



OPEN ACCESS

EDITED BY

Di Jin,
Woods Hole Oceanographic Institution,
United States

REVIEWED BY

Ella-Kari Muhl,
University of Waterloo, Canada
Christian T. K.-H. Stadtländer,
Independent Researcher, Destin, Florida,
United States

*CORRESPONDENCE

Holly J. Niner
✉ holly.niner@plymouth.ac.uk

†These authors have contributed equally to this work

RECEIVED 01 December 2023

ACCEPTED 19 June 2024

PUBLISHED 11 July 2024

CITATION

Niner HJ, Wilson D, Hoareau K, Strand M, Whittingham J, McGarry D, Erinoshio B, Ibrahim S, Tshiningayamwe S, Febrica S, Lancaster AMSN and Prokic M (2024) Reflections on the past, present, and potential futures of knowledge hierarchies in ocean biodiversity governance research. *Front. Mar. Sci.* 11:1347494. doi: 10.3389/fmars.2024.1347494

COPYRIGHT

© 2024 Niner, Wilson, Hoareau, Strand, Whittingham, McGarry, Erinoshio, Ibrahim, Tshiningayamwe, Febrica, Lancaster and Prokic. This is an open-access article distributed under the terms of the [Creative Commons Attribution License \(CC BY\)](https://creativecommons.org/licenses/by/4.0/). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.

Reflections on the past, present, and potential futures of knowledge hierarchies in ocean biodiversity governance research

Holly J. Niner^{1*†}, David Wilson^{2†}, Kelly Hoareau^{3,4†}, Mia Strand^{5†}, Jennifer Whittingham⁶, Dylan McGarry⁷, Bolanle Erinoshio^{8,9}, Sulley Ibrahim^{8,10}, Sirkka Tshiningayamwe¹¹, Senia Febrica¹², Alana Malinde S. N. Lancaster¹³ and Milica Prokic¹²

¹School of Biological and Marine Sciences, University of Plymouth, Plymouth, United Kingdom,

²Department of Humanities, Faculty of Humanities and Social Sciences, University of Strathclyde, Glasgow, United Kingdom, ³Institute for Marine and Antarctic Studies, Blue Economy Cooperative Research Centre, Centre for Marine Socioecology, University of Tasmania, Hobart, TAS, Australia,

⁴James Michel Blue Economy Research Institute and Island Biodiversity Conservation Centre, University of Seychelles, Mahé, Seychelles, ⁵Institute for Coastal and Marine Research, Department of Development Studies, Nelson Mandela University, Gqeberha, South Africa, ⁶SARChI Bio-economy Research Chair, Department of Environmental and Geographical Science, University of Cape Town, Cape Town, South Africa, ⁷Environmental Learning Research Centre, Rhodes University, Makhanda, South Africa, ⁸One Ocean Hub, University of Cape Coast, Cape Coast, Ghana, ⁹Derby Law School, University of Derby, Derby, United Kingdom, ¹⁰Department of Local Governance & Development Studies, Institute of Local Government Studies, Accra, Ghana, ¹¹University of Namibia, Windhoek, Namibia, ¹²One Ocean Hub, Law School, University of Strathclyde, Glasgow, United Kingdom, ¹³Caribbean Environmental Law Unit, Faculty of Law, The University of the West Indies, Cave Hill Campus, St. Michael, Barbados

Governance of the ocean and its biodiversity is deeply entangled within social, political and cultural histories. The evolution of marine science has been subject to similar influences, and we (the authors) consider these factors to create, embed and reinforce knowledge hierarchies in ocean governance processes and associated research that set societal patterns of prioritisation and exclusion. Such knowledge hierarchies have constructed dominant Western-oriented knowledge systems as 'rational' and 'objective' approaches to environmental governance in contrast to non-Western knowledge systems and have led to a dominance of natural (normal) sciences over centralised biodiversity governance. The extraction and incorporation of traditional knowledge into the Western-oriented scientific canon through myriad historical and contemporary processes in ocean biodiversity governance often reproduce knowledge hierarchies, do not benefit knowledge holders and are often considered incomplete, inappropriate or absent. As we address current ocean biodiversity and conservation challenges, researchers must be aware of the history of knowledge extraction, impositions and assumptions within their fields. Researchers must also actively acknowledge and address these histories in their work to avoid marginalisation and support ethical, empathetic, and rigorous knowledge production that meets the needs of society. In this paper, through a development of the concept of knowledge hierarchies, we explore case studies of research diverse in geography and discipline ranging from action research in Namibia, the application of arts-based methodologies in legal proceedings to research focused at an international level, and the concept of ocean literacies, all of which are located under the umbrella of a project

specifically targeting transformative ocean governance. It becomes evident that knowledge hierarchies are multi-layered, perpetuating, and often reproduced even when attempting to address hierarchies through such methods as the integration or ‘bringing together’ of diverse knowledge systems. Effective change will therefore require sensitive and multi-faceted approaches to knowledge hierarchies, including processes of embracing discomfort, which will be important to work with, as well as through. While there will be continued tensions between hierarchies, it is a *sine qua non* that researchers need to build a commitment to understanding where powers lie, rather than ignoring such imbalances or, similarly, by idealising approaches.

KEYWORDS

knowledge hierarchies: marine governance, biodiversity governance, ocean biodiversity, indigenous knowledge, transdisciplinary science, transformative governance

1 Introduction

Governance of the ocean and its biodiversity is deeply entangled within histories of colonisation and the parallel development of environmental marine sciences and Western-dominated conservationism (Trisos et al., 2021; Fischer et al., 2022). These developments have occurred alongside increasing efforts to optimise the utilisation of marine environments throughout the world (Okafor-Yarwood et al., 2020; Rudolph et al., 2020) and have set societal patterns of prioritisation and exclusion of information and knowledge (what we term knowledge hierarchies – see section 2.2). In 2023, the Intergovernmental Panel on Climate Change (IPCC) warned that historical and ongoing patterns of inequity such as colonialism, have exacerbated vulnerability, inequity, and marginalisation, especially for many Indigenous Peoples and local communities in climate-biodiversity governance (IPCC, 2023). As a result of colonisation and Western-dominated conservationism, existing approaches that aim to protect biodiversity have constructed dominant Western-oriented knowledge systems as ‘rational’ and ‘objective’ approaches to environmental governance in contrast to ‘non-Western’, traditional, or Indigenous knowledge systems that are cast as ‘cultural’ and ‘subjective’ (Escobar, 1998; Santos, 2016; Trisos et al., 2021). This has led to the exclusion of whole communities, from processes of ‘evidence-based’ governance globally, specifically through the dismissal of different ways of knowing as irrelevant, lacking rigour and “superstitions, opinions, [and] subjectivities” (Santos, 2016).

1.1 Addressing research bias and positionalities

We argue that sustainable approaches to ocean biodiversity governance require researchers to be aware of the histories and

legacies of knowledge extraction, imposition, and assumption within their research fields (Belhabib, 2021; Trisos et al., 2021). In addition, ocean biodiversity researchers should actively and continuously strive to acknowledge and address these colonial and inequitable legacies in their work. We acknowledge that this is not an easy task for researchers, even within research that recognises the need to implement paradigm shifts and transformations. Existing knowledge hierarchies have proven to be multi-layered and are often reproduced even when attempting to break down these asymmetrical patterns through approaches that aim to integrate or ‘bring together’ diverse knowledge systems. However, effective change, such as that required to address the intractable problems of marine biodiversity loss and sustainability, will require sensitive and multi-faceted approaches supported politically and financially, to reconstruct the relationship between knowledge and equitable governance. In rising to this challenge, it will be important for researchers to work with, as well as through, such tensions, with a commitment to explicitly face the power asymmetries often cast as invisible within the academy (Haraway, 2016b).

In practice, addressing knowledge hierarchies starts with acknowledging the influence of researcher positionalities. The provision of a positionality statement alongside research outputs is suggested as best practice to make explicit the context within which knowledge is being produced (Trisos et al., 2021; Muhl et al., 2023). As individuals, we are shaped by our geography, race, gender, sex, ability, spirituality, socioeconomic status, discipline, age, and so much more, which again influences our work, our ways of being and knowing (onto-epistemologies), the intended reader (the gaze), and the standpoint we write from (the pose) (Baker et al., 2019; Trisos et al., 2021). Actively considering these influences is a necessary start to the process of breaking down knowledge hierarchies in biodiversity research, and challenging the way we know the world from our own critical thought and reflexivity (Idahosa and Bradbury, 2020).

The authors of this article reject the notion that researchers are neutral actors in knowledge production (Abimbola, 2019; Green, 2020; Trisos et al., 2021) and describe our positionalities at the end of this article. As outlined in Section 7 our positionalities, and thus our understandings of and approaches to biodiversity governance, are influenced by varied geographical contexts, institutions, disciplines and lived experiences. Although many of us work with Indigenous and local communities as co-researchers and collaborators, we do in no way represent Indigenous and local knowledge systems of those we are not directly part of ourselves. The authors speak as representatives of the One Ocean Hub, which is based in Scotland, and various authors also work from, and are located in the Caribbean Island of Barbados, Ghana, Namibia, South Africa, Tasmania and the United Kingdom. However, a majority of authors were educated within Western University institutions, or institutions whose curriculum was founded on Western pedagogy, which will influence the knowledge hierarchies we are exposed to, and consequently impact how we approach ocean biodiversity governance research.

1.2 What is a knowledge hierarchy?

1.2.1 Knowledge and knowledges

Knowledge refers to the awareness, understanding or information about something, either gained through lived experiences, through social processes or formal education. Knowledge systems, defined as “bod[ies] of propositions that are adhered to, whether formally or informally, and are routinely used to claim truth” (Díaz et al., 2015), are related to complex governance arrangements, with knowledge embodied by the actors that can support or undermine the development of knowledge processes (van Kerkhoff, 2013). These established knowledge governance structures facilitate social hierarchies that remain and proliferate through global governance forums and practices, exacerbating existing inequalities through the perpetuation of Western-oriented knowledge systems. Typically, (in Western paradigms of education and their enduring legacies), knowledge is seen as an individual intellectual meaning-making endeavour, something we amass in ourselves over time. Yet, African feminist theory for example, challenges this individual and predominantly cognitive framing of knowledge, and sees it as also embodied; spiritual; always political; and oriented towards the collective (Wane, 2008; Ntseane, 2011; Moletsane, 2015), thus countering science as an objective and individualistic practice.

1.2.2 Knowledge hierarchies

A hierarchy refers to a systematic organisation according to perceived authority or status. Knowledge hierarchies can therefore be understood as the systematic ordering, ranking, valuation, and production of knowledges according to their perceived authority, legitimacy or status (Foucault, 2002; Jasanoff, 2004; Ndofirepi, 2017). The formalised hierarchisation of people in knowledge production was initiated during what is known as the ‘Enlightenment’ era in seventeenth- and eighteenth-century Europe, in order to justify asymmetrical power relations and order the world from “the

perspective of male Eurocentric consciousness” Fabian (1983). The legacy extending from this persists today and influences perceptions of what is considered legitimate knowledge production and “disqualifies, omits and devalues certain knowledge” (Said, 1993; Alatas, 2003; Escobar, 2007; Ndlovu-Gatsheni, 2013; Strand, 2022). Accordingly, for this article, we adopt the term knowledges as plural, to avoid perpetuating the idea that there is one universal knowledge built on one universal culture (see Mignolo, 2000), and recognise the differences between knowledge types (Smith and Sharp, 2012; Molnár et al., 2023).

The theory of situated knowledge describes the ways in which hierarchies amongst knowledges have been constructed, particularly accounting for the ways in which gender, class, geographies and race impact knowledge production and circulation (Hill-Collins, 1990; Harding, 2013; Haraway, 2016a). In proposing that all knowledge is “situated” or “located” within specific social, cultural, historical, and individual contexts, the theory challenges the idea that knowledge can be objective, neutral, or universal. Instead, our understandings of the world are shaped by personally held vantage points, influenced by factors such as gender, social class, race, ethnicity, and other dimensions of identities and experiences. Class-based and geographic disparities, for example, manifest in various ways within knowledge production (Ndlovu-Gatsheni, 2013; Ndofirepi, 2017). Formal academic knowledge, which often requires years of costly and specialised University training, is typically valued over different forms of knowledge such as experiential or Indigenous knowledge systems, and global rankings of academic institutions continue to give disparate influence to Western elite Universities in wealthy economies (Ndofirepi, 2017). This reverence imposes a hierarchy that not only devalues certain types of knowledge, centres the individual and excludes collective or collaborative intelligence, but also systematically excludes specific knowledge systems and worldviews.

In developing and writing this article, we (the authors) have expanded on the understanding of knowledge hierarchies available in existing literature. Agreement on a definition was challenged by divergent views (detailed in Supplementary Material). Whilst some authors understood knowledge hierarchies as the act of assessing knowledges, others understood knowledge hierarchies as a perpetuating social “structure” resulting from past and current political and social influences on knowledge production and sharing. The agreed definition of knowledge hierarchies as it relates to marine biodiversity governance was synthesised as:

The categorization of knowledge based on its perceived value and legitimacy as is created and perpetuated by social structures and power dynamics, influencing its use and recognition.

