

The living infinite: Envisioning futures for transformed human-nature relationships on the high seas

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ABSTRACT

We find ourselves at a critical crossroads for the future governance of the high seas, but the perceived remoteness of the global ocean creates a psychological barrier for people to engage with it. Given challenges of over-exploitation, inequitable access and other sustainability and equity concerns, current ocean governance mechanisms are not fit-for-purpose. This decade offers opportunities for direct impact on ocean governance, however, triggering a global transformation on how we use and protect the half of our planet requires a concerted effort that is guided by shared values and principles across regions and sectors. The aim of the series of workshops outlined in this paper, was to undertake a futures thinking process that could use the Nature Futures Framework as a mechanism to bring more transformative energy into how humans conceptualise the high seas and therefore

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how we aim to govern the ocean. We found that engaging with the future through science fiction narratives allowed a more radical appreciation of what could be and infusing science with artistic elements can inspire audiences beyond academia. Thus, creative endeavours of co-production that promote and encourage imagination to address current challenges should be considered as important tools in the science-policy interface, also as a way to elicit empathetic responses. This workshop series was a first, and hopefully promising, step towards generating a more creative praxis in how we imagine and then act for a better future for the high seas.

1. Introduction

“The sea is everything. It covers seven tenths of the terrestrial globe. Its breath is pure and healthy. It is an immense desert, where man is never lonely, for he feels life stirring on all sides. The sea is only the embodiment of a supernatural and wonderful existence. It is nothing but love and emotion; it is the Living Infinite.” Jules Verne (1870), *Twenty Thousand Leagues Under the Sea*.

The perceived remoteness and vastness of the global ocean has inadvertently created a psychological and cultural barrier for people to engage with it [1], particularly so in areas beyond national jurisdiction (ABNJ), which accounts for > 64% of the ocean and > 45% of our planetary surface. After decades of disposal and exploitation, with other threats rapidly accelerating, this once untouched part of our planet faces an uncertain future [2–5]. The *Mare Liberum* (the sea that is open) mentality that still prevails in international waters [6], in conjunction with the fragmented patchwork of sectoral management bodies that frequently lack the capacity to embrace a holistic approach to managing human activities, not only threaten endemic high-seas biodiversity and ecosystems, but also hundreds of species that straddle the high seas and the coastal ocean [7,8].

In essence, the current management regimes for the high seas are dated and no longer fit for purpose. Over the past century, humanity has ventured further and deeper into the ocean than ever before in search of resources, including food, oil and gas, minerals, for scientific research, or to find efficient trading routes [4,9]. However, it was not until 1982, when the UN Convention on the Law of the Sea (UNCLOS) was opened for signature, that Exclusive Economic Zones (EEZs) were established. EEZs were a political decision to allocate property rights to coastal and island nations over their biotic and abiotic resources and to help secure their economic and food security. With the creation of EEZs, the jurisdictional boundaries of ‘Areas beyond National Jurisdiction’ were formally created. Initially, ABNJ – for the purposes of this paper regarded as synonymous with the ‘high seas’ hereafter – were ostensibly left open for all, often without a corresponding governance framework. Since then, UNCLOS and the two subsequent implementing agreements on seabed mining and straddling or migrating fish stocks across jurisdictions have attempted to operationalise the management of activities in the high seas through the establishment of global or regional management bodies, including to ensure equitable access and sustainable use of biotic and abiotic resources. After 15 years of negotiations, in March 2023 a consensus was finally reached on a draft agreement to ensure the conservation and sustainable use of biodiversity in marine areas beyond national jurisdiction (BBNJ). However, there is a long way to go - 60 ratifications are required for the agreement to enter into force; an institutional framework will have to be created; and the integrated knowledge needed to support effective implementation of the agreement is yet to be generated [10,11].

Despite these advances, the governance seascape for the management of human activities and their impacts in the high seas remains fragmented, sectoral in nature, and often fails to achieve sustainability mandates [12,13]. The majority of these organisations operate through a consensus-based approach, which serves as a protection for less powerful countries, but also facilitates the blocking or vetoing of entire management measures by a single Party. Alternatively, Parties may decide to remove themselves from the convention and still engage in that particular sectoral activity (e.g. Japan leaving the International

Whaling Commission) or seek an exemption to specific regulations that are not in their interest (e.g. Iceland on the International Whaling Commission whaling moratorium).

While the principal sectoral activities (e.g. fishing and shipping) currently taking place in the high seas are dominated by certain nations and companies [14,15], their impacts are felt by many. A similar trend appears to be emerging for seabed mining [16]. The transboundary connectivity of species, ecosystems and processes between the high seas and the EEZs of coastal and island nations inevitably makes anthropogenic activities in international waters of direct concern to all maritime States and their peoples [17,18]. As anthropogenic pressures on the high seas and migratory species increase, transboundary, cross-sectoral management becomes more urgent. However, across most regions, the current governance framework is proving incapable of harnessing the necessary creativity, incentives and buy-in to deliver a joint vision and subsequent roadmap to arrive at a better future.

Systems thinking offers a framework of leverage points for unpacking where to intervene in a system to enable the greatest change [19]. From Meadow’s list of 12 potential interventions, Abson et al., [20] summarise these into four types of system characteristics that can be leveraged towards the goal of sustainability transformations: material or parameters; feedbacks; design and, the set of characteristics with the deepest leverage potential, intent (Fig. 1). High seas governance processes currently influence three of the four realms of leverage: Material, Process, and Design [20]. However, the most impactful area – Intent, which refers to mind-sets and paradigms – is arguably not being sufficiently addressed by the international community. This is where existing frameworks from systems thinking and the social sciences can help. It is increasingly recognised that transformative change is what is required for a more sustainable future for biodiversity [21], but how to put this thinking into practice can be challenging. The iceberg model, for example, is a systems thinking tool that is used to understand the underlying causes of a problem or event by visually representing the event or problem above the surface of the water and capturing the underlying patterns and causes at different levels below the surface [22]. This method helps to appreciate the mental models (explanations of how we think something works in the real world), underlying worldviews or paradigms that lock particular systems in place and that would need to shift in order to allow for a more transformative future to emerge. The three horizons framework is a foresight tool used to structure thinking about what alternative futures could look like and what potential pathways allow for transformations to occur [23]. It provides a structured way to think about what current systems are in place that need to decline and how alternative systems can be nurtured into the future [24].

Changing the fate of the high seas will require a paradigm shift to a new shared vision of the ocean we want across sectors, regions and cultures; something which perhaps may only be attained by generating and communicating different scenarios that lay out alternative models of coexistence between humans and the ocean. Here, we outline a participatory process that was undertaken to share inspirational stories about more desirable nature-centred futures for the high seas and how global society might achieve them. The creative imagining of preferable futures, which included a set of participatory workshops with a strong arts-based emphasis, inspired new possibilities for action that we hope can feed into the ongoing discussions of intergovernmental environmental frameworks.

1.1. Tools for Re-imagining the high seas

“Remember to imagine and craft the worlds you cannot live without, just as you dismantle the ones you cannot live within.” – Ruha Benjamin, <https://www.ruhabenjamin.com/>

There is a critical need to engage with our imaginations to be able to draw on more creative and dynamic stories about the future for improved decision-making in the present [26,27]. Stories are powerful in that they have the ability to create alternative futures; if we tell ourselves stories of despair and collapse, that is the more likely outcome, but if we are able to draw on stories of hope and change, these could become enablers for transformative change towards better futures [28]. However, as demonstrated by the *Radical Ocean Futures* scenarios developed by Merrie et al. [29], there is also a need to address the contested reality of what a desirable future is [26,27]. Scenarios can be used to keep track of what sort of future is emerging, and how to steer a trajectory towards one that is more socio-economically and ecologically sustainable. Any effort to steer towards a ‘desirable’ trajectory must engage with the normative discussion of what is and is not desirable, and for whom, and who is invited to the table to discuss desirability in the first instance [26,27]. This is where it is critically important to be explicit about the different values and worldviews that people hold, sometimes even in contradiction to each other in various times and places.

