reduce harm and support both groups even when they have different objectives.

Our third tenet reframes failure and breakdown as opportunity. Our examples above detailed such moments of frustration; *coalition* contends that such moments of friction do not indicate failure. And, further, that failure does not have to represent an end-point. Rather, moments where tension arise can point towards areas for growth. If we learn from the above examples, we might increase efficiencies and better prepare scientists for the day-to-day work of studying the ocean. Barad's framework is useful here. They introduce the notion of an 'agential cut,' a process of imagining, and therefore creating or re-capitulating boundaries. The agential cut creates a framework that determines accountability and practice. It allows scientists to remove themselves and their practices from the 'phenomena' itself.

Barad contends that drawing these boundaries according to different lines makes scientists accountable in potentially illuminating ways. In the case studies we discussed above, a participant created a boundary between science and maintenance. To re-frame their words in Barad-esque terms, they enacted a 'cut,' seeking to separate techno-science as all that is new. Other configurations that emphasise maintenance and coalition are not only possible, but full of potential. Understanding science as including communication and maintenance practices can inflect the types of experiments scientists construct, and, concomitantly, the types of answers their inquiries yield.

Finally, a coalition-centred imaginary must be proactive about harm reduction. When stakeholders adopt these coalition practices, they can help identify and ameliorate or avoid harm. Open lines of communication can allow scientists to get ahead of the catastrophic harms that are currently receiving attention in popular culture (c.f. *Picture a Scientist* [Cheney and Shattuck, 2020]; 30 Meter Telescope [Oishi, 2022]). The above examples focus on scientists who were concerned about (1) the need to calibrate equipment and the potential for losing it, (2) who they would have to call upon to assist with equipment, and (3) how they would be forced into communication with other specialists within and beyond the university. Of course, these are not the only sites for harm or vulnerability in polar ocean science. Identifying coalition with other stakeholders as scientific practice, and training and funding for it appropriately, could reduce harm to scientists and to the communities they touch. In coalition, scientists would think better of placing instruments that affect fishing routes, because open lines of communication with fishers would be considered a valued part of their practices. They would maintain communication with indigenous and other local people – not only when it served an urgent need – but also as a part of the knowledge-making process.

Ultimately, coalition is about taking **pragmatic action**: taking these findings in order to build approachable and accessible protocols. Scientific groups could benefit from being equipped to develop and maintain relationships with local communities. This maintenance practice would include sustained liaisons, ongoing feedback, and adaptive strategies to alleviate the struggles of collocated communities who are invested in the same place. One participant quoted above mentioned and dismissed indigenous coalition because tribal boats were not large enough to serve their ends of retrieving equipment; a coalition approach raises the question: what insights could spark if participants like this one did not simply seek a transactional relationship (retrieve X equipment for Y dollars)? What if scientific practice, and funding, incentivised communicating to understand complementary perspectives and imaginaries, as well?

CONCLUSION

This research illuminates four critical moments in which social science could guide inclusive and community-engaged scientific practice: identifying who is collocated, establishing community liaisons, integrating community

[6] On making people in power listen to stakeholders during the decision-making process, see Ramírez, D. M., Gutenkunts, S., Honan, J., Ingram, M., Quijada, C., Chaires, M., Sneed, S. J., Sandoval, F., Spitz, R., Carvajal, S., Billheimer, D., Wolf, A. M. and Beamer, P. I. (2022). Thinking on your feet: Beauty and auto small businesses maneuver the risks of the COVID-19 pandemic. *Frontiers in Public Health*, 10, 921704. https://doi.org/10.3389/fpubh.2022.921704.

in design, and calibration and quality control communication. Mirroring these four moments in the scientific process, Jordan has developed protocols for coalition that scientific laboratories have already begun deploying at sea: (1) Identifying Stakeholders & Building Meaningful Collocated Community, (2) Ongoing Liaison Communication and Setting Shared Agendas, (3) Participatory Design Workshops and (4) Adaptive Co-Repair and Iterative Design. These protocols are built from traditions of participatory design, community engagement, and interdisciplinary collaboration to devise pathways toward coalition within collocated communities.

While our concept of *coalition science* was developed in conversation with polar ocean scientists, we believe it could offer salubrious insights to practitioners in other fields. One benefit of coalition is that it values under-represented voices. Barad and other feminist science studies scholars have shown us that marginalised voices can help scientists understand phenomena in productive ways. Donna Haraway (1989) has demonstrated that feminist questioning of primatology has reshaped that field; Evelyn Fox Keller (1996) has shown that feminist questioning has greatly impacted embryology. In environmental studies, Giordano, Liboiron, Murphy, and others have modelled how anti-colonial and feminist laboratories can be built from the ground-up. Our work on coalition science complements this strategy by maintaining that existing laboratories can benefit from listening to under-represented voices and taking their insights seriously. Indeed, understanding different imaginaries of the ocean could have similarly illuminating effects on ocean science. As we have seen, coalition could iron out the miscommunications that hinder scientific knowledge-making. This technoimaginary could also create more equitable and just relationships that could lead to more ethical, more useful, and more sustainable imaginaries.

Coalition could build on current momentum to acknowledge and fund maintenance by recognising its centrality to scientific knowledge production. *Coalition science* affirms that relationships demand maintenance as much as any sensor does, and it emphasises the ongoing-ness of this work. Zoe Todd (2016) describes how past, present, and future 'stories in the bone' become embodied, literally inscribed on bones. Todd's work demonstrates the urgency of taking responsibility for scientists' impact on the environment and acknowledging how environmental variables impact scientific practices. This framework further emphasises the dynamic feedback loops that the above points also underscore. Science is in an ongoing and changing relationship with non-science, with objects of scientific inquiry and with people who hold non-scientific imaginaries. Scientific productivity, then, becomes less a matter of number of grants awarded or publications in press and more a matter of relationships, survival, and change.

If the techno-scientific imaginary privileges the new *as* science, our emphasis on coalition does similar work: it draws some elements into sharper focus (communication, relationships) and allows some to fade into the background (innovation). Wong et. al.'s (2020) words apply to our own imaginary well: 'While most speculative design artifacts foreground how users might interact with an artifact, speculative lifeworlds implicitly suggest that there are relationships and stakeholders beyond end use.' According to the frame we propose, leaving an instrument in the ocean is not the beginning. Experiment design can benefit from coalition well before the deployment of equipment. And the sense-making that happens after doesn't have to be – and, as we have seen, cannot pragmatically be – done in the silo of a university laboratory. By attending to *coalition*, the relationships that scientists build with collocated groups can create more durable infrastructures. This process serves scientific ends in that it can help prepare scientists for the extreme conditions that threaten their ability to complete grant-funded projects (and thus apply for new grants); it serves non-scientists in promoting the mutual exchange of information. *Coalition,* at bottom, entails the recognition that, while imaginaries might clash, people who hold those imaginaries can still operate with mutual care.

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