Our discussion is therefore based on a collective perspective that knowledge hierarchies exist in society as a result of degrees of authority to different types of knowledge, assigned through processes that are shaped by historical political, economic, gendered and contextual contemporary priorities. These knowledge hierarchies influence and erode parity within biodiversity governance structures, as they define the rules of

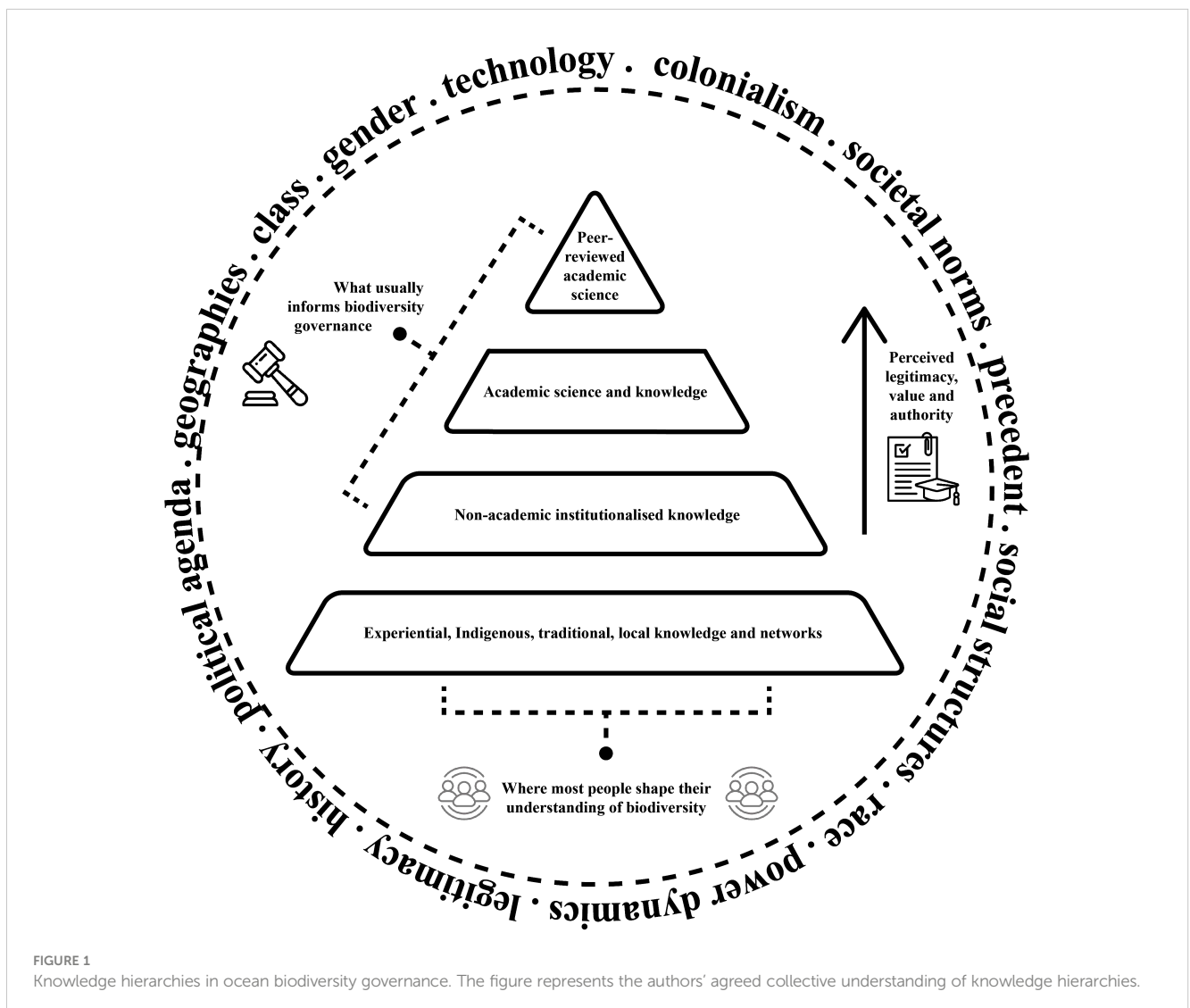
engagement in social and political processes, determining which sectors influence and shape decision-making and those that do not (Figure 1). Here we explore the historical and contemporary processes and influences that create and reinforce knowledge hierarchies in ocean biodiversity governance and research, and their consequences. Following this, through an examination of disparate case studies featuring oceans governance we seek to illuminate ways that knowledge hierarchies can be challenged by those engaged in and with research.

2 Knowledge for biodiversity governance

2.1 The professionalisation of marine science and the alienation of nature

The embedded coloniality of knowledge within ocean biodiversity governance research can be traced to the very beginnings of modern marine environmental sciences.

Oceanography, limnology, fisheries science, and related marine sciences emerged as professionalised sciences in the nineteenth and twentieth centuries, becoming institutionalised through the establishment of research laboratories, predominantly in Europe and North America. While first focused on surveying, classifying, and cataloguing the maritime world, often in service of imperial powers which required intimate knowledge of the oceans, these sciences were soon fundamental to proactive attempts to conserve and regulate the exploitation of marine populations and environments (Rozwadowski, 2004, 2013; Hubbard, 2006; Reidy, 2008; Finley, 2011; Reidy and Rozwadowski, 2014; Adler, 2019). This occurred within the context of, and was intrinsically entangled with, Western imperialism and went together with efforts to ‘optimise’ the use of marine environments throughout the world. While histories of marine science have tended to focus on the North Atlantic, where major international organisations including the International Council for the Exploration of the Seas (ICES) were predominantly focused, these developing sciences were also fundamentally shaping—and were shaped by—parallel attempts to order and regulate water bodies throughout both domestic and



colonised territories (Anker, 2001; Rozwadowski, 2002; Jennings, 2011; Breitinger, 2022). This encouraged the creation of research institutions across empires staffed with technical experts leading research programmes that were intended to inform the efficient exploitation of marine resources and, especially, fisheries (Jennings, 2011; Breitinger, 2022).

Through this process, scientists became, and continue to be, perceived as an intellectual elite capable of ‘knowing’ nature better than ‘others’. Through methods of data collection and analysis they maintain their position of power as those best placed to understand the natural world. The emphasis of detached objectivity within scientific methods, in which a rational observer investigates the material world without implicating themselves in what is being studied, also works to create a detachment of humans from nature (Morton, 2009). Nature becomes an entity separate from humans, that is a subject for objective study and manipulation (Barad, 2007). This continually reinforces a worldview where humans are separate from and superior to their environment (Drayton, 2000; Clarke, 2007; Adas, 2014; Haraway, 2016a, 2016b). Biodiversity, for example, is often assessed in terms of its ecosystem services and the benefits provided to humans like clean air, water, and soil fertility. While this perspective recognises the inter-dependence of humans and nature, it still places human utility at its centre (Muradian and Gómez-Baggethun, 2021). Accompanying this is the tendency in some scientific disciplines to reduce complex systems into more manageable components for easier study. Such an approach has been criticised by scholars in science and technology studies for valuing the efficiency of studying individual components over the interconnectedness of natural systems and humans – which is arguably much more difficult (Keller, 1995; Jasanoff, 2004). This form of scientific objectivity is also used to sustain knowledge hierarchies, where science dominates discourses of nature due to its claim to objectivity in comparison to different ways of knowing that are seen to provide only subjective knowledge or perspectives (Haraway, 2016a).

Fundamental to the contemporary dominance of scientific knowledge is that states have looked to science to inform and reinforce their own claims to authority over the natural world. In doing so, they have helped to enshrine scientific knowledge and, therefore, scientists as the elite voice concerning the natural world (Mukerji, 1989; Gascoigne, 2019; Oreskes, 2021). Governmental patronage has been fundamental to the rising reach and power of natural science in centralised biodiversity governance, just as science has been fundamental to the rising reach and power of governments (both domestically and internationally through imperial and neo-colonial expansion). This is not to suggest that biodiversity research has been beholden to governments or that governments have dictated scientific research agendas. Yet, governmental patronage and funding, especially from the mid-nineteenth century onwards, has played a significant role in shaping both the trajectories of scientific research and in elevating the scientific voice as the central authority on matters of nature (Mukerji, 1989; Gascoigne, 2019; Oreskes, 2021). As Mukerji (1989) and Oreskes (2021) have emphasised in their separate studies of the history of oceanography, the question of who funds scientific research is important as this not only creates opportunities that enable scientists to conduct the work that they

want to do but also shapes what research is not prioritised due to the limits of funding. While funding did not confine scientists to specific practical concerns of the state, it did shape the availability of finance for research surrounding subjects that concerned governments.

It is well recognised that the trajectories of science are highly influenced by economic agenda, and the priorities of both funders (Oreskes, 2021) and those undertaking the research (Thorp, 2023). This has played an important role in shaping what we know and do not know about the oceans. This influence sits uncomfortably with the perception that scientific research is autonomous and ‘pure’ particularly since the autonomy of science and scientists is also fundamental to the cultural authority of scientific knowledge. The authority that states seek to exploit to reinforce its own claims of authority over nature.

This is not to question the value or importance of normal science such as the natural sciences, which is critical to informing ocean biodiversity governance, but it is instead to highlight the embeddedness of science within broader governance processes that have constructed knowledge hierarchies to the detriment of other perspectives and knowledge holders. As Mukerji (1989) states, “the power of science lies less in what scientists tell the government than in the cultural authority of science as an institution ... it is this cultural authority that makes science so useful to the government.” This is achieved through the process by which governments make use of scientific rationales to inform myriad decisions and policies while, crucially, also justifying these decisions (Mukerji, 1989). In doing so, governments expropriate the voice of science, calling on the cultural authority of the scientific voice to legitimise its own activities. Crucially, there is not a universal scientific voice but, instead, governments can make use of the voices of scientific advisors that align with their agenda while ignoring the voices of those at odds with this. The importance is not in the truth or veracity of these voices but, instead, in their perceived cultural authority and autonomy.

2.2 Ventriloquising knowledge within governance

The scientific voice is simplified and ventriloquised – i.e. expropriated and/or reproduced to meet a particular goal – by governments to support and legitimise their decisions over nature. It is this seeming reliance on the scientific voice that provides the justification for governments to act as custodians over nature, as it is governments who have privileged access to this scientific knowledge through their patronage and authority. In the process, the dominant cultural authority of the scientific voice becomes further embedded through its centrality to governmental policies (Mukerji, 1989; Gascoigne, 2019). As it is (some) scientific knowledge that is constructed and exploited as the best possible source of information surrounding the natural world, different knowledges are then neglected or undermined as these are not so readily absorbed within or aligned towards governmental frameworks. This is especially true within the parallel contexts of centralisation and colonisation, in which the scientific voice was regularly used to provide justification for imperial rule through the language of

‘improvement’ and ‘efficiency’ (Drayton, 2000; Tilley, 2011; Ross, 2017; Oba, 2020). Where Oreskes (2021) states that “every history of science is a history both of knowledge produced and of ignorance sustained” it is important to also recognise that there is often a history of knowledge *ignored* and *suppressed* too.

Historically, domestic and colonial marine research programmes were led by amateur and professional scientists and relied heavily on the knowledge and observances of marine and coastal communities, and who were best informed of the surrounding marine biology and oceanography (Hubbard, 2006; Jennings, 2011; Jones, 2018; Silver et al., 2022). This was a process in which people who lived with the ocean engaged in intellectual conversation with researchers, leading to the exchange and co-production of knowledge. Yet, these marine and coastal communities were constructed as ‘informants’ in service of scientists and technical experts rather than intellectual agents in these exchanges each with their own realities and perspectives that were deeply rooted in place and experience. The embodied knowledge of these ‘informants’ was then enfolded into methodologies of normal science, scientific reports and recommendations, not only separating this knowledge from its source but also employing this knowledge to inform decisions in forums where the voices of knowledge holders were fundamentally excluded (Tilley, 2011; Jones, 2016; Mavhunga, 2018). Even as they were informing scientific research in both colonial and domestic settings, marine and coastal communities were portrayed by decision-makers as ill-informed and driven by self-interest, so that only ‘rational’ environmental management informed by technical experts and led by governmental agencies could provide for the ‘optimum’ exploitation of marine environments. In some global south contexts, these management systems were conflated with more sinister political racist systems of spatial management excluding communities from their traditional access to the ocean (Francis and McGarry, 2023).

The parameters of what entailed ‘optimum’ usage was also determined by the priorities of domestic and colonial governments, often relating to uncertain or arbitrary targets that were set without the necessary data or even the capacity to collect the data that supposedly underpinned such targets. In the process, governments perceived and constructed themselves as the ultimate custodians and stewards of marine environments, capable of making the most informed and rational decisions surrounding marine environments through a reliance on scientific research (Chirwa, 1996; Drayton, 2000; Clarke, 2007; Jennings, 2011; Breitinger, 2022). This underpinned the construction of systems—legal, political, economic, institutional, and educational—that empowered governments to assume and monopolise the rights to control and make decisions over water bodies (Anker, 2001; Tilley, 2011; Wilson, 2021; Breitinger, 2022). It is important not to overstate the efficacy of these processes, as governments regularly proved unable to manage marine environments in practice so that a pluralism of management regimes and knowledge systems remained—and remains—in practice (Beinart, 2000; Hodge, 2011; Jennings, 2011; Mbatha, 2018).

The development of ‘evidence-based’ ocean biodiversity governance and marine sciences worked to construct and embed

knowledge hierarchies within both ocean governance and ocean governance research by the mid-twentieth century whereby marine and coastal communities were excluded from decision-making processes (Tilley, 2011). This enabled governments to tighten their control of natural resources at the same time that “ecologists enlarged their system of global knowledge at the expense of local knowledge” (Anker, 2001). Local knowledge was central to the development of global scientific knowledge of marine biodiversity, but it was extracted, undermined, and relegated in the process. In some cases, their knowledge was weaponised against them, to inform oppressive fortress conservation systems.

2.3 Defining biodiversity for governance

Conceptually the definition of biodiversity (previously termed biological diversity) which is most commonly applied in marine science and ocean governance is that provided in the Convention on Biological Diversity (CBD) “*the variability among living organisms from all sources including ... diversity within species, between species and of ecosystem*” (CBD, 1992). The Convention is widely endorsed globally, but the political popularity during the 1990s of the field of conservation biology in the Global North perpetuated the widespread uptake of the term with its explicit goal of conserving biodiversity against increasing human pressure and to promote sustainable use and benefit sharing (Sarkar and Margules, 2002). Diversity in this context is understood to be essential for the resilience of natural systems to change or pressures (Mace et al., 2014). In describing “the variety of life” the term encompasses the full complexity of ecological systems and the relationships between and among organisms from molecules to systems (Sarkar and Margules, 2002). While the CBD intended to promote understanding of the interdependence of humans and nature within governance, in practice, the operational definition of biodiversity remains capricious and is often criticised as poorly encapsulating the ways in which human and non-human actors co-create diverse ecosystems and adapt to changing environmental conditions (Tsing, 2009).

The reverence of science-informed, or ‘evidence-based’ decision-making necessitates that the concept is simplified so that biodiversity can be measured, particularly in marine systems where ecological knowledge is inherently uncertain (Pascual et al., 2010). This simplification is guided by government priorities and applies the use of biodiversity surrogates that represent a simplified measure of biodiversity, to demonstrate changes (Mellin et al., 2011; McQuatters-Gollop et al., 2019). The definition of biodiversity surrogates creates “*new natures*” (Sullivan, 2013) that allow for biodiversity to be ‘seen’ within existing governance (and economic) frameworks and meet the needs of users in terms of ‘evidence’ (Robertson, 2006). In operationalising biodiversity, these practices determine commensurability to support exchange and substitutability that legitimise its use and degradation through compensation and offsetting or to further accumulation so actors can capitalise on “opportunities of environmental crisis and conservation” (Sullivan, 2013; Sullivan and Hannis, 2017). In doing so, this use of science to justify biodiversity’s use distances

the commodity being traded from its physical form and all its inherent complexity and does not readily recognise the “inextricable link” between biological and cultural diversity (Cocks, 2006; Robertson et al., 2014).

The term “biocultural diversity” has been used more frequently to denote this link, primarily in reference to Indigenous traditional communities, but there is potential for its broader application within biocultural discourse (Cocks, 2006). Literature suggests that social groups should be able to choose and define their own bio-cultural diversity (Belay, 2012) and that this flexibility is important to appropriately incorporate cultural and religious values into biodiversity conservation and research and close the growing divide between biodiversity and large sections of society (Escobar, 1998; Cocks, 2006).