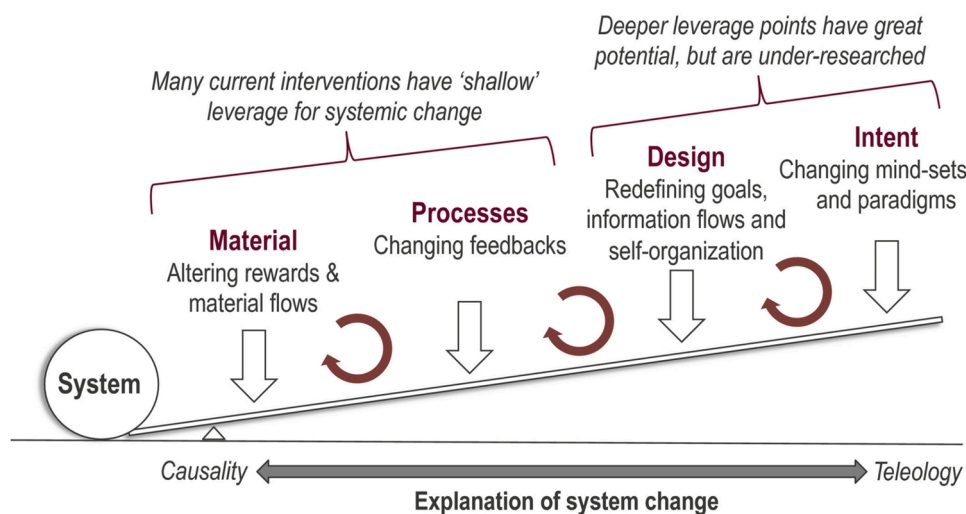
Future visions of a transformed ocean are rare (e.g. [29–31]), even more so what a desirable future for the high seas could look like from a diversity of perspectives and forms of knowledge [32]. Planque et al. [33] first detailed the development of separate scenarios based on distinct perspectives and subsequently described a process for the integration of these individual scenarios into multi-perspective, imagined futures [33]. However, according to Nash et al. [34] this two-step approach does not allow for end-to-end interdisciplinary collaborations that integrate worldviews from the outset. A lack of appreciation of difference by those with their own divergent perspectives can lead to conflict rather than cooperation as each tries to overrule the other with the powerful tending to win the day. Governance therefore becomes more difficult to negotiate as there is no clear idea of where it is we want to navigate towards, let alone a recognition of the potentially divergent pathways that different groups may want to take towards these alternative futures. We argue that given the current context of ocean governance negotiations, it is essential to co-produce a range of desirable visions for the high seas with key stakeholders, some of whose

perspectives may differ, if we are to transform the current system by leveraging a deep paradigm shift in values, goals and worldviews. Values help define what matters for communities and in situations involving a range of different stakeholders, it is important to ensure that their diverse voices are heard and included in the development of management options [35]. The need for such an approach is now being recognised within the biodiversity community [36–38], and was the main motivation for the development of the Nature Futures Framework (NFF) by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Task Force on Scenarios and Models [39].

The NFF builds on an ongoing scholarship that engages with the need for a diversified framing on values of nature and its contributions to people, including an emphasis on relational values [40]. It is a framework to capture diverse, positive values for human-nature relationships in a triangular space (Fig. 2a). Each vertex represents one of three perspectives for valuing nature: nature for nature, nature for society, and nature as culture. These build on the three values of nature (intrinsic, instrumental and relational, respectively), reconfiguring them to co-exist simultaneously and allowing for a heuristic that is actionable for the modelling and scenarios community (Fig. 2b). The NFF triangle illustrates how it is possible to emphasise a complex mixture of values for appreciating nature depending on where in the triangle you are situated and thus allows for a plurality of perspectives to be held in different times, contexts and spaces.

Recognising the need for more pluralistic, transformative and positive scenarios for nature, the IPBES task force on scenarios and models developed the NFF for use in research and governance processes that require a sense of what potential futures could be possible, even the more radical. There are an increasing number of examples employing the NFF, such as for restoring European landscapes [41], for the Atlantic forest in Brazil [42] and for urban environments [43]. A number of these use arts-based collaborations to enable a more imaginative process in scenario development, such as for the case study of the Hollandse Duinen in the Netherlands [44], for unpacking youth perspectives on nature futures [45] and in using African speculative fiction to help reveal what narratives currently exist to help imagine alternative futures [46].

Given the imagination gap that the NFF is trying to fill between recognizing the need for change, and conceptualising what a transformed future could look like, we propose it as a good starting point for a discussion on what governance and future relations between nature and humanity in the high seas could entail in the medium- to long-term future. Within the marine context, existing research already looks at



Adapted from D.J. Abson

Fig. 1. Illustration of Leverage Points for System Changes. Source: Fischer & Riechers [25] adapted from Abson et al. [20].

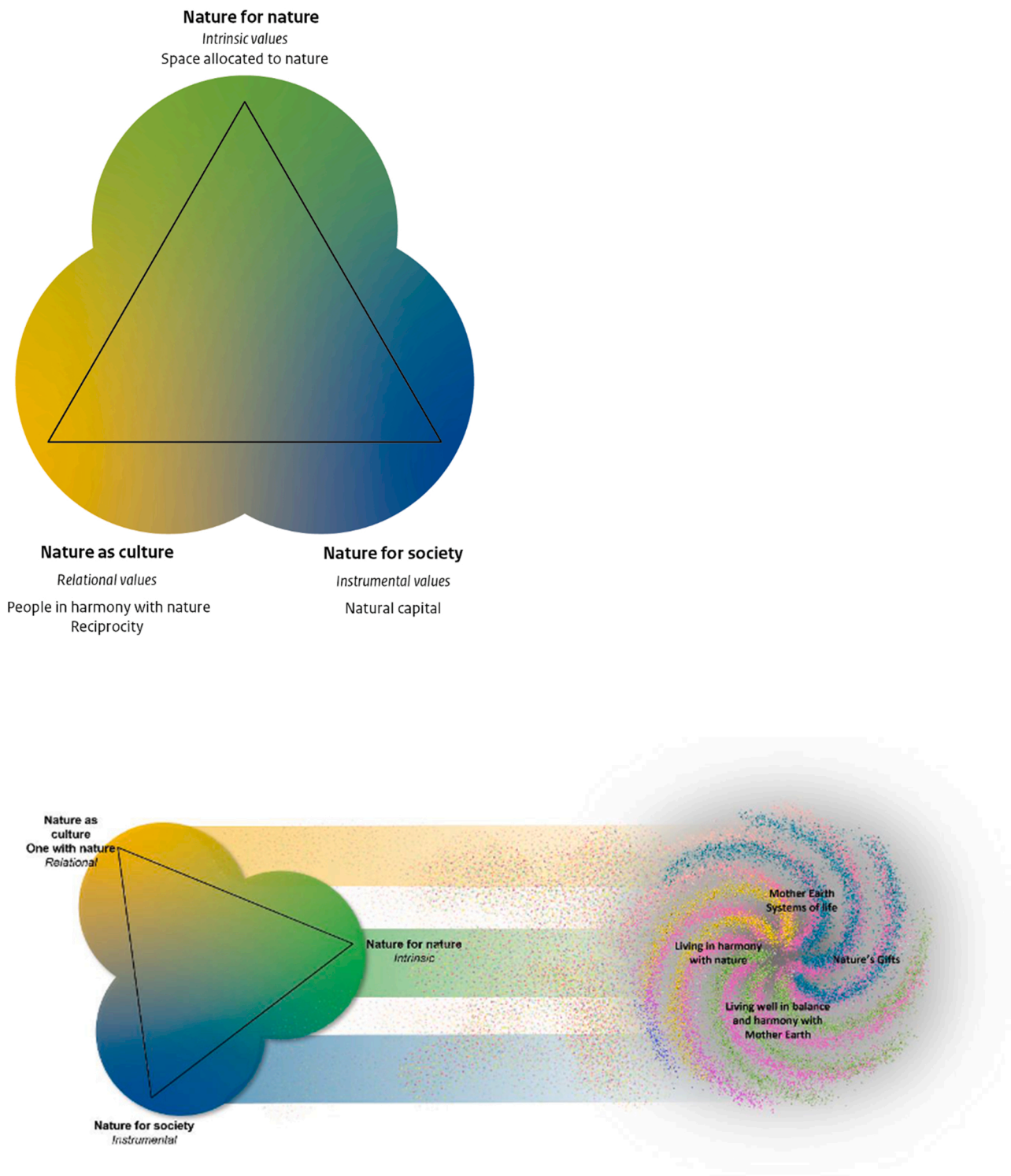


Fig. 2. (a) The simplified triangular space of the Nature Futures Framework that we used for the workshops (Source: IPBES Task Force on Scenarios and Models); (b) The Nature Futures Framework: A flexible tool to support the development of scenarios and models of desirable futures for people, nature and Mother Earth, as negotiated during the IPBES 9 Plenary (Source: IPBES Task Force on Scenarios and Models).

aspects of the different corners of the NFF triangle, but none of it has been brought together into one framework. For example, the rights of nature approach as applied to the high seas, which is deeply embedded within, but not exclusive to, the *Nature for Nature* value perspective, increasingly emphasises how “legal systems should recognise nature as a rights-bearing subject, rather than an object owned and controlled by humans” [47]. There is also work that directly seeks to link traditional

knowledge systems to the development of the biodiversity beyond national jurisdiction treaty, which forms a component of the *Nature as Culture* value perspective of the NFF [48,49]. Probably most research to date focuses on the *Nature for Society* value perspective where the largest high-seas sectors of fisheries, oil and energy, shipping and underwater cabling are engaged [50]. Emerging industries, such as seabed mining, offshore renewables, climate interventions, or marine genetic resource

harvesting must also be included in the generation of future scenarios [51–53]. Accounting for socio-economic trends, such as seafood production and green-technology mineral requirements, or climate change trajectories, is crucially important to craft reliable future scenarios that capture the likely emergence of new patterns of use or risks and how they could be better managed by current or future actors [54–56].

Below we set out a process, working with a small subset of diverse stakeholders and interest groups, to determine what a desirable future for the high seas might be. We lay out the process and outcomes of a deep exercise in participatory futures thinking to derive a set of visions and scenario skeletons.

2. Methods

The participatory scenario-building process consisted of a series of in-person and online workshops. The overarching structure of the online workshops followed the general structure of the three horizons framework [23], but adapted further from the more linear, innovations-led approach. Referencing the three ‘horizons’ of the framework- present, future, and transition space- we hosted three online workshops with a group of high seas experts (Fig. 3). Workshop 1 aimed at determining challenges to the high seas in the current regime that need to be overcome (Horizon 1); Workshop 2’s goal was to imagine visions of the high seas in the future using the NFF (Horizon 3); and then Workshop 3 started a discussion of how to get there (Horizon 2) that was to be preparatory work for the fourth, in-person meeting that aimed to refine all of these steps and included a creative arts-based activity.

This was intended to be a participatory process, but since it is impossible to get full representation of all stakeholders for the high seas, we designed it as an expert-led process. This lessened the power dynamics of the co-creation process, but we were mindful in the group allocation process to ensure that everyone in each group would feel comfortable to speak out. There is no perfect solution to addressing power in participatory processes other than to be mindful of the dynamics and to make sure that the space enables all voices to be heard [57,58].

As it is critical to have a representative mix of people in the room when undertaking such processes, we chose participants based on three factors: (1) that their work connected strongly with the high seas; (2) that there were diverse perspectives represented (i.e. research, but also

governance and business); and (3) that we had a good range of ages, geographies and gender identities represented. As workshops required a substantial commitment for attendance at 3×3 h online sessions over the course of 6 months, we started with reaching out to experts with whom either the convenors or the advisory board of the project had connections and then snowballed further participants from there (See [supplementary material](#)). The final participants were diverse in terms of their expertise on marine issues; from fisheries experts, marine ecologists and modellers to practitioners and activists across career stages, representing all inhabited continents. Crucially, many of the participants play active roles in shaping the future of the high seas knowledge production and governance spheres, whether through participating in ongoing negotiations or undertaking scientific research that will inform these negotiations. All participants were asked to sign a consent form prior to the workshop and it was agreed that Chatham House rules would be followed. Those who chose to be involved are all co-authors on this paper. Ethical approval for the research was granted by the Stockholm Resilience Centre at Stockholm University in May 2021.

Given the global distribution of workshop participants, each of the three online workshops had two sister replicate sessions on separate days to account for the different regional time zones and availability of the participants: Africa, Asia, Europe and Oceania on the first day, and Africa, Europe and Americas on the second day. The same structure was followed for sister workshops.

Online workshop 1: challenges in horizon 1.

A step-by-step explanation of the methods followed is available in the workshop report [59]. In summary, the first workshop focussed on identifying challenges. We had a total of 26 participants and five facilitators from 20 + different countries and a variety of sectors including academia, private, governmental and inter- and non-governmental organisations (See Workshop 1 report for more information on participants). The main objectives of this first workshop were to acquaint participants with the NFF and three horizons frameworks and to identify the main challenges associated with the high seas using the S.T.E.E.P. (Societal, Technological, Economic, Environmental & Political) categories as discrete guiding categories for identifying said challenges. Participants identified the challenges that they thought were most important to the high seas in the present and then went through a ranking exercise to identify those that were most pressing, but also the most challenging to deal with. These became the input challenges for

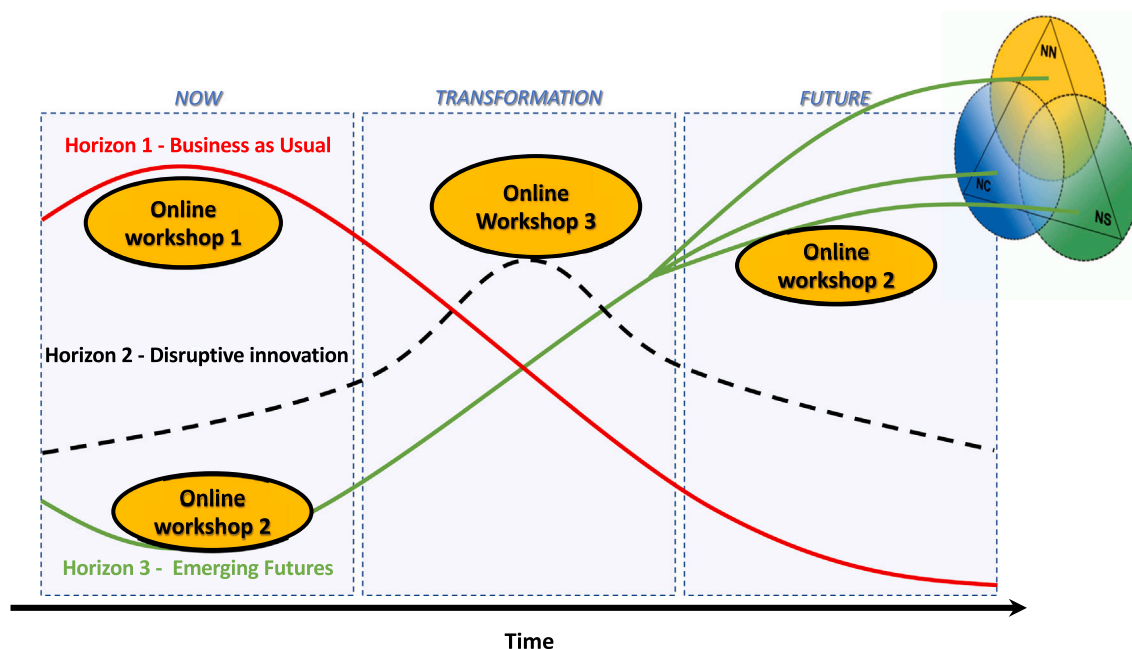


Fig. 3. Organisational diagram of the three online workshops, following the three-horizons framework[23].

workshop 3 on pathways.

Online workshop 2: aspirations of horizon 3.

The aim of the second workshop was to explore the Third Horizon (Fig. 3) through imaginative worldbuilding and storytelling methods. A diverse group of 30 stakeholders joined an online workshop in three parts to undertake a creative process to define transformative visions for the high seas. Participants co-designed futures in line with the three different corners of the NFF: Nature for Nature, Nature as Culture and Nature for Society. The main method for story building follows a similar protocol to science fiction prototyping, which brings scientific and objective empirical understandings of the world into dialogue with imagined - sometimes seemingly implausible - futures. Science fiction prototyping is a productive fusion of science and storytelling [29]. A core objective of this workshop was to overcome current mental models and transcend ways of thinking that tend to extrapolate and reinforce the status quo [60]. This required enabling the freedom to think and try what may seem impossible, despite the constraints of being in an online environment. In line with this, the workshop structure was planned

around a series of steps that could depart from current knowledge in order to then transcend it and enable a collective creative process. This process was facilitated by the design of a generative tool [61] in the form of virtual worksheets in the online tool Miro (www.miro.com). Three spaces were developed with the aims of: synthesising participants' contributions, supporting facilitation and conversation, and the possibility for participants to develop a storyline based on previous contributions. In addition, creativity is also influenced by non-rational processes such as emotional states or intuition [62]. To this end, the facilitators made use of inspirational images, music and multiple references to visual or other sensory qualities: colours, shapes and smells.

During the workshop, we combined the approach from "Seeds from the Good Anthropocenes" project (www.goodanthropocenes.net; [24]) in conjunction with science fiction prototyping [29,63]. Using the 'Seeds approach', we asked each participant to submit their idea of a seed – 'a process, initiative or way of seeing the world' that was currently marginal, but that they thought could contribute to a better future for the high seas [24]. Participants were allocated into the three breakout