2.4 International marine biodiversity governance

Despite a broad understanding of the ocean as a common resource i.e. a “shared resource [with] a defined community that devises protocols, norms and values to manage it” (Rudolph et al., 2020), ocean governance is inherently fragmented by sector. The framework of the 1982 United Nations Convention of the Law of the Sea (UNCLOS) has been the primary forum to address integration of ocean governance, supported by the CBD (1992) and the other Rio Earth Summit instruments (UNGA, 1992), which promote an ecosystem approach for sustainability that embedded the varying ways that people valued nature (Morgera and Razzaque, 2017). Despite this, fragmented and exclusive forms of governance of the ocean have continued to marginalise those most vulnerable to biodiversity loss, which has continued on a trajectory of decline (IPBES, 2019; Tessnow-von Wysocki and Vadrot, 2020; Tolochko and Vadrot, 2021; Erinoshio et al., 2022).

In recognition of these trends of decline, calls for the transformation of ocean governance to meet the interlinked demands of sustainability and justice have increased (Strand et al., 2022a; Lombard et al., 2023). The United Nations Conference on Sustainable Development in Rio de Janeiro in 2012 set out a pathway to do this, which finds its most recent expression in the Sustainable Development Goals (SDGs) and yet have still been limited in their influence (Biermann et al., 2022). Another notable action is the United Nations Decade of Ocean Science for Sustainable Development that prioritises the co-design and co-delivery of solution-oriented research and recommends co-design of “transformative science carried out by diverse actors will contribute to sustainable development” and promotes a spirit of inclusivity and openness for transformation through knowledge production and use (IOC-UNESCO, 2021). In support of this transformation, the Ocean Decade has a cultural framework programme that recognises Indigenous knowledge as important to transform ocean sciences and conservation, and encourages support for action (Febrica, 2023).

Furthermore, in the recent Agreement under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond

national jurisdiction (the BBNJ Agreement or High Seas Treaty) (UNGA, 2023), a mandate to respect, promote and consider the rights of Indigenous Peoples and local communities “when taking action to address the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction” was outlined to cut across all aspects of the Agreement (Article 7 of the BBNJ Agreement). Whilst current ocean biodiversity governance still suffers from a legacy of sectoral division, its evolution to one that reflects the multiple values held by society and effectively supports biodiversity health is increasingly on global political agenda.

2.5 Integrating Indigenous and local knowledge(s)

It is widely acknowledged in the literature that bridging or integrating knowledge systems is not easy, however, the challenge of ensuring such knowledge is appropriately considered and incorporated are often less appreciated or acknowledged. Recognising these challenges is important as optimistic visions of knowledge integration can obscure differences between actors and reproduce hierarchies between scientists and local communities in the negotiation of practice and policy (Nadsady, 1999). It is important that technical questions of compatibility and integration do not diminish focus on the ethical and political dimensions of integration practice (Nadsady, 1999; Green, 2009).

The value of Indigenous and local knowledges, including the context, values, and cosmological context within which that knowledge sits (Brosius, 2006), is increasingly recognised as essential for the sustainable management of social-ecological systems. However, there are concerns that in many cases knowledge integration can form a box-ticking exercise and perpetuate historic trends of marginalisation (Wohling, 2009; Green, 2012; Rivers et al., 2023). Research methods often do not involve knowledge holders in research design or analysis and are rarely considered as researchers pursuing their own research questions informed by their own world views (Chilisa, 2017). There is also a tendency to transpose Indigenous and local knowledges into the norms of Western-oriented natural science to fit with demands of Governments (Rivers et al., 2023). Such processes commonly aggregate, abstract and alienate knowledge from its holders (Berkes et al., 2000; Latulippe and Klenk, 2020) and assume a lack of interest of knowledge holders in outputs (Mosimege, 2017; Muhl et al., 2023).

Hierarchies are further imposed via demands for the ‘proof’ of credibility and validity, or even existence, of Indigenous and other diverse knowledge types to science and decision-making before inclusion and integration (Bohensky and Maru, 2011). This disparity is even evident within recent legal developments such as the BBNJ Treaty where consideration of Indigenous knowledge is caveated to apply only “where relevant” (UNGA, 2023). This is despite the often-foundational importance of these knowledge forms for the wellbeing of the communities within which they are held (Latulippe and Klenk, 2020). Demands of proof are rarely placed on natural or normal science from holders of various

knowledge types (Moller et al., 2004) and this disparity highlights the often-supplementary status afforded to such knowledge in practice.

3 Seeking transdisciplinarity for transformation – The One Ocean Hub case studies

There is a growing acknowledgement that a transformation of governance globally is necessary to avert the biodiversity and associated human rights crises. The required transformational change necessitates a “fundamental system-wide, reorganisation across technological, economic and social factors” (IPBES, 2019) away from the “technocratic and regulatory fix of environmental problems to more fundamental and transformative changes in social-political processes and economic relations” (Visseren-Hamakers and Kok, 2022).

Transdisciplinary, often defined as research that transcends academia to work with non-academic collaborators in knowledge co-production, is thought to be essential for a transformation that addresses the biodiversity crisis through solutions that bridge the divide between science and society (IOC-UNESCO, 2020; Strand et al., 2022a). The UKRI GCRF funded One Ocean Hub responds to this need directly, having been developed on the premise that research and the challenge of transdisciplinary research can act as a precursor to changes in decision-making¹. The One Ocean Hub is guided by a Code of Practice (One Ocean Hub, 2022) developed by project researchers and partners. This expanded on the requirement of the funder (UKRI) to articulate the project's processes of problematisation of both research and ethical research practice (Snow et al., 2021). This problematisation process (work package zero) remains ongoing and seeks to address issues of power and capacities in the project countries to co-define matters of concern, to ensure that research is challenge-driven, and benefits shared appropriately. In essence, the model of the One Ocean Hub has sought to tackle knowledge hierarchies, through understanding that transdisciplinarity requires a foundation based on communication across actors and an explicit acknowledgement that translation can reduce, diminish or subjugate knowledge. Crucially, this Code of Practice has recognised that meeting the challenge of transdisciplinarity will likely involve discomfort as knowledge systems are challenged and reorganised to allow for transformation to occur.

With the One Ocean Hub comprising researchers from varied geographies, across several different fields and disciplines within a broad understanding of marine science, ocean management and governance, there is significant diversity in approach to the project's objectives. The case studies that follow briefly present some of the divergent ways One Ocean Hub research from diverse geographic regions and research contexts is responding to knowledge

hierarchies within ocean biodiversity governance. They highlight examples of how gender gaps in ocean governance have been narrowed, the power of ocean literacy in amplifying the voice of “future generations”, the opportunities that natural capital approaches provide for surfacing diverse knowledge types, the invaluable role of intergenerational knowledge sharing, and the innovative way that arts-based approaches can tackle knowledge hierarchies.

3.1 Case study 1: empowering women to address knowledge hierarchies in small scale fisheries in Ghana

3.1.1 Background

Research has critically examined how culturally gendered roles influence marine biodiversity and ocean governance approaches in Ghana, and the empowering potential of more inclusive approaches. Across the diverse fishing communities of Ghana, there remains a strict gendered division of labour, in which men are predominantly employed in activities of fish-harvest, and women are employed in the post-harvest processing, including salting, smoking, freezing, and drying, and sale (Ameyaw et al., 2020). Women also play critical roles in pre-fishing activities, including pre-financing fishing expeditions of men (in cash and ‘in-kind’) such as through supplying fuels (Golo et al., 2022). At a community level, women's control over post-harvest activities means that they hold considerable knowledge of the small-scale fishing sector and can exert considerable influence over local economic fishing efforts. This knowledge and influence, however, continues to be underrepresented within both customary and formal fisheries governance processes in Ghana across all levels.

3.1.2 How research challenges knowledge hierarchies

This research sought to understand both the processes and extent to which women are disadvantaged in the small-scale fisheries sector and the mechanisms that explain these inequalities by using different methods of data collection, including legislative review, one-to-one interviews, and focus group discussions.

Legislative review revealed that state-led systems of marine governance tend to favour centralised governance frameworks, and this is underscored in the State's Fisheries Act (Ministry of Fisheries and Aquaculture Development, 2002). The Act establishes a Fisheries Commission and tasks it with sole responsibility to regulate and manage the utilisation of fisheries resources, including the development of fisheries management plans based on ‘best scientific evidence’. The legislation, however, fails to acknowledge existing customary knowledge systems, comprising customs, practices, and knowledge unique to the ethnic groups engaged in small-scale fishing. This arrangement that privileges statutory knowledge systems derives from the country's previous colonial state (Golo et al., 2022) and contributes to the marginalisation of local knowledge systems. For example, small-scale fishers are insufficiently represented on the Fisheries Commission Board which the Fisheries Act has established. The board includes only

¹ https://oneoceanhub.org/wp-content/uploads/2021/04/Policy-brief_FINAL_AAA.pdf.

one small-scale fishing representative that is actively involved in fish harvest. This constrained representation means that the voices (and knowledge) of women are lost in the statutory governance framework of marine biodiversity despite the significance of their role. This effectively marginalises the voices and perspectives of small-scale fishers from formal decision-making processes. It also means the state-led knowledge systems prioritise harvest activities (i.e. fishing) over pre- and post-harvest activities (Overå et al., 2022). Furthermore, customs and traditional gender divisions undermine women's participation in informal decision-making structures, which in turn undermines women's property rights and accumulation of financial capital, and thereby increases the poverty experienced by women (Torell et al., 2019).

The foregoing legislative and literature reviews were evaluated using field-based works to examine the perspectives of fisheries participants across the three-value chain system, including pre-fishing, fishing and post-fishing activities. The techniques of data collection included one-to-one in-depth interviews but also focus group discussions. Both methods considered gender issues, including organising interviews and focus group discussion with women separately from those of men. This segregation was intended to empower and enable women and men to confidently explain their respective views.

The meta-evidence obtained from integrating the findings of these interviews and focus group discussions with the legislative and literature reviews was used to organise four community workshops aimed at educating and empowering women on the effects of exclusions of their knowledge systems in both formal and informal fisheries decision-making processes. The workshops often had 30 to 40 participants and involved presentations, cultural displays and group works in which women worked with women to solve specific gender related fisheries problems. Importantly, these workshops included law clinics, where participants who had specific issues could seek legal advice from facilitators with legal expertise. This enabled a reciprocal exchange of knowledge and expertise between workshop facilitators and participants. The diversity in participants was reflected in their ages, level of education, years of experience in fisheries, and as members and leaders of different fisheries associations. Participants included women leaders known locally as *Konkohemaa* or rather *Queen Fishmongers*, and those who play senior roles in established small-scale fisheries associations, especially the *National Fish Processors and Traders Association*.

Across the workshops, attention was placed on emphasising women's crucial roles within the fisheries sector and how this could inform community, national, and international fisheries decisions. For example, the fieldwork studies demonstrated clearly that women tend to lack appreciation of their economic power in fishing, both as lead actors in post-harvest and pre-harvest activities, in which they constitute the primary financiers of fish-harvesting activities. The workshops often built on these insights, including presenting participants with different scenarios to evaluate their contribution to the sector. This included how women could be heard and engage other stakeholders in the sector with their respective knowledge systems.

Women were supported to build social networks, share knowledge, and appreciate the value in their own insights,

expertise, and contributions. In doing so, women were empowered to use their expertise to influence fishing activities to demand accountability from duty bearers to facilitate the equal participation and inclusion of women in fisheries governance. This empowerment is crucial to embrace a vital source of knowledge within the small-scale fisheries sector, particularly surrounding the financing, processing, and selling of harvested fishes.

3.2 Case study 2: conceptualising ocean literacies informed by children to challenge knowledge hierarchies

3.2.1 Background

Co-Investigators of the Hub have critically examined how decision-making on marine biodiversity and ocean governance approaches continue to impact children's lives, particularly their rights to development and culture (Strand et al., 2023), which continue to get limited consideration. This involves a recognition that the importance of marine biodiversity and sustainable marine governance are understood differently in different contexts, and that current understandings of sustainable development as dominated by the UN sustainable development goals (SDGs) may not be as contextually relevant in all children's lives (Strand et al., 2023). In practice, this approach would mean centring children's rights to be heard in ocean and marine biodiversity decision-making and ensuring that marginalised children in vulnerable contexts are provided equitable opportunities to share their views (Shields et al., 2023).

3.2.2 How research challenges knowledge hierarchies

A desktop analysis, applying a critical environmental justice approach to existing human rights guidelines and international legal discourse, coupled with participatory and arts-based research with children and youth in South Africa and the United Kingdom, finds that children are dependent on the ocean for their rights to development and culture. For example, for children and youth in South Africa, a healthy ocean is deeply intertwined with Indigenous and local knowledge systems, spiritual connections and cultural heritage (Strand et al., 2022c; McGarry, 2023). These connections are further recognised in the recent Decision of the Human Rights Council in the Torres Islanders Case, where the right to culture as fundamental when considering the links between climate and the ocean particularly with respect to traditional values, food sovereignty and inter-generational equity (Lancaster et al., 2024). Despite these increasingly recognised interdependencies, children's rights to culture are largely overlooked in both international and national marine biodiversity research and ocean decision-making processes such as the Agreement on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction (ABNJ), and the linkage between culture and the environment is scarcely mentioned in the UN General Comment 26 (UN CRC, 2023) on children's rights to a healthy environment. This lack of recognition can be attributed to existing knowledge hierarchies on marine biodiversity, and whose values,

priorities and knowledges are informing guidelines, processes and decision-making.

Thus, focusing on ocean literacy as the increasingly recognised ‘solution’ to better decision-making and science to inform global ocean governance (IOC-UNESCO, 2020), Hub researchers are calling for critical ecological justice approaches to ocean literacy programmes to better recognise how children’s rights to development, culture and wellbeing are dependent on healthy marine ecosystems and a healthy ocean. Ocean literacy can simply be defined as ‘an understanding of your influence on the ocean, and its influence on you’, or understood as a complex and adaptive concept that involves several dimensions such as awareness, access and experiences, emotional connections, and knowledge (McKinley et al., 2023). A challenge to this approach is ‘future’ oriented and focused framings for children’s work in environmental policy, as placing the burden of the ‘future’ onto children has shown to cause a huge level of anxiety and eco-grief. We therefore need to prioritise children’s opportunity to, rather than their responsibility to participate (Strand et al., 2023).

Acknowledging that the increasing focus on ocean literacy in schools and curricula continues to perpetuate and promote ‘awareness’-focused didactic and Western positivist natural science perspectives of marine biodiversity and ecosystems (UNICEF, 2018; Strand et al., 2023), Hub researchers are re-imagining and decolonising ‘ocean literacies’ embedded in contextually relevant education tools that better recognise the multiple ways of knowing, valuing and understanding the ocean. Examples from South Africa include how the ocean is sacred, as it is the resting place of the ancestors, and how the ocean can provide both spiritual and physical healing (Strand et al., 2022c; McGarry, 2023), which is currently not reflected in ocean literacy programmes such as the UNESCO Ocean Literacy Toolkit (Santoro et al., 2017). To better reflect a plurality of ocean knowledges, Hub researchers have identified key priorities to reimagine ocean literacies to ensure that marine biodiversity and governance is informed by different cultural realities and lived experiences. These include i) context-specific approaches to ocean literacies, which are informed by specific ocean knowledges, cultures and dependencies, ii) emphasising equitable participation and vernacular access, ensuring children can participate through a variety of platforms, languages and modalities to share their hopes, fears and dreams for the ocean, and iii) encouraging programmes ‘created by children for children’ (Strand et al., 2023).