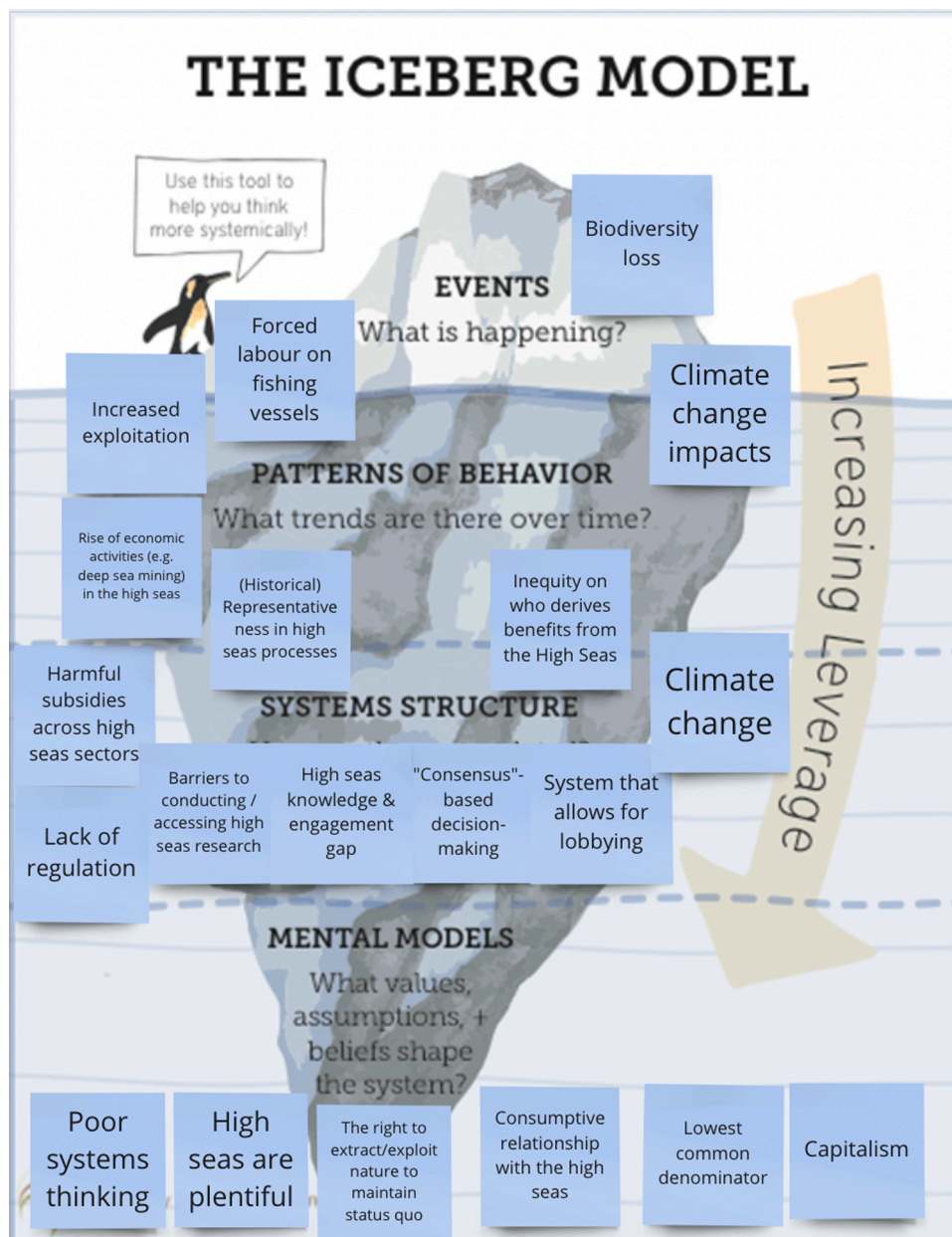


Fig. 4. An example of mapping the challenges onto the iceberg model.

groups formed around each corner of the NFF triangle to discuss a future, where either instrumental values for nature (Nature for Society), intrinsic values for nature (Nature for Nature) or relational values for nature (Nature as Culture) were emphasised. Each of the seeds (see Appendix in [64]) was allocated to a corner by the participant as they introduced the seed, but for purposes of keeping groups equal in size and mixed in terms of geography and expertise, the three groups did not always have all the people who had submitted seeds to that corner. As is outlined more fully in Chibwe et al. [64], each group had rich discussions about their seeds, what they represented and how they could grow to contribute to better futures. The result was a set of stories about the future of the high seas focusing on each corner of the NFF triangle. To help with the development of the narrative, each group started their narrative journey on board the same ocean research vessel, the “Manta”. Additionally, to push for more transformative, creative thinking, a set of seven outlandish characters were defined prior to the workshop by the workshop coordinators and allocated to each story based on their corner and a throw of the dice (see Appendix 2 in supplementary material). This allowed for common threads through the stories, although not all original characters are in the final stories and some new ones emerged.

Online workshop 3: pathways in horizon 2.

The final online workshop was a precursor to the in-person meeting aimed at initiating a conversation on what sort of pathways could address the challenges identified in workshop 1 to get to the futures described in workshop 2. The starting point for this workshop was the

‘iceberg model’ where the group categorised the challenges as events, patterns of behaviour, systems structures and, at the deepest layer, mental models (Fig. 4) [22]. This generally followed the leverage points approach where deeper points of leverage are linked to paradigms and mental models [20]. Based on this categorisation, the group chose challenges that they wanted to unpack for the first session of the workshop. These challenges were: lack of regulation and enforcement, consumptive relationship with the high seas, and decision-making in the high seas.

For each of the three challenges, the direct and indirect drivers as well as the relevant actors related to the challenge were mapped. Then, the potential responses to address these drivers and the responsible actors that could enable these interventions as well as potential barriers to these responses were identified. The second session focused on choosing the seeds that are most relevant for addressing the identified challenges and to map what needs to be done to enable the seed to grow (enabling conditions), who needs to do this (actors), and what the barriers to the seed growing are. In summary, the most important ideas from the group discussions were all placed on the ‘three horizons’ diagram to illustrate what needed to be done for the current system to decline (addressing present challenges in Horizon 1) and for the future system to grow (enabling the seeds in Horizon 3) (Fig. 5).

In person Workshop 4: Putting it all together creatively.

A smaller group of participants who were able to travel met in Cape Town from 28th February - 3rd March 2022. Six participants

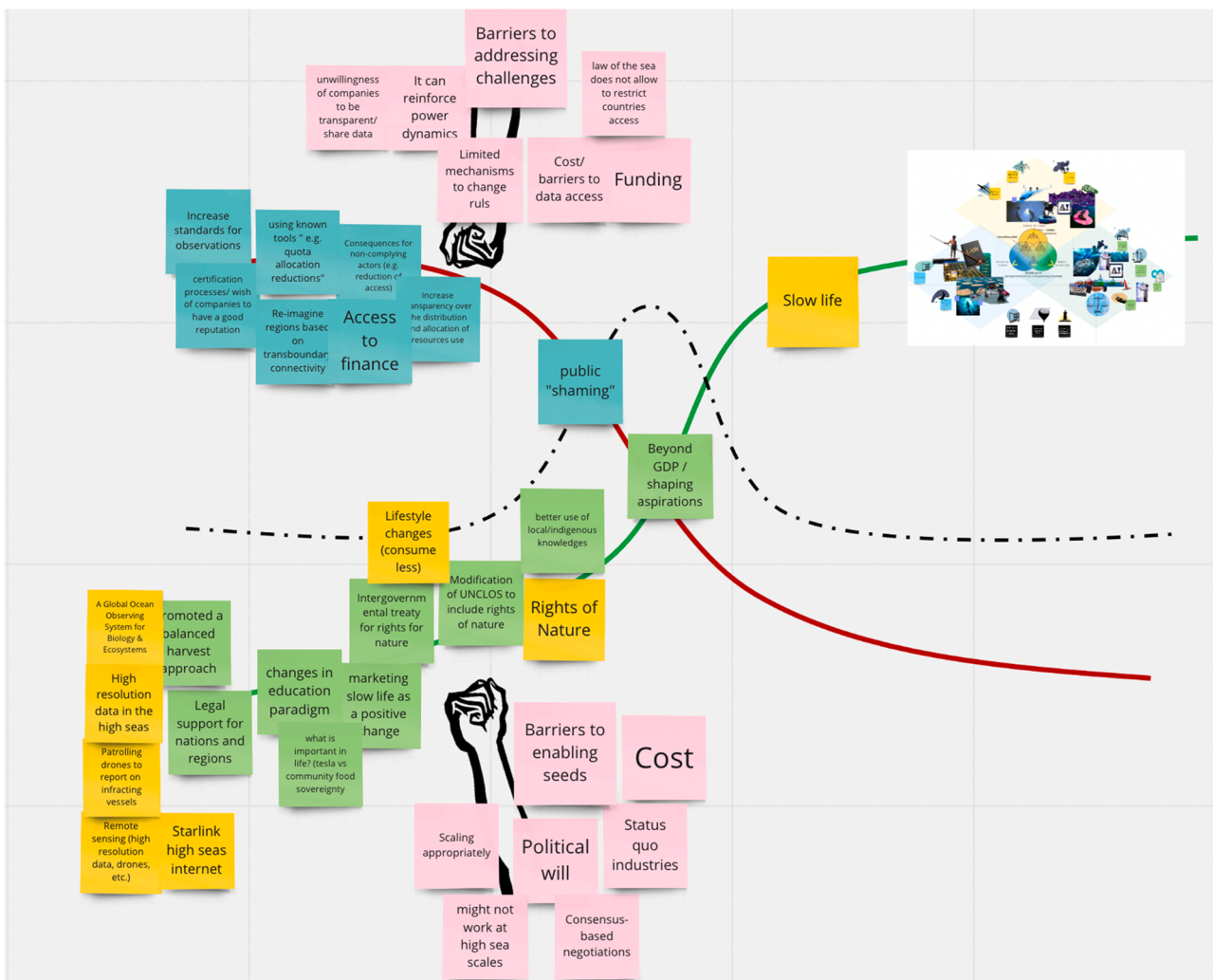


Fig. 5. Mapping the interventions on the Three Horizons diagram and the potential barriers to allowing the system to decline and to enable the future system to grow.

representing research, governance and practitioners, and the two co-convenors met at Monkey Valley resort, Noordhoek, Cape Town for four days of workshoping to finalise the scenarios that were emerging from the process. The structure of the workshop followed a synthesis of all the previous workshops to consolidate the findings and connect them using the framework illustrated in Fig. 6.

An important addition was the use of an immersive artistic experience facilitated by CareCreative and documented by Sandile Fanana. Using paint and junk items, participants co-created a visual representation of each of the Horizons, starting with the chaotic challenges in Horizon 1 (Fig. 7) and then the calming end point visuals of Horizon 3 (Fig. 8). Finally, through a performance, they enacted how the transformation from one system would need the current system to break down and allow the alternative future to emerge, Horizon 2 (Fig. 9, Video 1). This shared creativity allowed the group to land in a similar understanding of what the journey from the present to the alternative futures could look like and made it easier to agree on the specific pathways.

3. Results

In this section we present the results from each of the workshops using the Three Horizons framework to structure the presentation. Starting with Horizon 1 (the outcomes from online workshop 1), Section 3.1 presents the results on the challenges. Section 3.2 presents the results on the pathways of what needs to be done for the current system and its challenges to decline and for an alternative system to grow (Horizon 2), and Section 3.3 summarises the narrative accounts of the future worlds (Horizon 3).