3.3 Case study 3: natural capital and the deep sea: Developing a framework to make all knowledge visible

3.3.1 Background

There is growing interest in both the protection and the potential economic opportunities of Areas beyond national jurisdiction (ABNJ), those areas of the ocean beyond State’s economic limits of 200 nautical miles (Van Dover et al., 2017; Levin et al., 2023; Morgera et al., 2023; Vrancken, 2023). Ecological understanding of these regions is highly uncertain, yet we know that

as part of the global ocean ABNJ are critical to thriving societies (Niner et al., 2024). This radical uncertainty challenges the appropriate integration of knowledge and information that represents all human-ocean and marine biodiversity relationships. One Ocean Hub research responds to the risks presented by radical uncertainty and historic precedent in terms of what evidence is viewed as legitimate and acceptable for inclusion in decision-making.

3.3.2 How research challenges knowledge hierarchies

Our research makes use of a natural capital approach. Natural capital approaches describe the elements of nature that directly or indirectly produce value for people. They describe the full ecological system with ecosystem services linking benefits that people experience to the foundational building blocks of the system – biotic (species, habitats) and abiotic (water column, substrate) natural capital assets. While the determination of nature as ‘assets’ is critiqued as perpetuating a utilitarian (or capitalist) standpoint, the approach seeks to demonstrate that these assets provide benefits in the absence of human input (or other capital investment) and that these benefits are elementary to human wellbeing and thriving societies (Costanza and Daly, 1992; Mace, 2019). Natural capital approaches are also inherently flexible and can provide space for different knowledge types and connections far beyond those signalled by attempts at utilitarian valuation. This flexibility supports a richer description of human-nature connections even when data is limited.

Natural capital approaches allow us to explore the system, using all available knowledge to understand who and what may be affected by decisions and associated risks (Mace et al., 2015; Rees et al., 2022). For example, dependencies between assets and benefits can be made explicit even if constrained to a high level e.g. the biological pump crucial for climate regulation and habitable conditions globally implicate assets including but not limited to deep-sea sediments, the water column, fish stocks, and plankton. The relative importance of each of these assets remains poorly understood yet it is accepted that degradation of these stocks sets the ecosystem’s potential to deliver this benefit at risk, and that this risk increases as degradation accumulates.

Such approaches can push back against the hierarchies imposed by traditional modes of knowledge integration or ‘evidenced-based decision-making’ by making explicit the risks of trade-offs even where abilities to quantify these risks are constrained. In making these risks explicit, natural capital approaches can inform assessments of precaution within decision-making as mandated by multiple legal instruments that exist at all scales. Further, in making the risks associated with decisions visible, such approaches can democratise the governance of ocean biodiversity.

In demonstrating connections and risk within the system using all available data (La Bianca et al., 2023; McQuaid et al., 2023; Niner et al., 2024), our research challenges the norms that the only data that can drive precaution and constrain immediate economic extraction is quantified and statistically certain. The frameworks developed seek to change how uncertainty and risk are viewed in decision-making such that demands for precaution and protection of these important

regions are supported (Niner et al., 2024). As such, natural capital approaches may be perceived by some as perpetuating the current capitalist agenda through accepting normative decision-making protocols that diminish biodiversity and human-nature relationships to support cost-benefit analysis or exchange, viewing them as isolated systems. In seeking pragmatic change, such approaches adopt capitalist languages and structures in a bid to provide space, make visible and amplify all available knowledges that demonstrate human-nature and nature-nature connections. In adopting “*the master’s tools*” natural capital approaches perhaps do not seek a radical shift in governance and perhaps may never “*dismantle the master’s house*” (Lorde, 1984) and drive the transformative change needed for sustainable and just marine biodiversity governance. However, it is our aim as researchers, given the urgency of marine biodiversity degradation, to provide an effective platform that can include all available information regardless of certainty or ‘type’ that can drive change (and precaution) with immediate effect.

3.4 Case study 4: working with youth to promote the culture and knowledge of the Topnaar people in Namibia

3.4.1 Background

Namibia’s desert coastline extends for approximately 1,570 kilometres and is one of the most productive ocean regions of the world (Remmert, 2018). Amongst coastal communities the Topnaar community are a clan of the Nama group who belong to the Khoi-Khoi ethnic group (Mortimer et al., 2016). The Topnaar are amongst the oldest inhabitants of Namibia and the original Indigenous people of the Central Namib coast (Kinahan, 2017; Krämer, 2020). Historically, their livelihoods depended strongly on ocean resources, using Indigenous knowledge systems to sustainably make use of these resources (Kanyimba et al., 2021). The Topnaar people now reside in scattered communities along the Kuiseb River in the Namib-Naukluft National park about 60 km from the sea. The founding of the National park at the beginning of the twentieth century by the German colonial administration meant the complete loss of Topnaar land rights (Krämer, 2020). This lack of land rights is part of the reason why the Topnaar people are marginalised and live in precarious socio-economic circumstances. Loss of land rights subsequently meant loss of fishing resources which in turn affects income and food security for the Topnaar (Chan et al., 2019), alongside a loss of tradition including fishing methods such as shallow water spearfishing with oryx horns. The low social status of the Topnaar, low education levels and lack of strong political structures aggravate their socio-economic crisis (Dieckmann et al., 2013; Warikandwa et al., 2023). The Topnaar people now depend on locally foraged !nara melons and raising livestock (Mortimer et al., 2016). In recent years, the Topnaar community has possessed two tourism concessions, one in the Namib-Naukluft Park, and the other in the neighbouring Dorob National Park (Mortimer et al., 2016).

Through the emphasis on social inclusion in the constitution (Republic of Namibia, 1990) and aspiration of the fifth National Development Plan to maximise and equitably share economic

benefits from ocean resources to all Namibians (Republic of Namibia, 2017), there is a stated mandate to address marginalisation in decision making and blue economy policy development platforms. Governance reform that addresses the lack of Topnaar and other communities’ representation and participation in decision-making is noted as important to recognise marginalised communities’ rights and to enable them to benefit from the ocean economy (Kanyimba et al., 2021; Warikandwa et al., 2023).

3.4.2 How research challenges knowledge hierarchies

The One Ocean Hub has been using participatory research methods to engage the Topnaar people on their relationships, traditions and histories with the sea, and their involvement in ocean governance. Specifically, Hub researchers supported a youth project documenting intangible heritage, histories and ocean connections of the *Hurinin* (people of the sea) with their descendants within the Topnaar community.

A primary focus of the Topnaar youth project is the knowledge holders, Topnaar elders, who will share their recollections and experiences regarding the sea and associated cultural traditions. The community has been forcibly removed from the ocean, but carries many stories, mythologies, and memories, as well as customary traditions and material cultures, connected to the sea. In this context, the ocean lives in their memories and yearnings to return to it. This project brings together the sea, local culture and young people to explore ways of understanding sustainable ocean livelihoods. Critical to this research was the process of story collection by the youths involved. The process involved discussing personal accounts and enabled the development of understanding of Indigenous knowledge systems related to how they and their forefathers connected to the sea. This process was facilitated through fire events where youth sat around the fire with elders narrating and performing their stories, poems, songs and dances from the Topnaar Hurinin and which also celebrated and reinvigorated their culture that is slowly disappearing from living memories.

Intergenerational sharing of knowledge supports a continuation of cultural values and practices that allow the young people to relate to the coastal environment, its benefits and incentives to participate in coastal protection, and also to promote appreciation of diverse knowledge systems (Kanyimba et al., 2021). In turn, it is hoped that strengthening a sense of culture across generations will empower the marginalised community to influence decisions that will shape the future of ocean governance for equity.

3.5 Case Study 5: “The Blue Blanket”: How art can challenge knowledge hierarchies in court and classrooms

3.5.1 Background

The Blue Blanket (Empatheatre, 2021) is a thought-provoking short film created by the Empatheatre collective (Empatheatre, 2023), that emerged during the response against oil and gas giant Shell’s plans to explore for offshore fossil fuels within the South African Economic Exclusive Zone in 2021. Small-scale fishers and

other ocean defenders took Shell and the South African government to court for poor consultation, challenging how their Indigenous knowledge, cultural heritage and everyday livelihoods had not been considered in the various associated impact assessments. In addition to this, popular media and advocacy at the time was popularising the environmental concerns, and challenging narratives that rendered the ocean as a ‘resource’. Stories were dominated by soundbites from scientists and conservation organisations, yet little discourse was given to Indigenous concerns, and what this rush for fossil fuels in our ocean spelled for coastal communities livelihoods, culture, economic, and spiritual wellbeing.

3.5.2 How research challenges knowledge hierarchies

In response, public storytelling collective Empatheatre, worked with a traditional healer/performer (Mpume Mthombeni), a poet (Helen Walne), a composer (Braam du Toit), and an Educational sociologist/artist (Dylan McGarry) to respond to this blind spot, and obvious knowledge hierarchy, in popular media.

The film opens, with brief text outlining that the ocean, when spoken in traditional Nguni languages, such as Zulu or Xhosa is called “Ulwandle”. This word can exist within the same noun class as the word “Ubuntu”. Distinct to these Southern African languages, this noun class includes all concepts of ecological and social reciprocity, and phenomena in which our wellbeing is tied in with the well-being of others. Put simply, ubuntu means: I am, because we are (Mnyaka and Motlhabi, 2005). Thus, in the framing of the film, the preface asks, if a poem was to be written from the perspective of the ocean, it would be explained as a “We” and not an “I”.

The film continues to view the planned seismic survey for oil and gas, from the perspective of the collective web that is ‘ulwandle’. As such an entirely different paradigm is established, one in which the ocean’s wellbeing is seen through a sacred Indigenous knowledge perspective. The ocean is understood as a symbiotic assemblage that includes people and all-more-than-human and earthly materials. The ocean also asks questions to the viewer, questioning the ways in which decisions made about ‘us’, have been made up to that point.

Through its mesmerising visuals, poetic narrative and original musical score, “The Blue Blanket” surfaces an intersectional ecological framing of ocean justice in South Africa.² Notably, the film, within a few weeks, was seen by over 11 thousand people and shared across multiple social media platforms. The film became an advocacy and popular media generative theme that supported the testimonies and affidavits emerging from small-scale fishers and customary rights holders, and later was issued as evidence in a court case alongside these testimonies. The judges granted interdicts in favour of communities, effectively halting seismic surveys from Oil and Gas giant Shell (Sunde, 2022).

This legal recognition of the ocean’s sacredness, with a particular focus on its role as a dwelling place for ancestors,

represents an unprecedented shift in South African law, and in re-framing and re-articulating the value of the ocean and marine biodiversity. By acknowledging the customary rights and spiritual dimensions of citizens’ relationships with the ocean, these judges set a new legal precedent that can challenge current knowledge hierarchies around ocean knowledge in South Africa.

Finally, it is important to mention, the Blue Blanket film also calls into question current knowledge hierarchies in environmental education in South Africa, with most Ocean literacy dominated by marine science framings of the sea. The film is now being included in classrooms and curricula around the country, with new stories emerging almost daily, of teachers and lecturers using it in their classrooms.

4 Discussion

4.1 There is a need to re-balance how we engage with biodiversity

Ocean governance has evolved from a long history of colonisation and the interconnected development of normal marine science, and Western- and natural science-dominated biodiversity conservation. Western-oriented knowledge systems are seen as rational and objective approaches to environmental (and ocean) governance, with biodiversity framed within this as a global “asset”. The term “biodiversity” has evolved out of spatial-temporal and socio-political relations and is not universally applicable, and can be considered elitist, due to conflated relationships with settler colonialism and conservation (McGarry, 2023). Local, contextually rooted, knowledge remains central to the development of marine biodiversity knowledge. Yet such knowledge continues to be extracted from local places (and cultures) and relegated via processes of transposition to meet the demands of governance forums dominated by Western-orientated science that seek to base decisions on quantified and statistically certain information. This has led to abstract understandings of biodiversity, and fragmented governance approaches that, in a rejection of a post-normal framing (Funtowicz and Ravetz, 1994), do not adequately manage human impact on the ocean’s biodiversity.

Despite an officially recognised definition of biodiversity within governance at a global level, the case studies presented illustrate the varied ways through which biodiversity is conceptually engaged both within research and governance. These modes of engagement are influenced by the location and context of the research and researchers and:

- Highlights the influence of gendered roles on resource use (fishing) and ocean governance (Case Study 1).
- Reflects on the rights of children to engage with ocean governance in the context of their cultural realities and lived experiences (Case Study 2).
- Develops a tool aimed at enabling decisions relating to impacts on biodiversity while allowing for precaution in the face of uncertainty (Case Study 3).

² <https://www.youtube.com/watch?v=4UBublpCWuk>.

- Supports intergenerational knowledge sharing that values biodiversity for what it brings to the community (Case Study 4).
- Illustrates the ocean's intrinsic value and cultural meaning to local communities (Case Study 5).

Our case studies indicate that although the term “biodiversity” is not always explicitly referred to by communities, the importance of social-ecological systems in different cultural settings is common across all contexts. This finding highlights how the term “biodiversity” itself can perpetuate hierarchies if its use overshadows perspectives and concerns that are implicitly connected and/or depend on biodiversity yet do not directly engage with the term. Culturally sensitive, innovative and transdisciplinary approaches to research, like those described in the case studies, allow for the inclusion of different priorities and values in research and research-related outputs. In creating space for a more inclusive expression of priorities and world views, such approaches render these values visible to global governance forums and in doing so support their appropriate integration. The authentic co-design, co-development and co-delivery of innovative research can help dismantle hierarchies that currently exist in knowledge creation.

4.2 Research method selection is important to provide contextually relevant platform for knowledge

The case studies presented underline how the structures provided for the production, assimilation and visibility of knowledge are highly influential in addressing knowledge hierarchies. Common across all case studies was the creation of space for the inclusion of all voices to bring the various ways that humans ‘value’ biodiversity into relief, to demonstrate not only that these values exist but their legitimacy and significance to decision-making under existing and emerging international obligations. The various methodological approaches applied to this end are described within case studies and range from arts-based (Erwin et al., 2022; McGarry, 2023) to deeply sociological (Mbatha, 2018; Francis and McGarry, 2023; McGarry, 2023), legal (Shields et al., 2023; Strand et al., 2023) and to natural capital approaches (Niner et al., 2024). These methods present a spectrum through which often obscured or ignored relationships with biodiversity are brought to light. Also demonstrated is how simply providing the opportunity to contribute a view, or have your voice heard on a matter (particularly for marginalised groups) is only a very small part of a meaningful response to breaking down entrenched knowledge hierarchies. Invisible power dynamics are highly influential even when the right people are brought into the room. Accordingly a visible platform is the very basis of what is required, this should be accompanied by a set of research relations that acknowledge historical and ongoing injustices, that elevate marginalised knowledges, ensure participatory parity (Bozalek et al., 2020), that value multiple ways of knowing (Strand, 2023), and that are not primarily focused on science and research as a

professional endeavour. Furthermore, the differences between these case studies, including those where methodologies and philosophical groundings sit uncomfortably against each other, are a stark reminder that there will never be a single methodological approach through which to effectively address knowledge hierarchies. Despite often universally common issues arising from and perpetuating knowledge hierarchies in marine biodiversity governance, different contexts will require different approaches sensitive to the context within which research is taking place (Temper et al., 2019).

4.3 Knowledge co-production and transdisciplinary research approaches can challenge, create, and reproduce knowledge hierarchies

As the above case studies demonstrate, there are multiple knowledge systems that need to feed into ocean biodiversity governance. This, of course, is not a new finding. Over the past three decades, there have been increasing calls for greater engagement of different knowledge systems and worldviews across various aspects of ocean governance that are implicitly or explicitly linked to biodiversity (Díaz et al., 2018). Yet, marine scientists and policymakers regularly struggle to engage with knowledges that exist outside of the structures of conventional Western-orientated science. This includes difficulty engaging with varying disciplinary perspectives drawn from the arts and humanities as well as with the knowledges of ocean users and communities. Part of the reason for this is the way in which these sciences evolved following what Reid et al. (2021) refer to as a “utilitarian worldview where humans are in control of nature,” which is intrinsically connected to processes of colonisation and has come to be characterised by claims of objectivity that are able to reduce systems-to-be-governed to quantitative models created, controlled, and interpreted by specific groups of experts and governors (Jentoft and Chuenpagdee, 2009; Aguado et al., 2021; Silver et al., 2022).

While scientists acknowledge the uncertainty in the statistical models applied for ocean biodiversity governance, these are commonly seen to be based on the “best available evidence” of the time, which can be refined and verified as new data arises. Such evidence, however, largely refers to cultivated ‘traditional’ scientific data (Reid et al., 2021). Historical perspectives show that scientists have regularly drawn from and relied on local ecological knowledge holders to inform their understanding of marine spaces. Accordingly, the perceived value of today’s “best available knowledge” is founded on the unrecognised contributions of knowledge holders outside of the field of science. It is important that such history is explicitly recognised as it contests binary thinking around scientific and other knowledge-making traditions, which were (and are) not always as separate as is imagined through concepts of ‘modern’ and ‘traditional’ marine governance. The problem in the past has not been that scientists are unwilling to engage with various forms of knowledge or to co-produce knowledge with ocean communities. Instead, it is that such

co-produced knowledge has been folded into scientific reports and models that have been used to inform the creation and imposition of laws and policies over ocean and ocean users by external centralised orders without providing the space for input from situated knowledge holders in how their knowledge is used or what decisions are made on the basis of their knowledge (Tilley, 2011; Osseo-Asare, 2014; Mavhunga, 2018; Wilson, 2021).

More recent moves to ‘integrate’ other forms of knowledge beyond traditional scientific and technical data have in large part continued with this trend, in which knowledges that do not fit the ‘normal’ science mould have been taken and reshaped in attempts to fit into such moulds. This has reduced such knowledges to ancillary data to better inform scientific models and approaches for problems and challenges already set and defined by governmental or scientific research agendas (Walley, 2004; Etiegni et al., 2020). Such approaches can fail to acknowledge non-traditional scientific knowledge as being *more than* ecological knowledge, centred on place-based issues with specific contexts, histories, challenges, experiences, and interests. Extracting such data to integrate and ‘scale up’ into regional or national models or policies not only simplifies and homogenises such knowledge, smoothing the edges to fit more neatly within scientific models or to meet the specific criteria set by scientists or policymakers, but also fails to recognise the ‘living’ and ‘social’ nature of such knowledge and the ‘hybrid’ realities that these represent on the ground. Case study 3 which describes the development of a framework to include a holistic and varied range of biodiversity values of ABNJ shows how rich detailed description of these values and how they vary at a community, regional or national level is missed when representation at an International scale is required. While the framework developed can include and consider all available information, when decisions are required of the International ocean and the relationships of all society are needed to be captured that included will invariably be limited and therefore skewed to that which is easily accessible (as supported by the arts-based methods applied in case study 5) or more readily described. Case studies 1, 4 and 5, in applying research to a more specifically defined scale can offer this detail and clearly demonstrate how knowledge is held and lived by its holders. Such knowledge is not static or homogenous but instead is influenced by a range of effects and transformations that cannot be easily reduced to stereotypes of ‘modern’ or ‘traditional’ knowledge; instead, it is a mix of diverse knowledges that have been co-produced on the ground as communities, environments, technologies, economies, and governance structures have transformed over time. This then provides not only ecological knowledge but also context-specific economic, social, cultural, and political knowledge (Walley, 2004; Williams, 2017; Fischer et al., 2022; Msomphora et al., 2022). Such knowledge cannot be easily reduced and integrated into scientific models (often via quantification) that form the basis of decision making but, instead, constitutes an entire web of different knowledges that should not only inform decisions but that should also inform how problems are framed, what knowledge needs to be produced in order to address such problems, and to what end (i.e. who benefits) (Brugnach, 2017; Fischer et al., 2022).

Co-production provides one approach towards this more active engagement of different knowledge systems across research. As Cooke et al. (2021) describe knowledge co-production:

“is conducted collaboratively, inclusively, and in a respectful and engaged manner—from the identification of research needs to study design, data collection, interpretation, and application—with the idea of creating actionable science (i.e., knowledge needed to enable change and that inherently links theory and practice) and benefits to the partners involved.”

When approached meaningfully, co-production offers clear scope to challenge knowledge hierarchies by providing the space to collaboratively set objectives and research activities while also interpreting the data from different perspectives and using this to inform the recommendations arising from the research (Maxwell et al., 2020; Cooke et al., 2021; Reid et al., 2021). While co-production is most often seen as a means to bring together and negotiate across distinctive worldviews and values through engagement with diverse communities and stakeholders (Maxwell et al., 2020; Reid et al., 2021), the above case studies also demonstrate that knowledge co-production is also essential in bridging the hierarchies within academic discourses too. Co-production and transdisciplinary research methods are not just complementary but should be seen as intrinsically entwined. Transdisciplinary research cannot bridge the knowledge-action gap without engaging in forms of co-production between knowledge holders, stakeholders, researchers, and policymakers. While meaningful co-production requires a range of researchers whose knowledge includes different and distinctive approaches towards collaborative data collection, includes participatory approaches to interpretation, and participative parity in making claims from said research.

It is important to emphasise that co-production and transdisciplinary research approaches do not offer a panacea to challenging knowledge hierarchies. Instead, knowledge hierarchies can be both challenged and reproduced through such approaches. Decisions need to be made on what issues to concentrate on (Latour, 2004); how to approach such challenges, and how to act on, interpret, and disseminate research findings; all of which can challenge certain knowledge hierarchies while reinforcing others (Weber et al., 2017). In order to arrive at any negotiated consensus, difficult decisions need to be made that will inevitably lead to the sacrifice of different interests, desires, and goals (Jentoft and Chuenpagdee, 2009; Weber and Stevenson, 2017; Aguado et al., 2021). It behoves society to ensure this sacrifice is not only or even primarily asked of the most marginalised and vulnerable communities. Co-production and transdisciplinary research offer an approach to navigate such sacrifices through transparent processes and collective decisions based on diverse knowledges so that decisions made are genuinely shared and consensual among stakeholders rather than imposed and unilateral. This requires keen and attentive vigilance to how power, access and participation are

realised in decision making. As the above case studies demonstrate, this is an iterative and continual process that requires substantial time, trust, and resources (Gutiérrez et al., 2011; d'Armengol et al., 2018; Etiegni et al., 2020; Maxwell et al., 2020; Cooke et al., 2021; Reid et al., 2021; Silver et al., 2022).

4.4 We can only address knowledge hierarchies by embracing aspects of discomfort, conflict and failure

There are several theoretical and practical obstacles in pursuing research that adequately breaks down knowledge hierarchies in marine biodiversity knowledge production and governance. As the case studies and above discussion shows, this includes aspects such as how biodiversity is understood and conceptualised, knowledge co-production processes that consider power structures and historical inequalities in representation and influence, and more practical limitations of funding, time and institutional support. In this section we delve deeper into a discussion on the importance of considering discomfort, conflict and failure in marine biodiversity research to ensure that projects, even those with the best intentions, cease to reinforce or perpetuate existing knowledge hierarchies.

Idahosa and Bradbury (2020) emphasise the role of discomfort in limiting the risk of perpetuating colonial or Western knowledge hegemonies in knowledge production processes, arguing that we as researchers can and should 'utilise emotions of paralysis, discomfort and contradiction towards positive social change'. By critically reflecting on our own positionalities and how these may influence our behaviours and attitudes towards people and ways of knowing different from our own, we can better ensure that discomfort becomes productive instead of paralysing (Idahosa and Bradbury, 2020; Leavy, 2020). In practice, embracing discomfort and reflexivity means acknowledging how our inherent biases shape the research process and experience, and can involve questions such as 'am I the right person to be researching this?', 'what knowledges am I promoting or elevating through my arguments?', 'am I claiming to represent anyone else but myself through my work?', 'am I comfortable with acknowledging that I am wrong?' 'Have claims been validated by participants including knowledge holders and co-researchers, before finalising them?' These questions support a reflection of whether we are, consciously or unconsciously, devaluing different knowledge systems through our research. For example, trying to integrate the spectrum of values held within societies into marine biodiversity governance that continue to devalue, disregard or refute approaches to co-existence and rights to self-governance (Rivers et al., 2023).

Co-production and transdisciplinary research approaches ultimately emphasise a coming together of different knowledges, which attempt to address ongoing tensions and power imbalances in order to arrive at some form of negotiated consensus between stakeholders that can address the knowledge-action gap within ocean biodiversity governance (Gómez and Köpsel, 2022; Strand et al., 2022a). One of the greater challenges of transdisciplinary

research, therefore, is navigating various ontologies and epistemologies (Raymond et al., 2010; Moon et al., 2021), where ontologies refer to 'how one perceives reality and the world' and epistemologies refer to 'how one values something to be true or valid' (Strand et al., 2022b). Even within this group of authors, we have diverging disciplinary and contextual backgrounds that influence how we perceive and understand knowledge hierarchies in biodiversity research (see [Supplementary information](#)), and this can often result in conflict and disagreement. Despite the apparent need for conflict resolution mechanisms and training in navigating disagreement in research, there is limited support in academic institutions to prepare researchers for these realities, and institutional and academic systems do not adequately promote this reflection.

However, as we experienced in our own discussions in theorising and co-writing this paper, we should not try to ignore or distort the tensions, conflict, and emotions that arise in the process of such co-production. Doing so ignores how working with the multi-layered tensions surrounding even specific concepts – such as the very idea of 'knowledge hierarchies' – can reveal the implicit ambiguities and uncertainties at the core of complex issues. These have too often been ignored or brushed over in the past in the name of efficiency or to project findings that appear more definitive or objective than they are in reality; exactly the process through which knowledge hierarchies are often constructed in the first place (Knowles, 2023). Instead, such tensions need to be mediated while ambiguities and uncertainties need to be openly acknowledged, accepted, and disseminated by all involved in knowledge co-production (Galafassi et al., 2018; Strand et al., 2022a). This moves away from claims to universal truths to instead acknowledge that imperfect decisions must be made on imperfect data, mediating tensions and unequal power relations through engagement of stakeholders and knowledge holders in data collection, analysis, and decision making (Manuel-Navarrete et al., 2021; Moon et al., 2021; Trisos et al., 2021). This accepts that there are only "clumsy solutions" to "wicked problems," but that such "clumsy solutions" are all the more clumsy if they are not generated through (honest) dialogue between a diverse group of knowledge holders interpreting a wide range of data from distinctive perspectives, worldviews, and values (Weber et al., 2017; Temper et al., 2019; Moon et al., 2021; McGarry, 2022). Ultimately, we echo Haraway's (2016b) call to "stay with the trouble" and resist the temptation of easy solutions or escapist fantasies in the face of complex, multi-faceted problems. Adopting an iterative, ongoing ethic of care, can foster meaningful and robust responses that support comfort with such reflection and promote approaches to biodiversity governance that is grounded in empathy.

Closely linked with the importance of embracing discomfort and conflict and making explicit the fallibility of science, is the need to consider failure in marine biodiversity research. Failure is a critical aspect of any research endeavour, but scientists are often discouraged or even stigmatised from openly discussing this in their work (Cvitanovic et al., 2022). Assessing conservation project

publications, [Catalano et al. \(2019\)](#) find that it is rare to find reports of failure, despite the opportunities these could create in providing a repository of lessons learned for future research. Similarly, [Ounanian \(2021\)](#) discusses the ‘the collective tendency in (social) science to conceal the imperfections of field research’ and aims to portray the often-overlooked failure and redesign of marine social science processes. The limited attention to failure can also be extrapolated from the case studies presented in this paper (Section 4), and the authors feel we are usually encouraged to report on our successes and impact but rarely asked to expand on our failures and shortcomings. Reflecting on the importance of normalising and learning from failure in marine social science, [Cvitanovic et al. \(2022\)](#) provide several considerations and actionable steps to better navigate and overcome failure. This includes communicating uncertainties prior to fieldwork, sharing emotions during research collaborations and even ‘phone a friend’ to discuss feelings of stress and pressure, and debrief with collaborators as a group to process aspects that may have gone wrong or not according to plan ([Cvitanovic et al., 2022](#)). Enabling and even promoting humility within scientific practice through an openness to failure, not only strengthens science but also invites question and critique from those outside of the ‘black box’, a process essential to achieve appropriate, fair, and effective integration of knowledge.

5 Conclusion

This article has attempted to understand and deconstruct existing knowledge hierarchies in ocean biodiversity governance research, by discussing opportunities to better recognise, challenge and ultimately dismantle these through various research practices and approaches. One of the initial challenges of conceptualising this paper was the diverging ideas of what knowledge hierarchies entail. In grappling with the discordance among authors we have reached agreement in the definition as ‘the categorization of knowledge based on its perceived value and legitimacy as is created and perpetuated by social structures and power dynamics, influencing its use and recognition’.

Scrutinising the myriad ways in which knowledge hierarchies persist in marine biodiversity governance, we have outlined five case studies undertaken under the banner of a single project that seek transformation through transdisciplinary research. What we find is that knowledge hierarchies are rooted in historical processes and perpetuated through cultural norms, ocean decision-making, research practices and international biodiversity governance, which means that the work of deconstructing these hierarchies needs to be multifaceted, iterative and reflexive. Specifically, researchers engaged in marine biodiversity governance research have to pay attention to the danger of reproducing knowledge hierarchies in their work. Such reproduction can be avoided through the careful selection of contextually relevant research methods, sensitive and reflective problematisation of research questions, and efforts to re-balance how we engage with biodiversity. Justice should also be centred within research, paying particular attention to cognitive justice which is the equal

valuation and treatment of all knowledges and knowledge systems ([de Sousa Santos, 2018](#); [Strand, 2023](#)).