3.1. Problem space and challenge prioritisation

The high seas are subject to a wide range of direct and indirect stressors which act cumulatively and degrade the health of multiple ecosystems in this shared portion of the ocean. Through the two iterations of the first online workshop, participants identified 135 S.T.E.E.P. challenges that are currently eroding the resilience and health of the high seas. These challenges were further contextualised using six themes, which alongside the categories in S.T.E.E.P. provide a useful bi-axial framework through which we can define and refine the ‘problem-space’ for the high seas, as well as classify the innovative solutions and



Fig. 7. Painting Horizon 1: Present Challenges.

potential pathways for transformation that participants identified in subsequent workshops.

- Theme 1: Overexploitation / pollution / climate change.
- Theme 2: People’s attitudes and cultures.
- Theme 3: Disparities / cohesion.
- Theme 4: Legal frameworks.
- Theme 5: Data / knowledge / actionable intelligence.

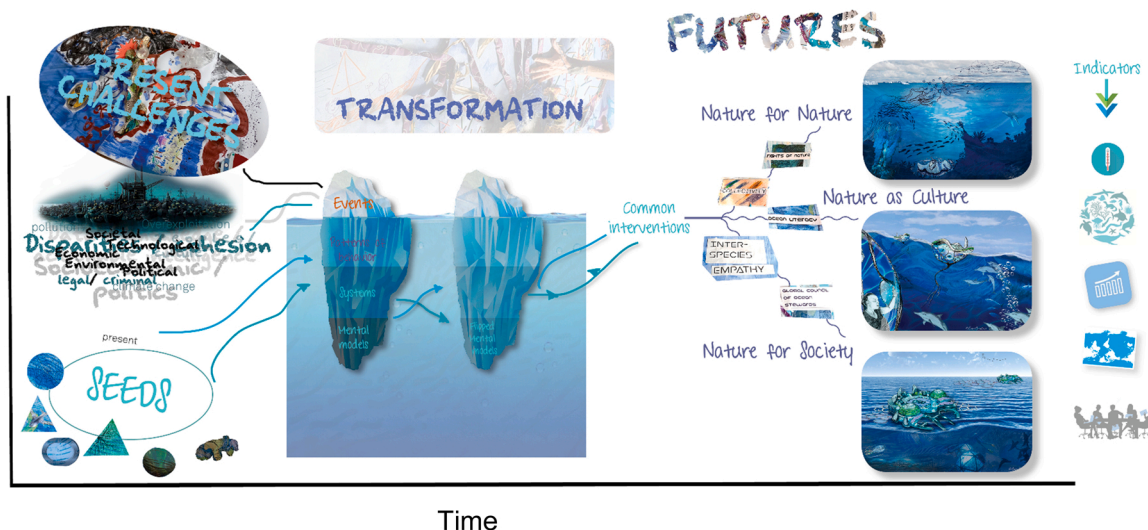


Fig. 6. Overarching process adapting the three horizons framework. Starting with challenges and seed ideas in the present (left side) and then moving through a transformative process of flipping paradigms through the iceberg model (middle), that offers the common starting points for the three more preferable futures to emerge on the right and brainstorming the indicators that would be needed to measure progress.

Source: Authors’ own.



Fig. 8. Painting Horizon 3: Future Potentials.



Fig. 9. Video 1: Painting Horizon 2: Transformation....

Theme 6: Socioeconomics / politics.

Participants in each of the two Workshop 1 sessions engaged in a ranking exercise to identify what they perceived were the ten most important challenges (Table 1):

3.2. The road to high seas transformation

The final iceberg models (that categorised challenges into events, patterns of behaviour, systems structure or mental models) highlighted some key challenges in our current mental models of the high seas that need to be addressed before transforming to a more sustainable

Table 1

Top 18 expert-derived challenges which are currently eroding the resilience and health of the high seas across S.T.E.E.P. categories.

Category	High Seas Challenges
Political	1. Private sector lobbying for exploitation
	2. Creating a cohesive vision with what should be prioritised nationally and internationally
	3. Consensus decision-making in global policy arenas
	4. Consensus-based decision-making / lowest common denominator
	5. Importance of systems-thinking to understand the teleconnections between impacts / regions
Technological	6. The vastness of the ocean is a challenge - you can't use satellite imagery to see under it (only the sea surface and the seabed)
	7. High cost of collecting data in the high seas
Societal	8. National interests prevail over international concern in protecting the high seas
	9. Intergovernmental processes are not inclusive enough (environmental justice)
	10. Patriarchal / capitalist consumptive relationships with the high seas
Environmental	11. Not well understood enough to manage - very little data, processes not understood, oceanographic processes inferred
	12. Forced labour on fishing vessels
	13. Climate change impacts
	14. Biodiversity loss in ABNJ, including lack of understanding of the environmental and ecosystem-level impacts such as cascades
Economic	15. Rise of economic activities (e.g. seabed mining) in the high seas
	16. Capitalism's perpetual growth model
	17. Harmful subsidies across high seas sectors
	18. Inequities - who can profit in the high seas

relationship. This aligns well with the proposal by the IPBES Task Force that refers to the need for both common features of the NFF (that need to be the same for all futures; that build the normative aspect of what's inside the triangle- or desirable- rather than outside the triangle- what is not desirable) as well as specific features determined by the value perspectives in the corner. Challenges and their flipped mental models are emphasised in bold in the following text.

These common features included powerful socioeconomic forces such as **capitalism** that precondition a **consumptive relationship** with the high seas as places where people have the **right to extract nature**, creating a self-reinforcing feedback loop that maintains and entrenches the status quo. This particular condition may have been instigated by Article 87 of the United Nations Convention of the Law of the Sea, which lists a series of high-seas **freedoms**. At the same time, the notion that the **high seas are plentiful** reinforces this extractive mentality. A problematic governance factor identified is that the current consensus-based decision-making frameworks are leading to a **lowest common denominator** in decisions rather than an aspirational outcome. A more general observation was **poor systems thinking** that leads to siloed decision-making and a lack of a comprehensive overview of high seas governance and actions.

In order to 'flip' the iceberg from a base comprised of problematic perceptions and understandings to one where mental models comprise a sustainable foundation, these challenges needed to be addressed. The current capitalist socio-economic paradigm was replaced by a more **collective feminist approach** that emphasised **sustainable and equitable living** where the common good was underlined. This also took into account the need for an **equity-based approach** that took redistribution of access and resources into account. A more **stewardship-like relationship** with high seas resources was also needed, embedded within conscious thinking about the **limits of high seas resources**. A **whole systems approach** that had foundations in **long-term thinking** rather than short-termism was another paradigm shift that needed to be undertaken. Finally, a fundamental aspect of the flipped iceberg model was to ensure that **nature has legal rights**.

Having flipped the icebergs, the group realised that there would be a

series of shared actions that still needed to be accomplished before the trifurcation into the three scenario pathways. As pointed out in the methods, the group was also fully aware that key specific actions leading to the change in mental models in the flipped iceberg are also critical to unpack, but that this required further engagement to do it justice. The following interventions were deemed critical across all the pathways and so formed the starting point of the second horizon for each of the three narratives. These align with the ‘common features’ described in the methodological guidance of the NFF (IPBES 2023).

Institutional reform was seen as a core area of change. Inclusive and participatory management is critical for sustainable futures to arise, as is the need to institute a precautionary approach to management. One suggestion was the need to govern at the level of social-ecological systems in the high seas rather than sticking to old models of jurisdiction. Long-term thinking could be instituted by ensuring that future generations have legal representation- thinking that stems from the Seventh generation principle of the Haudenosaunee Confederacy (Iroquois) that states the decisions we make today should result in a sustainable world seven generations into the future. Similarly, the need to ensure that nature has legal representation (emphasising the nature has rights discourse that was also brought up as a seed during the second workshop) could also eventually lead to a cultivation of inter-species empathy.

Scientific foundations included the need for ecosystem-based metrics and indicators for monitoring systems health/change and assurance that data are open access and transparent in terms of who has generated it, how and for what reasons. The need for decolonising science and from that, metrics (e.g. alternative measures of economic well being), was a critical intervention that could also ensure that more diverse knowledge systems are recognised and valued. Such a move would require new monitoring technologies, such as AI and blockchain to monitor catch composition, as well as an eDNA monitoring network in conjunction with non-scientific ways of measuring change and perceiving the environment. At the same time, the need to measure human impact beyond just what humans are able to perceive, such as sensory perception beyond human aural and visual ranges, would need to be developed.

Through a more transparent system of generating data (across multiple knowledge systems), evidence-based decision-making could then move beyond politics and focus on the actual state of play requiring action, based on a more holistic understanding of what needs to be monitored and tracked. Ensuring that consumption is commensurate with needs would be another key requirement, stipulating some sort of consumption threshold and leading to a more equitable allocation of access, benefits and burdens across nations and peoples. These interventions led to a common starting point of the need for an Ocean stewardship council, already mentioned by participants at the start of the second workshop. It was also clear that UNCLOS 2.0 would look different in the different future worlds (based on the need to allocate access across different regimes), but that its reform was essential to shifting towards a better trajectory. There was also a need to define the relationship between the EEZs and high seas. In some instances, the removal of the classification between national and international waters made sense, but in others it could be seen as alienating. As different governance regimes emerged at different levels for the three futures, it became clear that the EEZs and high seas could be re-defined in the three emergent futures as follows:

Nature for Nature: high seas as human no-go areas versus EEZs defined as areas where humans can use the ocean (where access is not necessarily based on coastal access).