Building on lessons from the five case studies, we argue that transdisciplinary knowledge co-production, if carefully crafted with respect and value to multiple knowledge systems, can assist in challenging existing and seemingly intractable knowledge hierarchies in marine biodiversity governance. However, transdisciplinary research and knowledge co-production is not a panacea, and the work to deconstruct knowledge hierarchies requires critical reflection around positionality, power asymmetries in relationships and inherent assumptions of what counts as ‘truth’ or legitimate value claims. We find that attention to discomfort, conflict and failure in transdisciplinary knowledge co-production should be promoted and discussed more openly in academia and biodiversity research. Instead of brushing over the tensions, conflicts, and emotions that arise in the processes of coproduction, researchers should actively reflect on what these tensions may lead to when it comes to the perceived value, recognition, legitimacy and use of various knowledges and knowledge claims.

Author contributions

HN: Conceptualization, Visualization, Writing – original draft, Writing – review & editing. DW: Conceptualization, Writing – original draft, Writing – review & editing. KH: Conceptualization, Writing – original draft, Writing – review & editing. MS: Conceptualization, Visualization, Writing – original draft, Writing – review & editing. JW: Conceptualization, Writing – original draft, Writing – review & editing. DM: Conceptualization, Writing – original draft, Writing – review & editing. BE: Writing – original draft, Writing – review & editing. SI: Writing – original draft, Writing – review & editing. ST: Writing – original draft, Writing – review & editing. SF: Conceptualization, Writing – original draft, Writing – review & editing. AL: Conceptualization, Writing – original draft, Writing – review & editing. MP: Conceptualization, Writing – original draft.

Funding

The author(s) declare financial support was received for the research, authorship, and/or publication of this article. Research was funded by the One Ocean Hub, a collaborative research program for sustainable development funded by United Kingdom Research and Innovation (UKRI) through the Global Challenges Research Fund (GCRF) (Grant Ref: NE/S008950/1). MS & JW - PhDs funded by the National Research Foundation (South Africa).

Acknowledgments

We thank Elisa Morgera for a detailed review, and members of the One Ocean Hub International Impact Working Group (IIWG) for insightful feedback. Icons in [Figure 1](#) sourced from [flaticon.com](#).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated

organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fmars.2024.1347494/full#supplementary-material>

References

- Abimbola, S. (2019). The foreign gaze: Authorship in academic global health. *BMJ Glob. Health* 4, e002068. doi: 10.1136/bmjgh-2019-002068
- Adas, M. (2014). *Machines as the Measure of Men: Science, Technology, and Ideologies of Western Dominance* (Ithaca and London: Cornell University Press).
- Adler, A. (2019). *Neptune's Laboratory: Fantasy, Fear, and Science at Sea* (Cambridge, Massachusetts, and London: Harvard University Press). doi: 10.4159/9780674241893
- Aguado, S., Segado, I., Vidal, M., Pitcher, T., and Lam, M. (2021). The quality of fisheries governance assessed using a participatory, multi-criteria framework: A case study from Murcia, Spain. *Mar. Policy* 124, 104280. doi: 10.1016/j.marpol.2020.104280
- Alatas, S. F. (2003). Academic dependency and the global division of labour in the social sciences. *Curr. Sociol.* 51, 599–613. doi: 10.1177/00113921030516003
- Ameyaw, A. B., Breckwoldt, A., Reuter, H., and Aheto, D. W. (2020). From fish to cash: Analyzing the role of women in fisheries in the western region of Ghana. *Mar. Policy* 113, 103790. doi: 10.1016/j.marpol.2019.103790
- Anker, P. (2001). *Imperial Ecology: Environmental Order in the British Empire 1894–1945* (Cambridge and London: Harvard University Press).
- Baker, K., Eichhorn, M. P., and Griffiths, M. (2019). Decolonizing field ecology. *Biotropica* 51, 288–292. doi: 10.1111/btp.12663
- Barad, K. (2007). *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham, North Carolina: Duke University Press). doi: 10.2307/j.ctv12101zq
- Beinart, W. (2000). African history and environmental history. *Afr. Aff. (Lond)* 99 (395), 269–302. doi: 10.1093/afraf/99.395.269
- Belay, M. (2012). *Participatory Mapping, Learning and Change in the context of Biocultural Diversity and Resilience* (Makhandia: Rhodes University).
- Belhabib, D. (2021). Ocean science and advocacy work better when decolonized. *Nat. Ecol. Evol.* 5, 709–710. doi: 10.1038/s41559-021-01477-1
- Berkes, F., Folke, C., and Colding, J. (2000). *Linking social and ecological systems: management practices and social mechanisms for building resilience* (Cambridge: Cambridge University Press).
- Biermann, F., Kickmann, T., Senit, C.-A., Beisheim, M., Bernstein, S., Chasek, P., et al. (2022). Scientific evidence on the political impact of the Sustainable Development Goals. *Nat. Sustain* 5 (9), 143–154. doi: 10.4324/9781003030850-14
- Bohensky, E. L., and Maru, Y. (2011). Indigenous knowledge, science, and resilience: What have we learned from a decade of international literature on “integration”? *Ecol. Soc.* 16 (4), 6. doi: 10.5751/ES-04342-160406
- Bozalek, V., Holscher, D., and Zembylas, M. (2020). *Nancy Fraser and Participatory Parity: Reframing Social Justice in South African Higher Education*. Eds. V. Bozalek, D. Holscher and M. Zembylas (London: Routledge). doi: 10.4324/9780429055355
- Breitinger, J. C. (2022). A lake to serve: the exploration, modification, and degradation of lake victoria 1920s to 1960s. *J. Imp. Commonw. Hist.* 50, 144–184. doi: 10.1080/03086534.2021.1985212
- Brosius, J. P. (2006). “What counts as local knowledge in global environmental assessments and conventions,” in *Bridging scales and knowledge systems: concepts and applications in ecosystem assessment* (Washington D.C.: Island Press), 129–144.
- Brugnach, M. (2017). The space in between: where multiple ways of knowing in water management meet. *J. Southwest* 59, 34–59. doi: 10.1353/jsw.2017.0005
- Catalano, A. S., Lyons-White, J., Mills, M. M., and Knight, A. T. (2019). Learning from published project failures in conservation. *Biol. Conserv.* 238, 108223. doi: 10.1016/j.biocon.2019.108223
- CBD (1992). Convention text. Available online at: <https://www.cbd.int/convention/articles/default.shtml?a=cbd-00> (Accessed October 9, 2017).
- Chan, C. Y., Tran, N., Pethiyagoda, S., Crissman, C. C., Sulser, T. B., and Phillips, M. J. (2019). Prospects and challenges of fish for food security in Africa. *Glob. Food Sec.* 20, 17–25. doi: 10.1016/j.gfs.2018.12.002
- Chilisa, B. (2017). Decolonising transdisciplinary research approaches: an African perspective for enhancing knowledge integration in sustainability science. *Sustain Sci.* 12, 813–827. doi: 10.1007/s11625-017-0461-1
- Chirwa, W. C. (1996). Fishing rights, ecology and conservation along southern Lake Malawi 1920–1964. *Afr. Aff. (Lond)* 95 (380), 351–380. doi: 10.1093/oxfordjournals.afraf.a007738
- Clarke, S. (2007). A technocratic imperial state? The colonial office and scientific research 1940–1960. *Twentieth Century Br. History* 18, 453–480. doi: 10.1093/tcbh/hwm017
- Cocks, M. (2006). Biocultural diversity: moving beyond the realm of ‘Indigenous’ and ‘Local’ People. *Hum. Ecol.* 34, 185–200. doi: 10.1007/s10745-006-9013-5
- Cooke, S. J., Nguyen, V. M., Chapman, J. M., Reid, A. J., Landsman, S. J., Young, N., et al. (2021). Knowledge co-production: A pathway to effective fisheries management, conservation, and governance. *Fisheries (Bethesda)* 46, 89–97. doi: 10.1002/fsh.10512
- Costanza, R., and Daly, H. E. (1992). Natural capital and sustainable development. *Conserv. Biol.* 6 (1), 37–36. doi: 10.1046/j.1523-1739.1992.610037.x
- Cvitanovic, C., van Putten, E. I., Tuohy, P., and Annand-Jones, R. (2022). Normalizing failure: when things go wrong in participatory marine social science fieldwork. *ICES J. Mar. Sci.* 79, 2184–2195. doi: 10.1093/icesjms/isc153
- d'Armengol, L., Prieto Castillo, M., Ruiz-Mallén, I., and Corbera, E. (2018). A systematic review of co-managed small-scale fisheries: Social diversity and adaptive management improve outcomes. *Global Environ. Change* 52, 212–225. doi: 10.1016/j.gloenvcha.2018.07.009
- de Sousa Santos, B. (2018). *Decolonising the University: The challenge of deep cognitive justice* (Cambridge: Cambridge Scholars Publishing).
- Díaz, S., Demissew, S., Carabias, J., Joly, C., Lonsdale, M., Ash, N., et al. (2015). The IPBES Conceptual Framework - connecting nature and people. *Curr. Opin. Environ. Sustain* 14, 1–16. doi: 10.1016/j.cosust.2014.11.002
- Díaz, S., Pascual, U., Stenseke, M., Martín-López, B., Watson, R. T., Molnár, Z., et al. (2018). Assessing nature's contributions to people: Recognizing culture, and diverse sources of knowledge, can improve assessments. *Sci. (1979)* 359, 270–272. doi: 10.1126/science.aap8826
- Dieckmann, U., Odendaal, W., Tarr, J., and Schreij, A. (2013). *Indigenous peoples and climate change in Africa: report on case studies of Namibia's Topnaar and Hai||om communities* (Windhoek: Legal Assistance Centre).
- Drayton, R. (2000). *Nature's Government: Science, Imperial Britain, and the 'Improvement' of the World* (New Haven and London: Yale University Press).
- Empatheatre. (2021). Blue Blanket. Available online at: <https://www.youtube.com/watch?v=4UBublpCWuk> (Accessed November 29, 2023).
- Empatheatre. (2023). Empatheatre. Available online at: www.empatheatre.com (Accessed November 29, 2023).
- Erinosh, B., Hamukuaya, H., Lajaunie, C., Malinde, A., Lancaster, S. N., Lennan, M., et al. (2022). *Transformative Governance for Ocean Biodiversity* (Cambridge: Cambridge University Press). Available at: <https://ssrn.com/abstract=3853886>.
- Erwin, K., Pereira, T., McGarry, D., and Coppen, N. (2022). “Lalela uLwandle: An Experiment in Plural Governance Discussions,” in *The Palgrave Handbook of Blue Heritage* (Springer International Publishing, Cham), 383–409. doi: 10.1007/978-3-030-99347-4_20
- Escobar, A. (1998). Whose Knowledge, Whose nature? Biodiversity, Conservation, and the Political Ecology of Social Movements. *J. Political Ecol.* 5, 53–82.

- Escobar, A. (2007). Worlds and knowledges otherwise. *Cultural Stud.* 21, 179–210. doi: 10.1080/09502380601162506
- Etiegni, C. A., Irvine, K., and Kooy, M. (2020). Participatory governance in Lake Victoria (Kenya) fisheries: whose voices are heard? *Maritime Stud.* 19, 489–507. doi: 10.1007/s40152-020-00195-x
- Fabian, J. (1983). *Time and the Other: How Anthropology Makes its Object* (New York: Columbia University Press).
- Fabrera, S. (2023). Mainstreaming ocean art and culture in ocean management (One Ocean Hub). Available online at: <https://oneoceanhub.org/mainstreaming-ocean-art-and-culture-in-ocean-management/> (Accessed November 16, 2023).
- Finley, C. (2011). *All the Fish in the Sea: Maximum Sustainable Yield and the Failure of Fisheries Management* (Chicago). doi: 10.7208/chicago/9780226249681.001.0001
- Fischer, M., Maxwell, K., Nuunoq, Pedersen, H., Greeno, D., Jingwas, N., et al. (2022). Empowering her guardians to nurture our Ocean's future. *Rev. Fish Biol. Fish* 32, 271–296. doi: 10.1007/s11160-021-09679-3
- Foucault, M. (2002). *The birth of the clinic* (Routledge). doi: 10.4324/9780203406373
- Francis, B., and McGarry, D. (2023). “Grandmothers of the Sea,” in *Hydrofeminist Thinking With Oceans: Political and Scholarly Possibilities* (London: Routledge), 173.
- Funtowicz, S., and Ravetz, J. R. (1994). Emergent complex systems. *Futures* 26, 568–582. doi: 10.1016/0016-3287(94)90029-9
- Galafassi, D., Daw, T. M., Thyresson, M., Rosendo, S., Chaigneau, T., Bandeira, S., et al. (2018). Stories in social-ecological knowledge cocreation. *Ecol. Soc.* 23, 29. doi: 10.5751/ES-09932-230123
- Gascoigne, J. (2019). *Science and the State* (Cambridge: Cambridge University Press). doi: 10.1017/9781316659120
- Golo, H. K., Ibrahim, S., and Erinosho, B. (2022). Integrating communities' customary laws into marine small-scale fisheries governance in Ghana: Reflections on the FAO Guidelines for Securing Sustainable Small-Scale Fisheries. *Rev. Eur. Comp. Int. Environ. Law* 31, 349–359. doi: 10.1111/reel.12478
- Gómez, S., and Köpsel, V. (2022). “Towards a new culture of reflexive and diverse marine transdisciplinarity,” in *Transdisciplinary Marine Research* (Routledge, London), 271–284. doi: 10.4324/9781003311171-19
- Green, L. J. (2009). ‘Indigenous knowledge’ and ‘science’: Reframing the debate on knowledge diversity. *Archaeologies* 4, 144–163.
- Green, L. J. (2012). Beyond South Africa's indigenous knowledge-science wars. *S Afr. J. Sci.* 108, 1–10. doi: 10.4102/sajs.v108i7/8.631
- Green, L. (2020). *Rock | Water | Life: Ecology and Humanities for a Decolonial South Africa* (Durham, North Carolina: Duke University Press). doi: 10.1215/9781478004615
- Gutiérrez, N. L., Hilborn, R., and Defeo, O. (2011). Leadership, social capital and incentives promote successful fisheries. *Nature* 470, 386–389. doi: 10.1038/nature09689
- Haraway, D. (2016a). “Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective,” in *Space, Gender, Knowledge: Feminist Readings* (New York: Routledge), 53–72.
- Haraway, D. J. (2016b). *Staying with the Trouble: Making Kin in the Chthulucene* (Durham, North Carolina: Duke University Press). doi: 10.1215/9780822373780
- Harding, S. (2013). “Rethinking standpoint epistemology: What is ‘strong objectivity?’,” in *Feminist epistemologies* (New York: Routledge), 49–82.
- Hill-Collins, P. H. (1990). Black feminist thought in the matrix of domination. *Black feminist thought: Knowledge consciousness politics empowerment* 138, 221–238.
- Hodge, J. M. (2011). “Science and Empire: An Overview of the Historical Scholarship,” in *Science and Empire* (Palgrave Macmillan UK, London), 3–29. doi: 10.1057/9780230320826_1
- Hubbard, J. (2006). *A Science on the Scales: The Rise of Canadian Atlantic Fisheries Biology 1898–1939* (Toronto, Buffalo, London: University of Toronto Press). doi: 10.3138/9781442670464
- Idahosa, G. E., and Bradbury, V. (2020). Challenging the way we know the world: overcoming paralysis and utilising discomfort through critical reflexive thought. *Acta Academica* 52, 31–53. doi: 10.18820/24150479/aa52i1/SP3
- IOC-UNESCO. (2020). *Global Ocean Science Report 2020 - Charting Capacity for Ocean Sustainability*. Ed. K. Isensee (Paris: UNESCO Publishing). Available at: <https://unesdoc.unesco.org/ark:/48223/pf0000375147>.
- IOC-UNESCO. (2021). *Co-designing the Science We Need for the Ocean We Want: Guidance and Recommendations for Collaborative Approaches to Designing & Implementing Decade Actions* (Paris: UNESCO).
- IPBES. (2019). *Global Assessment Report of the Intergovernmental Science-Policy Platform on Biodiversity*. Eds. E. S. Brondizio, J. Settele, S. Diaz and H. T. Ngo (Bonn, Germany: IPBES secretariat). doi: 10.5281/zenodo.3831673
- IPCC (2023). *Climate Change 2023. Summary for Policymakers: Synthesis Report* (Geneva, Switzerland: IPCC).
- Jasanoff, S. (2004). *States of Knowledge: The Co-Production of Science and the Social Order*. Ed. S. Jasanoff (New York: Routledge). doi: 10.4324/9780203413845
- Jennings, C. (2011). “Unexploited Assets: Imperial Imagination, Practical Limitations, and Marine Fisheries Research in East Africa 1917–53,” in *Science and Empire* (Palgrave Macmillan UK, London), 253–274. doi: 10.1057/9780230320826_12
- Jentoft, S., and Chuenpagdee, R. (2009). Fisheries and coastal governance as a wicked problem. *Mar. Policy* 33, 553–560. doi: 10.1016/j.marpol.2008.12.002
- Jones, P. (2016). *Technological Innovation and Resource Management in the Fisheries of the British Isles, ca.1400–1900* (Glasgow: University of Strathclyde). doi: 10.48730/zadn-ag82
- Jones, P. (2018). The spread of bottom trawling in the British Isles, c.1700–1860. *Int. J. Marit. Hist.* 30, 681–700. doi: 10.1177/0843871418804486
- Kanyimba, A. T., Tshiningayamwe, S., and Jonas, M. (2021). *Exploratory notes collected during interview with small scale fishermen in the coastal areas of Namibia*.
- Keller, E. F. (1995). *Refiguring life: Metaphors of twentieth-century biology* (New York: Columbia University Press). doi: 10.7312/kell92562
- Kinahan, J. (2017). No need to hear your voice, when I can talk about you better than you can speak about yourself... Discourses on Knowledge and Power in the !Khuiseb Delta on the Namib Coast 1780–2016 CE. *Int. J. Hist. Archaeol.* 21, 295–320. doi: 10.1007/s10761-016-0387-9
- Knowles, C. (2023). *With Dreams in their hands: Towards transgressive knowledge-making cultures* (Makhanda: Rhodes University).
- Krämer, M. (2020). Neotraditional authority contested: The corporatization of tradition and the quest for democracy in the Topnaar Traditional Authority, Namibia. *Africa* 90, 318–338. doi: 10.1017/S0001972019001062
- La Bianca, G., Rees, S., Attrill, M. J., Lombard, A. T., McQuaid, K. A., Niner, H. J., et al. (2023). A standardised ecosystem services framework for the deep sea. *Front. Mar. Sci.* 10. doi: 10.3389/fmars.2023.1176230
- Lancaster, A. M. S. N., Nurse, B. G., and Marshall, A. Y. (2024). “Ocean-Based Solutions As Tools For Achieving Climate Justice: Some Reflections From the Perspective Of Vulnerable States & Peoples,” in *The Fourth Environmental Era: Climate Justice*. Eds. F. Doughty-Wagner, S. Atapattu and E. X. de Oliveira (Vernon Press, Delaware).
- Latour, B. (2004). Why has critique run out of steam? From matters of fact to matters of concern. *Crit. Inq.* 30, 225–248. doi: 10.1086/421123
- Latulippe, N., and Klenk, N. (2020). Making room and moving over: knowledge co-production, Indigenous knowledge sovereignty and the politics of global environmental change decision-making. *Curr. Opin. Environ. Sustain* 42, 7–14. doi: 10.1016/j.cosust.2019.10.010
- Leavy, P. (2020). *Method Meets Art: Arts-Based Research Practice. 3rd Edn* (New York: Guildford Press).
- Levin, L. A., Alfaro-Lucas, J. M., Colaço, A., Cordes, E. E., Craik, N., Danovaro, R., et al. (2023). Deep-sea impacts of climate interventions. *Sci.* (1979) 379, 978–981. doi: 10.1126/science.ade7521
- Lombard, A. T., Clifford-Holmes, J., Goodall, V., Snow, B., Truter, H., Vrancken, P., et al. (2023). Principles for transformative ocean governance. *Nat. Sustain* 9 (12), 1587–1599. doi: 10.1038/s41893-023-01210-9
- Lorde, A. (1984). “The Master's Tools Will Never Dismantle the Master's House,” in *Sister Outsider: Essays and Speeches* (Crossing Press, Berkeley), 110–114.
- Mace, G. M. (2019). The ecology of natural capital accounting. *Oxf. Rev. Econ. Policy* 35, 54–67. doi: 10.1093/oxrep/gry023
- Mace, G. M., Hails, R. S., Cryle, P., Harlow, J., and Clarke, S. J. (2015). Towards a risk register for natural capital. *J. Appl. Ecol.* 52, 641–653. doi: 10.1111/1365-2664.12431
- Mace, G. M., Reyers, B., Alkemade, R., Biggs, R., Chapin, F. S., Cornell, S. E., et al. (2014). Approaches to defining a planetary boundary for biodiversity. *Global Environ. Change* 28, 289–297. doi: 10.1016/j.gloenvcha.2014.07.009
- Manuel-Navarrete, D., Buzinde, C. N., and Swanson, T. (2021). Fostering horizontal knowledge co-production with Indigenous people by leveraging researchers' transdisciplinary intentions. *Ecol. Soc.* 26, art22. doi: 10.5751/ES-12265-260222
- Mavhunga, C. C. (2018). *The Mobile Workshop: The Tsetse Fly and African Knowledge Production* (Cambridge and London: The MIT Press). doi: 10.7551/mitpress/9780262535021.001.0001
- Maxwell, K. H., Ratana, K., Davies, K. K., Taiapa, C., and Awatere, S. (2020). Navigating towards marine co-management with Indigenous communities on-board the Waka-Taurua. *Mar. Policy* 111, 103722. doi: 10.1016/j.marpol.2019.103722
- Mbatha, N. P. (2018). *The influence of plural governance systems on rural coastal livelihoods: the case of Kosi Bay* (Cape Town: University of Cape Town).
- McGarry, D. (2022). Suitably Strange: Re-imagining learning, scholar-activism, and justice. *Crit. Stud. Teach. Learn.* 10, 93–115. doi: 10.14426/cristal.v10i1.511
- McGarry, D. (2023). “When ancestors are included in ocean decision and meaning-making,” in *Hydrofeminist Thinking with Oceans: Political and pedagogical possibilities*. Eds. T. Shefer, V. Bozalek and N. Romano (London: Routledge), 17–32.
- McKinley, E., Burdon, D., and Shellock, R. J. (2023). The evolution of ocean literacy: A new framework for the United Nations Ocean Decade and beyond. *Mar. Pollut. Bull.* 186, 114467. doi: 10.1016/j.marpolbul.2022.114467
- McQuaid, K. A., Bridges, A. E. H., Howell, K. L., Gandra, T. B. R., de Souza, V., Currie, J. C., et al. (2023). Broad-scale benthic habitat classification of the South Atlantic. *Prog. Oceanogr.* 214, 103016. doi: 10.1016/j.pocan.2023.103016
- McQuatters-Gollop, A., Mitchell, I., Vina-Herbon, C., Bedford, J., Addison, P. F. E., Lynam, C. P., et al. (2019). From science to evidence - how biodiversity indicators can

- be used for effective marine conservation policy and management. *Front. Mar. Sci.* 6. doi: 10.3389/fmars.2019.00109
- Mellin, C., Delean, S., Caley, J., Edgar, G., Meekan, M., Pitcher, R., et al. (2011). Effectiveness of biological surrogates for predicting patterns of marine biodiversity: A global meta-analysis. *PLoS One* 6, e20141. doi: 10.1371/journal.pone.0020141
- Mignolo, W. D. (2000). *Local histories, global designs: subaltern knowledges and border thinking* (Princeton: Princeton University Press).
- Ministry of Fisheries and Aquaculture Development. (2002). Fisheries Act (Ghana). Available online at: <https://www.fao.org/faolex/results/details/en/c/LEX-FAOC034737/> (Accessed April 30, 2024).
- Mnyaka, M., and Motlhabi, M. (2005). The African concept of ubuntu/botho and its socio-moral significance. *Black Theol.* 3, 215–237. doi: 10.1558/blth.3.2.215.65725
- Moletsane, R. (2015). *Whose Knowledge is It? Towards Reordering Knowledge Production and Dissemination in the Global South* Vol. 4 (Gqeberha: Educational Research for Social Change (ERSC), 35–47.
- Moller, H., Berkes, F., Lyver, P. O. B., and Kisalalioglu, M. (2004). Combining science and traditional ecological knowledge: monitoring populations for co-management. *Ecol. Soc.* 9 (3), 15. doi: 10.5751/ES-00675-090302
- Molnár, Z., Fernández-Llamazares, Á., Schunko, C., Teixidor-Toneu, I., Jarić, I., Díaz-Reviriego, I., et al. (2023). Social justice for traditional knowledge holders will help conserve Europe's nature. *Biol. Conserv.* 285, 1–10. doi: 10.1016/j.biocon.2023.110190
- Moon, K., Cvitanovic, C., Blackman, D. A., Scales, I. R., Browne, N. K., Tietbohl, M. D., et al. (2021). Five questions to understand epistemology and its influence on integrative marine research. *Front. Mar. Sci.* 8, 1–9. doi: 10.3389/fmars.2021.574158
- Morgera, E., McQuaid, K., La Bianca, G., Niner, H., Shannon, L., Strand, M., et al. (2023). Addressing the ocean-climate nexus in the BBNJ agreement: strategic environmental assessments, human rights and equity in ocean science. *Int. J. Mar. Coast. Law* 38, 447–479. doi: 10.1163/15718085-bja10139
- Morgera, E., and Razaque, J. (2017). *Biodiversity and Nature Protection Law* (Cheltenham: Edward Elgar Publishing). doi: 10.4337/9781783474257
- Mortimer, D. J., Trivino, G. C., Gagnon, J. A., Iwanicki, S. W., Mortimer, D. J., Trivino, G. C., et al. (2016). *Creating Tourism Employment Opportunities for the Topnaar in the Namib Sand Sea* (Worcester, Massachusetts: Worcester Polytechnic Institute).
- Morton, T. (2009). *Ecology without Nature* (Cambridge, Massachusetts: Harvard University Press). doi: 10.2307/j.ctv1n3x1c9
- Mosimege, M. D. (2017). "Research protocols and ethical considerations in indigenous knowledge systems," in *Handbook of Research on Theoretical Perspectives on Indigenous Knowledge Systems in Developing Countries* (Hershey, Pennsylvania: IGI Global), 156–172.
- Msomphora, M. R., Njaya, F., and Jentoft, S. (2022). Ecosystem-based governance according to the Malawi principles: a test for the southern Lake Malawi. *Maritime Stud.* 21, 297–307. doi: 10.1007/s40152-022-00266-1
- Muhl, E. K., Armitage, D., Anderson, K., Boyko, C., Busilacchi, S., Butler, J., et al. (2023). Transitioning toward "deep" knowledge co-production in coastal and marine systems: examining the interplay among governance, power, and knowledge. *Ecol. Soc.* 28, 17. doi: 10.5751/ES-14443-280417
- Mukerji, C. (1989). *A Fragile Power: Scientists and the State* (Princeton: Princeton University Press). doi: 10.1515/9781400860241
- Muradian, R., and Gómez-Baggethun, E. (2021). Beyond ecosystem services and nature's contributions: Is it time to leave utilitarian environmentalism behind? *Ecol. Economics* 185, 107038. doi: 10.1016/j.ecolecon.2021.107038
- Nadsady, P. (1999). The politics of tek: power and the "Integration" of knowledge. *Arctic Anthropol.* 36, 1–18. Available online at: <https://www.jstor.org/stable/40316502>.
- Ndlovu-Gatsheni, S. J. (2013). "Coloniality of power in postcolonial Africa," in *Myths of decolonization* (CODESRIA, Dakar).
- Ndofrepi, A. (2017). African universities on a global ranking scale: Legitimation of knowledge hierarchies? *South Afr. J. Higher Educ.* 31, 155–174. doi: 10.20853/31-1-1071
- Niner, H. J., Rees, S. E., La Bianca, G., McQuaid, K. A., and Howell, K. L. (2024). A risk assessment for the remote ocean: the case of the South East Atlantic. *Front. Mar. Sci.* 10. doi: 10.3389/fmars.2023.1168686
- Ntseane, P. G. (2011). Culturally sensitive transformational learning. *Adult Educ. Q.* 61, 307–323. doi: 10.1177/0741713610389781
- Oba, G. (2020). *African Environmental Crisis: A History of Science for Development* (London and New York: Routledge). doi: 10.4324/9781003002161
- Okafor-Yarwood, I., Kadagi, N. I., Miranda, N. A. F., Uku, J., Elegbede, I. O., and Adewumi, I. J. (2020). The blue economy-cultural livelihood-ecosystem conservation triangle: the African experience. *Front. Mar. Sci.* 7. doi: 10.3389/fmars.2020.00586
- One Ocean Hub. (2022). Code of Practice. Available online at: <https://oneoceanhub.org/about/>.
- Oreskes, N. (2021). *Science on a Mission: How Military Funding Shaped What We Do and Don't Know about the Ocean* (Chicago: University of Chicago Press). doi: 10.7208/chicago/9780226732411.001.0001
- Osseo-Asare, A. D. (2014). *Bitter Roots: The Search for Healing Plants in Africa* (Chicago and London: The University of Chicago Press). doi: 10.7208/chicago/9780226086163.001.0001
- Ounanian, K. (2021). "Naked methodology: Baring it all for a realistic account of marine social science," in *Researching People and the Sea: Methodologies and Traditions* (Cham, Switzerland: Springer International Publishing), 23–45. doi: 10.1007/978-3-030-59601-9_2
- Overà, R., Atter, A., Amponsah, S., and Kjelleve, M. (2022). Market women's skills, constraints, and agency in supplying affordable, safe, and high-quality fish in Ghana. *Maritime Stud.* 21, 485–500. doi: 10.1007/s40152-022-00279-w
- Pascual, U., Muradian, R., Brander, L., Martín-López, B., Gómez-Baggethun, E., Verma, M., et al. (2010). The Economics of Valuing Ecosystem Services and Biodiversity. Available online at: <https://www.researchgate.net/publication/303444184>.
- Raymond, C. M., Fazey, I., Reed, M. S., Stringer, L. C., Robinson, G. M., and Evelyn, A. C. (2010). Integrating local and scientific knowledge for environmental management. *J. Environ. Manage.* 91, 1766–1777. doi: 10.1016/j.jenvman.2010.03.023
- Rees, S. E., Ashley, M., Cameron, A., Mullier, T., Ingle, C., Oates, J., et al. (2022). A marine natural capital asset and risk register—Towards securing the benefits from marine systems and linked ecosystem services. *J. Appl. Ecol.* 59, 1098–1109. doi: 10.1111/1365-2664.14121
- Reid, A. J., Eckert, L. E., Lane, J., Young, N., Hinch, S. G., Darimont, C. T., et al. (2021). Two-Eyed Seeing™: An Indigenous framework to transform fisheries research and management. *Fish Fisheries* 22, 243–261. doi: 10.1111/faf.12516
- Reidy, M. S. (2008). *Tides of History: Ocean Science and Her Majesty's Navy* (Chicago: University of Chicago Press). doi: 10.7208/chicago/9780226709338.001.0001
- Reidy, M. S., and Rozwadowski, H. M. (2014). The spaces in between: science, ocean, empire. *Isis* 105, 338–351. doi: 10.1086/676571
- Remmert, D. (2018). *Towards a Blue Economy: Harnessing Namibia's Coastal Resources Sustainably* (Windhoek, Namibia: Institute for Public Policy Research; Hanns Seidel Foundation Namibia).
- Republic of Namibia (1990). *Constitution of the Republic of Namibia*.
- Republic of Namibia (2017). *Namibia's 5th National Development Plan (NDP 5)*.
- Rivers, N., Strand, M., Fernandes, M., Metuge, D., Lemahieu, A., Benkenstein, A., et al. (2023). Pathways to integrate Indigenous and local knowledge in ocean governance process: lessons from the Algoa Bay Project, South Africa. *Front. Mar. Sci.* 9. doi: 10.3389/fmars.2022.1084674
- Robertson, M. M. (2006). The nature that capital can see: science, state, and market in the commodification of ecosystem services. *Environ. Plan D* 24, 367–387. doi: 10.1068/d3304
- Robertson, M., BenDor, T. K., Lave, R., Riggsbee, A., Ruhl, J., and Doyle, M. (2014). Stacking ecosystem services. *Front. Ecol. Environ.* 12, 186–193. doi: 10.1890/110292
- Ross, C. (2017). *Ecology and Power in the Age of Empire* (Oxford: Oxford University Press). doi: 10.1093/acprof:oso/9780199590414.001.0001
- Rozwadowski, H. M. (2002). *The Sea Knows No Boundaries: A Century of Marine Science under ICES* (Seattle and London: International Council for the Exploration of the Sea, University of Washington Press).
- Rozwadowski, H. M. (2004). Internationalism, environmental necessity, and national interest: marine science and other sciences. *Minerva* 42, 127–149. doi: 10.1023/B:MINE.0000030023.04586.45
- Rozwadowski, H. M. (2013). The promise of ocean history for environmental history. *J. Am. History* 100, 136–139. doi: 10.1093/jahist/jat069
- Rudolph, T. B., Ruckelshaus, M., Swilling, M., Allison, E. H., Österblom, H., Gelcich, S., et al. (2020). A transition to sustainable ocean governance. *Nat. Commun.* 11, 1–14. doi: 10.1038/s41467-020-17410-2
- Said, E. (1993). *Culture and Imperialism* (New York: Knopf).
- Santoro, F., Selvaggia, S., Scowcroft, G., Fauville, G., and Tuddenham, P. (2017). *Ocean Literacy for All - A toolkit* (Paris: IOC/UNESCO; UNESCO Venice Office).
- Santos, B. D. S. (2016). Epistemologies of the South and the future. *From Eur. South: A transdisciplinary J. Postcolonial Humanities* 1, 17–29.
- Sarkar, S., and Margules, C. (2002). Operationalizing biodiversity for conservation planning. *J. Biosci.* 27, 299–308. doi: 10.1007/BF02704961
- Shields, S., Longo, A., Strand, M., and Morgera, E. (2023). Children's human right to be heard at the ocean-climate nexus. *Int. J. Mar. Coast. Law* 38, 545–580. doi: 10.1163/15718085-bja10140
- Silver, J. J., Okamoto, D. K., Armitage, D., Alexander, S. M., Atleo, C., Burt, J. M., et al. (2022). Fish, people, and systems of power: understanding and disrupting feedback between colonialism and fisheries science. *Am. Nat.* 200, 168–180. doi: 10.1086/720152
- Smith, H. A., and Sharp, K. (2012). Indigenous climate knowledges. *Wiley Interdiscip. Rev. Clim Change* 3, 467–476. doi: 10.1002/wcc.185
- Snow, B., Erinosh, B., Lajaunie, C., McGarry, D., Morgera, E., Niner, H. J., et al. (2021). How to enable transformative science during the International Decade of Ocean Science for Sustainable Development. Available online at: <https://oneoceanhub.org/publications/policy-brief/> (Accessed November 27, 2023).
- Strand, M. (2022). Coloniality and othering in DFID's development partnership with South Africa. *South Afr. J. Int. Affairs* 29, 365–386. doi: 10.1080/10220461.2022.2127871
- Strand, M. (2023). *Arts-based participatory research for more equitable ocean governance in South Africa* (Gqeberha: Nelson Mandela University).