Nature as Culture: No EEZs as all ocean is held as a global common.

Nature for Society: EEZs and high seas need to be aligned in their management as they are interdependent.

The subsequent three branching points were then the specific features that defined the different pathways leading towards the three corners of the NFF in a more exploratory scenarios framework. Finally, a brainstorm of potential indicators in these futures worlds was also

developed and clustered into environmental, economic, social and political. (Table 2). Please note this is in no way meant to be exhaustive, but is a starting point for a more quantitative analysis and could be helpful for ecosystem-based management approaches.

3.3. Future worlds

Here we present short summaries of the stories that were developed to describe the futures worlds as well as their accompanying artworks. For each, we present the artwork followed by a short summary of the key transformative elements of the future and then a synopsis of the storyline (story synopsis). The full stories are available online at this reference [65]. The stories are not chronological, but intended as parallel futures with potential links and pathways between them. Due to the level of technology and progress in each of the stories, the reader may pick up a temporal logic to the order in which each of the stories is presented here. This is more for ease of reading than to put them on any single timeline. However, it may help if the reader jumped ahead a few decades in their mind in-between reading each narrative. These stories are not intended to be utopian, but they hopefully offer a pause to reflect on where we want to go and how we might get there....

3.3.1. Nature for society - the Nemo chronicles

Transformative elements explored in the scenario:

The negotiation of a new law of the sea treaty is a key foundation for this future world. However, in this future, the focus of the new governance instrument is in enabling heavy investment in advanced technologies to enhance the relationship between humans and the ocean. Overall, governance is overseen by a Global system that operates out of One Blue Station, a state of the art floating research and decision-making platform. Human-ocean relationships are based on science and science drives almost all ocean literacy. Robots exist that fish selectively on the high seas; and those operating fisheries use science as the foundation for their operational and strategic decisions. Vessels are equipped with both advanced sensor suites and highly selective gear that eliminates bycatch. To support analysis of and equitable access to vast amounts of open data, high speed internet is universally available, no matter how far out to sea. In terms of overarching legal structure, there is a ‘Universal Court’ that has dispute resolution jurisdiction over all activities that take place on the high seas, or affect them. Corporations and individuals are aggressively prosecuted in support of extreme accountability. There are also stringent and technologically sophisticated Monitoring, Control, Surveillance, Enforcement and Compliance systems operating in the high seas. Commercial entities can benefit from activities on the high seas, but profit levels are capped via a high seas operational tax, and activities are closely monitored. People live on the high seas in a diverse set of seasteading communities. Climate change impacts continue to unfold, with climate refugee shelters in operation on the high seas. The key principle governing operations in the high seas is sustainable use of living as well as non-living resources embedded in a collectivist approach drawing on feminist governance and international relations theory. (Fig. 10).

Story synopsis:

In this story, we learn about the unscrupulous adventures of the infamous gene pirate ‘Agent Nemo’ who mysteriously disappeared, bringing to an end his decade long criminal enterprise of stealing marine genetic sequences and then selling them to the highest bidder. The story is told from the perspective of scientists on One Blue Station and the crew of the enforcement vessel Manta who have been victims of Agent Nemo’s piracy many times. The discovery of a new species of deep-sea turtle rocks the station and those empowered to govern the high seas. The race is on and as the story concludes, the crew come face to face with the white whale himself, Agent Nemo.

Table 2

Brainstorm of potential indicators that would be needed to measure impacts and improvements in the future worlds as well as whether the indicators exist and are available at an appropriate scale for the high seas.

Class	Indicator	Does the indicator exist?	If yes, available at scale for the high seas?	
Abiotic indicators	Ocean temperature	Yes	Yes	
	Sedimentation	Yes	No	
	Water column stratification & mixing	Yes	No	
	Water chemistry (pH, nutrient concentration, salinity)	Yes	No	
	Oceanographic connectivity	Yes	Yes	
Biotic indicators	Horizontal and vertical nutrient cycling	Yes	No	
	Trophic Index and Efficiency	Yes	No	
	Passive and active connectivity models	Yes	No	
	Species distribution and abundance/density estimates	Yes	No	
	Genetic connectivity / metapopulation estimates	Yes	No	
	Nutrient cycling capacity of ecosystems	Yes	No	
	Carbon sequestration capacity	Yes	No	
	Ecosystem genetic and functional diversity index	No	No	
	Population Status and Vulnerability	Yes	No	
	Anthropogenic disturbance indicators	Phenological disturbance index	No	No
Species nutritional performance indices		No	No	
Multi-species Nutritional Maximum Sustainable Yield		No	No	
Acoustic, chemical, light, endocrine disruptor pollution		Yes	No	
Species response velocities to climate change		Yes	No	
Number, size and impact of seasteading communities		No	No	
Species distress index (hormone levels, genetic disruption, stressed induced mutations)		No	No	
Integrated ecosystem health index		Yes	No	
Spatial Climate Change Vulnerability Index		Yes	Yes	
Index of ecosystem services valuation and performance		Yes	No	
Ocean literacy level (number and effectiveness of education levels)		No	No	
Performance and management		Indices for spatiotemporal anthropogenic overlap with nature	Yes	No
		Exclusive Economic Zone anthropogenic impact export index	No	No
		Sustainable ocean investment index (NBS, restoration, etc.)	No	No
		Equitable resource access index	No	No
	Multilateral management performance index	No	No	
	Representativity and inclusivity index	No	No	

Table 2 (continued)

Class	Indicator	Does the indicator exist?	If yes, available at scale for the high seas?
	Cultural heritage integration index (TK, LC, etc)	No	No
	Resource utilization/circularity index (RRR-based - reduce, reuse, recycle)	Yes	No
	Human-well being index (in relation to high seas health and access)	No	No
	% Ocean explored biophysically (mapped, characterisation, etc.)	Yes	Yes
	% Ocean understood ecologically	Yes	No
	% Ocean monitored	Yes	Yes
	% Ocean protected	Yes	Yes
	Sectoral compliance-enforcement indices	Yes	No
	Human biomimicry index (visual, chemical, acoustic integration)	No	No

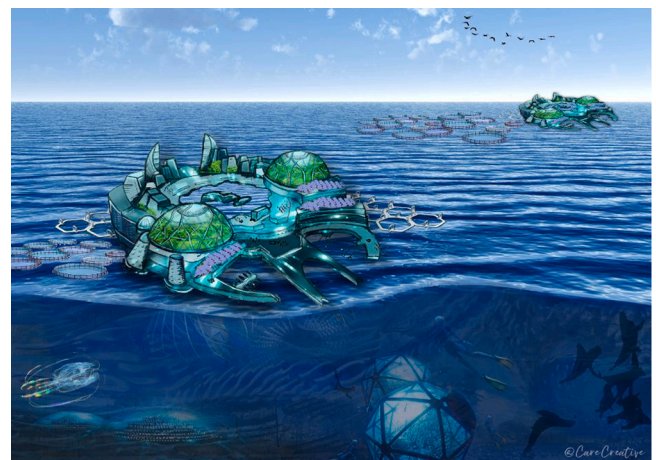


Fig. 10. The Nemo Chronicles © Care Creative (shared with permission).

3.3.2. Nature as culture - polycultural fractals of the ocean Transformative elements explored in the scenario:

Here, a starting point for the scenario was a shifted relationship between humans and nature. In this future world, the human-nature relationship is built on deep empathy, an intrinsic sense of equality and a foundation in fairness within human societies and between nature and humans. Both spirituality and folklore have become more prominent as attributes of human relations, and spiritual-based visions of desirable human-nature futures show potential for inspiring transformative ocean governance. Governance is focused on a devolution from the global to the local. A feature of these local governance systems are pockets of micro-sovereignty where local groups take decisions and have control over different processes and activities such as community-based sustainable fishing and family farming. This devolved governance system is enabled and supported by a singular economic system. This world has a large number of interacting community-based economies, which includes sharing and bartering. In terms of the legal system, redistributive justice is a significant focus, with an approach emphasising human rights. Corporations must be accountable for having been granted personhood and the responsibilities this entails under the law. They are held to account for disasters that are worsened by their

activities past and present, and culture-related crimes that impact on human rights. Punishments for corporate malfeasance can be harsh, including dissolution and/or economic reparations. Corporations can no longer settle out of court, but must face their accusers and defend themselves in every case. Technology supports circular processes, including multitrophic, integrated aquaculture. Education is accessible, community-based, focused on ocean literacy and centred in cultural and spiritual values that acknowledge and uphold different knowledge systems. On the high seas, seasteading exists, whereby humans inhabit the oceans on floating structures, but these are there mainly in support of those who may have lost their original, traditional, historical relationship with the ocean (including climate refugees). However, it closes with a reflection on how despite our best intentions, humans still need to learn more about the kind of impacts that we have on nature, opening up for a wider discussion on empathy. (Fig. 11).