- Strand, M., Ortega-Cisneros, K., Niner, H. J., Wahome, M., Bell, J., Currie, J. C., et al. (2022a). Transdisciplinarity in transformative ocean governance research—reflections of early career researchers. *ICES J. Mar. Sci.* 1–15. doi: 10.1093/icesjms/fsac165
- Strand, M., Rivers, N., Baasch, R., and Snow, B. (2022b). Developing arts-based participatory research for more inclusive knowledge co-production in Algoa Bay. *Curr. Res. Environ. Sustainability* 4, 100178. doi: 10.1016/j.crsust.2022.100178
- Strand, M., Rivers, N., and Snow, B. (2022c). Reimagining ocean stewardship: arts-based methods to ‘Hear’ and ‘See’ Indigenous and local knowledge in ocean management. *Front. Mar. Sci.* 9. doi: 10.3389/fmars.2022.886632
- Strand, M., Shields, S., Morgera, E., McGarry, D., Lancaster, A. M. S. N., Brown, L., et al. (2023). Protecting children’s rights to development and culture by re-imagining ‘ocean literacies.’ Available online at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4506603.
- Sullivan, S. (2013). Banking nature? The spectacular financialisation of environmental conservation. *Antipode* 45, 198–217. doi: 10.1111/j.1467-8330.2012.00989.x
- Sullivan, S., and Hannis, M. (2017). Mathematics maybe, but not money”: On balance sheets, numbers and nature in ecological accounting. *Accounting Auditing Accountability J.* 30, 1459–1480. doi: 10.1108/AAAJ-06-2017-2963
- Sunde, J. (2022). A seismic shift. *Samudra Report: Triannual J. Int. Collective Support Fishworkers* 87, 4–7.
- Temper, L., McGarry, D., and Weber, L. (2019). From academic to political rigour: Insights from the ‘Tarot’ of transgressive research. *Ecol. Economics* 164, 106379. doi: 10.1016/j.ecolecon.2019.106379
- Tessnow-von Wysocki, I., and Vadrot, A. B. M. (2020). The voice of science on marine biodiversity negotiations: A systematic literature review. *Front. Mar. Sci.* 7. doi: 10.3389/fmars.2020.614282
- Thorp, H. H. (2023). ChatGPT is fun, but not an author. *Sci. (1979)* 379, 313. doi: 10.1126/science.adg7879
- Tilley, H. (2011). *Africa as a Living Laboratory: Empire, Development, and the Problem of Scientific Knowledge 1870–1950* (Chicago and London: The University of Chicago Press). doi: 10.7208/chicago/9780226803487.001.0001
- Tolochko, P., and Vadrot, A. B. M. (2021). The usual suspects? Distribution of collaboration capital in marine biodiversity research. *Mar. Policy* 124, 104318. doi: 10.1016/j.marpol.2020.104318
- Torell, E., Bilecki, D., Owusu, A., Crawford, B., Beran, K., and Kent, K. (2019). Assessing the impacts of gender integration in Ghana’s fisheries sector. *Coast. Manage.* 47, 507–526. doi: 10.1080/08920753.2019.1669098
- Trisos, C. H., Auerbach, J., and Katti, M. (2021). Decoloniality and anti-oppressive practices for a more ethical ecology. *Nat. Ecol. Evol.* 5, 1205–1212. doi: 10.1038/s41559-021-01460-w
- Tsing, A. (2009). Beyond economic and ecological standardisation. *Aust. J. Anthropol.* 20, 347–368. doi: 10.1111/j.1757-6547.2009.00041.x
- UN CRC. (2023). *General comment No. 26 (2023) on children’s rights and the environment, with a special focus on climate change*.
- UNGA. (1992). *Report of the United Nations Conference on Environment and Development. Rio De Janeiro*.
- UNGA. (2023). *Agreement under the United Nations Convention of the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction*.
- UNICEF. (2018). *Learning through play: Strengthening learning through play in early childhood education programmes* (New York: UNICEF).
- Van Dover, C. L., Ardron, J. A., Escobar, E., Gianni, M., Gjerde, K. M., Jaeckel, A., et al. (2017). Biodiversity loss from deep-sea mining. *Nat. Geosci.* 10, 464–465. doi: 10.1038/ngeo2983
- van Kerkhoff, L. (2013). Knowledge governance for sustainable development: A review. *Challenges Sustainability* 1, 82–93.
- Visseren-Hamakers, I., and Kok, M. T. J. (2022). *Transforming Biodiversity Governance*. Eds. I. J. Visseren-Hamakers and M. T. J. Kok (Cambridge: Cambridge University Press). doi: 10.1017/9781108856348
- Vrancken, P. (2023). *State Ocean Jurisdiction* (London and New York: Routledge). doi: 10.4324/9781003383871
- Walley, C. J. (2004). *Rough Waters: Nature and Development in an East African Marine Park* (Princeton and Oxford: Princeton University Press). doi: 10.1515/9781400835751
- Wane, N. N. (2008). Mapping the field of Indigenous knowledges in anti-colonial discourse: a transformative journey in education. *Race Ethn. Educ.* 11, 183–197. doi: 10.1080/13613320600807667
- Warikandwa, T. V., Shakalela, E., and Libebe, E. L. (2023). *Financial Inclusion and the Small-Scale Fisheries Sector in Namibia: A Contemporary Legal Perspective* (Cham: Springer). 289–322. doi: 10.1007/978-3-031-23863-5_14
- Weber, E. P., Lack, D., and Steel, B. (2017). “Introduction: Science and Problem Solving for Wicked Problems: Challenges and Responses,” in *New Strategies for Wicked Problems: Science and Solutions in the 21st Century*. Eds. B. S. Steel, D. Lach and E. P. Weber (Oregon State University Press, Corvallis). doi: 10.1353/book56396
- Weber, E. P., and Stevenson, A. P. (2017). “Collaborative Governance, Science, and Policy Outcomes,” in *New Strategies for Wicked Problems: Science and Solutions in the 21st Century*. Eds. B. S. Steel, D. Lach and E. P. Weber (Oregon State University Press, Corvallis). doi: 10.1353/book56396
- Williams, D. R. (2017). “The Role of Place-Based Social Learning,” in *New Strategies for Wicked Problems: Science and Solutions in the 21st Century*. Eds. B. S. Steel, D. Lach and E. P. Weber (Oregon State University Press, Corvallis). doi: 10.1353/book56396
- Wilson, D. (2021). European colonisation, law, and Indigenous marine dispossession: historical perspectives on the construction and entrenchment of unequal marine governance. *Maritime Stud.* 20, 387–407. doi: 10.1007/s40152-021-00233-2
- Wholmg, M. (2009). The problem of scale in indigenous knowledge: A perspective from Northern Australia. *Ecol. Soc.* 14, 14. doi: 10.5751/ES-02574-140101

Glossary

Biodiversity	The variety of life in a particular habitat or ecosystem. It encompasses the diversity within species, between species, and of ecosystems.
Indigenous Knowledge	Understandings, skills, and philosophies of societies rooted in long histories with their natural environment, often passed down through generations and integral to a community's identity and culture.
Knowledge	Familiarity, awareness, or understanding gained through experience or study. It pertains to facts, information, descriptions, or skills acquired through experience or education.
Knowledges	A plural form of knowledge, often used to emphasise multiple forms or types of understanding, particularly in contexts where various cultural, disciplinary, or epistemological perspectives are recognised.
Knowledge hierarchies	The categorisation of knowledge based on its perceived value and legitimacy as is created and perpetuated by social structures and power dynamics, influencing its use and recognition.
Knowledge Processes	The methods and procedures through which knowledge is acquired, managed, used, and shared. This includes learning, teaching, researching, and communicating.
Knowledge Production	The generation of new information or insights through research, study, or innovation. It pertains to the creation of new knowledge within academic, cultural, or societal contexts.
Knowledge Systems	Integrated sets of practices, beliefs, values, and norms that encompass ways of knowing and organising information. These can be based on culture, discipline, or methodology.
Marine Biodiversity	Refers specifically to the variety and variability of life forms found within marine ecosystems, including species, genes, and ecological functions.
Marine Science	The study of the ocean, its ecosystems, and its life forms. It also explores the physical properties of the oceanic environment and the impacts of human activities on marine life.
Marine Social Science	The application of social science methodologies and theories to the study of relationships between humans and the marine environment. This might include the study of marine resource management, coastal communities, and maritime cultures.
Ocean Biodiversity Governance	The strategies, policies, and practices aimed specifically at conserving and sustainably using the biodiversity within the oceanic environment.
Ocean Governance	The conduct of the policy, actions, and affairs related to the world's oceans. It encompasses the rules, institutions, and processes by which oceans are managed at local, national, regional, and global levels.
Ocean Governance Approaches	Strategies, policies, and practices implemented to manage and protect the ocean and its resources. This includes laws, regulations, agreements, and institutions related to the ocean.
Natural Science	A branch of science that seeks to understand the laws governing the natural world. It encompasses fields such as physics, chemistry, biology, and geology.
Sustainable Marine Governance	An approach to managing marine resources that aims to balance ecological, social, and economic objectives to ensure the long-term health and resilience of marine ecosystems.
Western Science	A systematic approach to knowledge rooted in the scientific method and empirical evidence, originating from the Greco-Roman tradition and evolving in Europe during the Renaissance and Enlightenment.