Story synopsis:

We join this short science-fiction story as Ehukai is reflecting on the life and achievements of their grandmother, Sefina Tausa'afia, celebrated lawyer and advocate for nature and marginalised ocean communities around the world. They reflect on her life from the artificial island, the Polynesian Seastead in the Oceania Protected Area. The story finds Ehukai in a reverie preoccupied with the negotiations for the law of the Sea Treaty 2.0, which was finally signed into force in 2082 after coming so very close to failing. During their reminiscences, they remember pivotal turning points driven by two singular and strange personalities; Zalazar Crobuzon, the mayor of the Scar, an anarchist community of climate refugees and, the human-shark hybrid and multispecies rights advocate Adoara.

3.3.3. Nature for nature - sentient stewards of the sea

Transformative elements explored in the scenario:

The point of departure for this scenario is the negotiation of a new Law of the Seas Treaty: UNCLOS 2.0. This treaty and the scenario puts Nature centre stage. Resources are directed towards better understanding nature and developing appropriate technologies to further such understanding. A key provision of the UNCLOS 2.0 is that Nature is granted personhood and therefore must be considered to have rights equal to humans, which has multidimensional implications that are addressed in the scenario. Supporting treaties such as the Convention on Biological Diversity must also transform accompanied by radical change in jurisdiction, which creates an enabling environment for not only protection of vast areas of the high seas, but a focus on restoration and rehabilitation. Due to the focus on nature, direct human presence in the high seas is severely limited, but there is a network of floating stations

that has a mandate for restoration and to support augmented carbon sequestration. As an implication of the granting of personhood to non-human entities, there is a fledgling 'Convivium' being set up that has non-human representation and may prove to be a successor of the governance institution; the 'Global Ocean Stewardship Council' featured in the other stories. This institution is supported by an enhanced international criminal court focused on environmental crimes and ecocide. The high seas in this future scenario includes extensive protected areas that are complete no-go areas for humans. They are vulnerable to pathogens, invasive species, and other threats and so are monitored extremely closely with a network of sensors that can assess in-situ conditions in real time and evaluate them against ecosystem thresholds and then act accordingly. A key transformative feature envisaged in this scenario is an increased ability to enhance the natural carbon sequestration capacity of the high seas. (Fig. 12).

Story synopsis:

This short science-fiction story joins Ofera and her crew on their vessel the Manta in the 2100s. Ofera and her team are part of the Ocean Stewardship Convivium that are tasked with monitoring, rehabilitating, repairing and restoring the ocean. During the story, we meet Jeremy, a timid sentient microbe, who, along with many other species have been granted personhood as sentient beings and manage the ocean alongside their human counterparts. Ofera, her crew and Jeremy must deal with the unexpected appearance of the Gaia swarm, a powerful rogue swarm of nanobots that operate independently of humans in their efforts to restore and protect the high seas.

Participant reflections.

Towards the end of the workshop series, the high-seas experts took part in semi-structured interviews about their experiences participating in creative and imaginative futuring methods (see Lübker [66]). They described specific potential applications - particularly for storytelling - in their line of work. Interviewees stated that the creative work was useful to think differently or 'out of the box' about their area of expertise, pushing their cognitive limits and broadening their horizons. What now may seem like impossible and intractable environmental problems with few realistic solutions, may actually prove to be solvable, or at least more manageable, if we are willing to work together more abstractly, across multiple scales and dimensions, including those that challenge us or make us uncomfortable. A clear example is the debate and deliberation around sentient beings and the ramifications this notion is likely to have on the way we as humans live in harmony with nature. We are hopeful that this philosophy will underpin the need for creatively thinking about "transformative change".

Interesting and immersive stories were also thought to foster an



Fig. 11. Polycultural fractals of the ocean © Care Creative (shared with permission).

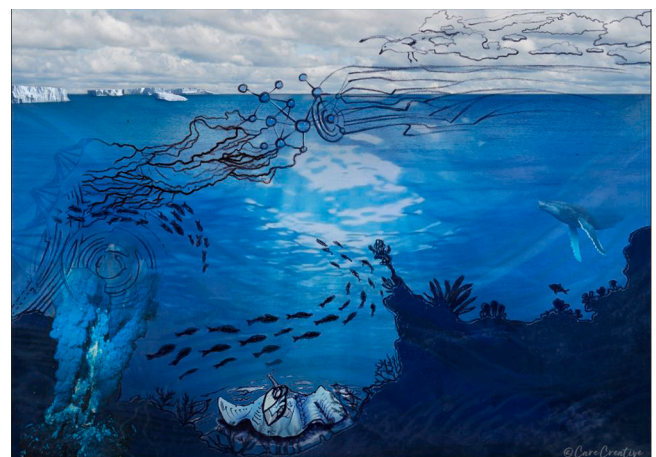


Fig. 12. Sentient stewards of the sea © Care Creative (shared with permission).

emotional connection with the ocean, decreasing the psychological distance to this geographically quite distant ecosystem, thereby fostering human-nature relationships. On a broader level, interviewees mentioned that imaginative approaches could also help to increase empathy with oceanic wildlife, create awareness and engage diverse audiences, which would not come into contact with high-seas issues otherwise. Further, it was suggested that policy makers working for intergovernmental organisations should participate in exercises similar to the ones used in the workshops, to shift their perceptions and foster a more transformative and empathetic mindset. Some interviewees also mentioned how such approaches could open spaces for dialogue and reflection, potentially evoking a heightened interest in the high seas beyond those stakeholder groups already engaged.

Further, more specific applications for creative visions of the future were shared. For example, a participant described how she would like to start her next strategy or horizon scanning meeting with an introductory talk by a creative futurist. This would set the scene in a way that fosters long-term thinking and gives participants confidence to share even the boldest of ideas without fear of judgement. Another participant stated that she would like to include visual art in her presentations to keep her audience engaged. It was mentioned that creative scenario building exercises might be actionable tools to use with younger audiences, for example in schools, to allow them to personally relate to the scientific content by having them write about relevant issues using characters and plotlines.

4. Discussion

4.1. The power of storytelling for transformative change

“The imagination is a means for breaking the seductive yet nefarious hegemonic view of the given as the only possible reality—to achieve the velocity necessary to escape the gravitational pull of the here and now. we must be able to imagine change before we can pursue it” Roy Bendor ([67] pg. 158).

To motivate and guide decision-making towards transformative change, societies require the capacity to collectively envision desirable futures [68]. While the human mind relies on experiences in the past to anticipate the future, our imagination can be expanded by creating novel experiences, even if the experiences are fictional (e.g. based on reading an immersive story) [68].

Arts-based methods, including storytelling, can be applied to remember and imagine - or reimagine - ways in which people relate to and care for the ocean. These vital socio-cultural connections are often neglected, silenced, or omitted in ocean management approaches [69]. Such methods also offer avenues to expand the possibility space and even critically reflect on what is seen as ‘impossible’ [70]. Ortiz [71] describes ‘storytelling otherwise’ as a process of reimagining and radical unlearning in a decolonial research practice. This ‘storytelling otherwise’ can challenge the western canon with reparative stories, including the often-dismissed tacit knowledge of stakeholders. Communicating research outcomes in the form of stories reserves space for the emergence of new insights, space for the audience to consider *their own* relationships to the issues presented, instead of creating predefined and prescriptive solutions [72,73]. Infusing science with creative, artistic elements could interest and inspire audiences beyond academia [29], as stories are more accessible and memorable than traditional scientific communication [74].

Transformative change, as defined by IPBES, is the “fundamental, system-wide reorganisation across technological, economic and social factors, including paradigms, goals and values, needed for the conservation and sustainable use of biodiversity, long-term human wellbeing and sustainable development” [75]. Solutions to global challenges that have local drivers and local impacts, will need fresh approaches and plenty of lateral thought. Storytelling shows much promise as a vector to

initiate transformative change towards more sustainable ocean and planetary futures. For example, Riedy and Waddock’s [76] survey identifies transformative social imaginaries emanating from shared stories as key in helping to identify and promote transformative pathways. The role of stories as a central means of visioning is being interrogated by experts undertaking the IPBES Transformative Change Assessment that is currently underway [75], with the hope that criteria defining influential visions in this regard can be identified and invoked to encourage much needed changes and innovative solutions to human-nature relationships, especially in reducing conflicts. These stories, although seemingly far beyond the deep blue yonder, both literally and imaginatively, speak volumes about the capacity for humans to reimagine, reframe and realign society’s governance and stewardship of life on Earth.

Participants of a similar workshop series on climate action in the Kitchener-Waterloo Region (Canada) reported on the value of imaginative storytelling in futures thinking, stating that it made them feel more hopeful, counteracting the “overwhelmingness” of environmental crises, and being an enjoyable and motivational exercise [77]. The inspiration instilled in the participants may be a relevant outcome, as an inspired mindset may “follow them into their lives” and feed into emergent processes of change [77], especially since the participants of these workshops are leaders in their fields. Yet more research is needed to determine how inspirational processes can be connected to action more directly.

We therefore argue that creative endeavours of co-production that promote and encourage imagination for current challenges should be considered as important tools in the science-policy interface [26], especially regarding the high seas as part of the Global Commons [78]. Creative imaginings should not only be a critical tool in how we assess potential futures, but also a way to elicit empathetic responses [26]. As researchers, we can enable co-production processes that enable deeper investment and more creative participation in these ideas, and also help inform decision-makers of the options available to them. We further hope that with this creative spark, we are able to take a step along that journey of first imagining and then actioning a better future for the high seas and the Earth as a whole.

4.2. Bridging imagination and modelling

Leventon et al. [79] outline how embracing the plurality of values of biodiversity requires changes at deeper leverage points (LP) within the governance system. This includes moving away from market-based mechanisms and a commodification of nature (LP: intent) and creating space for diverse knowledge systems and human-nature relationships (LP: design). The operationalization of the NFF in ocean governance processes (such as the ratification and implementation of the new draft UN Biodiversity Beyond National Jurisdiction Agreement (BBNJ)) would begin to address these issues. However, these ideas are very rarely included in quantitative models of the future due to the lack of knowledge of their non-linear dynamics and reconfiguration of system component relationships.

There are several ways in which participatory qualitative/narrative scenario processes could complement quantitative modelled scenarios in understanding and anticipating the broad range of diverse social-ecological factors and their interactions that will play a role in the future(s) of the high seas. Building on the suggestions outlined by Trutnevyte et al. [80], we see the following three broad categories of possible complementary interactions between quantitative and qualitative scenarios in this space:

- **Bridging** – creating plausible qualitative/narrative scenarios to compare to modelled ocean-use pathways
- **Iterating** – modelling ocean-use pathways with pre-defined political & societal feasibility constraints (which can be defined in

participatory qualitative/narrative scenario-development processes with stakeholders)

- **Merging** – real-world political & societal feasibility constraints into structurally modified models

For example, in a reimagining of sustainable fisheries, the application of these ideas into quantitative tools, could look like viewing fish as part of an ecosystem rather than a single “stock” by fisheries managers and their scientific bodies [81]. When we apply this qualitative concept of a reimagined fishery, prioritisation of ecosystem-based management tools for modelling habitat outcomes would be a prioritised end-goal over the maximum sustainable yield of a given exploited fish species. The concept of sustainable fishing, currently mostly focused on a stock-specific environmental index, can also be expanded to a more holistic concept where sustainability includes not only the ecological, but also social and cultural aspects of a fishery. This way, a fishery that is “biologically sustainable” from a target-species perspective, but negatively interferes with other species (e.g., lobster fishery in the US that is currently closed [82]) or where human rights are not respected (e.g., the “new forms of slavery” [83]), or where indigenous relationships with the species are not recognised [84], would benefit from this approach.

Another example of how qualitative storylines can help generate quantitative marine modelling inputs can be seen in the work being carried out by the The Fisheries and Marine Ecosystem Model Inter-comparison Project (Fish-MIP). The global network of ecosystem modellers is using Ocean System Pathways frameworks, which situate the Shared Socio-economic Pathways (SSPs) in the context of marine fisheries to create policy-relevant scenarios for global oceanic ecosystems (see [85]). These efforts use the SSPs as guidance for future scenarios that are reflected in quantitative variables (e.g., sea surface temperature or salinity). Yet, the incorporation of qualitative metrics mainly related to cultural values of nature (e.g., quantifying the cultural impact of a collapsed stock) are not clearly incorporated in modelling frameworks. Bridging across disciplines is thus necessary to catalyse new approaches that can help to bridge the gap between ecological and socio-cultural aspects (such as socio-ecosystem models and Ecosystem Based Management), thereby moving away from relying only on modelling frameworks that are heavily based on quantitative variables, but also from decision making that is highly dependent on these modelling frameworks. These are often seen as the only solution, yet, they can be only one part of a more inclusive process as illustrated in this other example of a project exploring near-futures of the ocean (<https://futureseas2030.org/our-approach/>).

Drawing on these types of examples, we believe there is great potential for complementary marine quantitative and qualitative scenario development processes to go beyond cost-optimization and include wider aims of sustainable ocean/high seas governance. Exploratory, qualitative scenario development processes have the potential to help produce diverse marine scenarios that can help: 1) anticipate trajectories of complex social-ecological marine-systems; 2) integrate various forms of relevant knowledge (e.g., qualitative and quantitative, natural and social scientific, academic and practice-oriented); 3) link global to regional/national/local scales; and 4) design target-seeking scenarios that sustain healthy marine ecosystems and the fisheries they support.

Qualitative scenario development processes can also help facilitate structured, inter- or transdisciplinary communication and learning about marine futures and thus widen understandings of possible future marine governance developments based on the interactions between a broad range of political, economic, technological, and social risks and benefits. Qualitative scenario development processes can also increase critical reflection to allow those involved in thinking about the future(s) of the high seas to examine and challenge the assumptions embedded in marine modelling, planning and governance.

4.3. Radical imaginaries for improved decision-making processes

This study emphasised the dire need for decision-making transformation in high seas conservation and governance. The question going forward is how to act on these changes. Indicators have long been recognized as useful measures of the problem as well as means of tracking our actions implemented to tackle the problems, and finally the success or differences that these actions can make on the high seas environment and its broader contributions to people. As part of the process described here, we brainstormed a variety of re-imagined indicators that could assist in measuring the extent of human-nature interactions. Reimagined indicators of anthropogenic disturbance included a “species distress index” and “phenological disturbance”, whereas indicators that might measure high seas management effectiveness included “EEZ anthropogenic export impact” and “sustainable ocean investment” indicators. Development of a system of reporting on high seas ecosystem status as well as on high seas management effectiveness could transform the way we respond to high seas issues. Central to this approach would be recognition of diverse visions for a sustainable and equitable high seas future arising from diverse value systems. Operationalizing the NFF in the high seas provides a key, timely case study for examining the need for transformative change, the role of envisioning futures, how transformative change can occur and the process of rolling out transformative change. This output could feed directly into the ongoing IPBES assessment of the underlying causes of biodiversity loss and the determinants of transformative change and options for achieving the 2050 Vision for Biodiversity [75].

Another ongoing marine governance process that could benefit from the outcomes of this work includes the development of an international legally binding instrument under the United Nations Convention on the Law of Sea on the conservation and sustainable use of marine biodiversity (BBNJ). The focus of the new draft BBNJ agreement is on balancing the risks of various ocean activities – it aims to provide states with more detailed processes, thresholds and guidelines for environmental impact assessments (EIAs) in the marine environment, includes draft provision for considering cumulative impacts of multiple activities, and proposes detailed monitoring and reporting obligations. The development of a system for assessing high seas social-ecological interactions, which includes indicators arising from diverse value systems, would be highly relevant to inform the implementation of the new BBNJ guidelines. Whilst engaging with the future through science fiction narratives and infusing science with artistic elements cannot be incorporated into the BBNJ Agreement per se, this historic legal framework is for the benefit of the common heritage of humankind. We argue that implementation can only benefit from a general public that is more aware and engaged with deep sea mysteries, inspired by a global ocean for which citizen science and collective buy-in should play their part in social-ecological assessments and sustainable use decision-making. Furthermore, like any international agreement, the BBNJ provides high-level guidelines that will have to be codified and implemented in different situated contexts where participatory visioning can play an important role in activating anticipatory governance of this critical part of the world for future generations.

5. Conclusion

We find ourselves at a critical crossroads for the future governance of the high seas. The years 2021–2023 offer opportunities for direct impact on ocean governance, including the initiation of the United Nations Decade of Ocean Science [86]; the ratification and implementation of a new international legally binding instrument for the conservation and sustainable management of biodiversity beyond national jurisdiction (UN General Assembly Resolution 69/292); the implementation of the Kunming-Montreal Global Biodiversity Framework under the Convention on Biological Diversity (CBD); and the Mining Code being developed at the International Seabed Authority. However, triggering a global

transformation on how we sustainably and equitably use as well as protect the half of our planet beyond the jurisdiction of all nations requires a wide concerted effort that is guided by shared values and principles across regions and sectors: from the way we collect data, to how we handle asymmetric levels of access, risk and responsibility across stakeholder groups in different regions, sectors and jurisdictions.

Whilst the imaginative process undertaken in this project may not appeal to all stakeholders, we nevertheless believe it is urgently important to create spaces for more transformative and creative engagements with the future of the ocean as has been advocated in recent literature [29,31,87,88]. A more diverse toolbox of methods to envision sustainable futures is necessary, and part of this mix needs to be more creative approaches that increase stakeholder inclusivity and can explore transformation rather than just unpacking risk and uncertainty [89]. This process was an illustration of what could be undertaken to shape future approaches and outputs, but in a limited way with a small number of participants who were already interested in more creative approaches and therefore willing to give of their time and energy. Alternative tools and approaches would be needed to get a more diverse range of stakeholder inputs and cross-sectoral buy-in, perhaps through crowd-sourcing such as was done in UNEP's GEO-6 report [90] or even gaming [91,92].

Infusing science with creative, artistic elements could interest and inspire audiences beyond academia [29] as stories are more accessible and memorable than traditional scientific communication [74]. Creative endeavours of co-production that promote and encourage imagination for current challenges should be considered as important tools at the science-policy interface [26]. Creative imaginings should not only be a critical tool in how we assess potential futures, but also a way to elicit empathetic responses [26,31]. As researchers, we can enable a broader approach to participatory stakeholder co-creation processes that can enable a greater investment in these ideas and also help inform decision-makers of the options available to them. This workshop series was a first, and hopefully promising step towards generating a more creative praxis in how we imagine and then act for a better future for the high seas and for the Earth as a whole.

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Declaration of Competing Interest

None.

Data availability

Data will be made available on request.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.marpol.2023.105644.

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