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REVIEW

The Kelp Forest Challenge: A collaborative global movement to protect and restore 4 million hectares of kelp forests

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Abstract
Marine kelp forests cover 1/3 of our world's coastlines, are heralded as a nature-based solution to address socio-environmental issues, connect hundreds of millions of people with the ocean, and support a rich web of biodiversity throughout our oceans. But they are increasingly threatened with some areas reporting over 90% declines in kelp forest cover in living memory. Despite their importance and the threats they face, kelp forests are entirely absent from the international conservation dialogue. No international laws, policies, or targets focus on kelp forests and very few countries consider them in their national policy. The Kelp Forest Challenge addresses that gap. Together with 252 kelp experts, professionals, and citizens from 25 countries, the Kelp Forest Challenge was developed as a grassroots vision of what the world can achieve for kelp forest conservation. It is a global call to restore 1 million and protect 3 million hectares of kelp forests by 2040. This is a monumental challenge, that will require coordination across multiple levels of society and the mobilization of immense resources. Pledges may therefore include area for protection or restoration, enabling pledges which assist in conservation (funding, equipment, professional expertise, capacity building), or awareness-based pledges which increase awareness or education about kelp forests. Correspondingly, participants may be from government, scientific institutions, private sector, NGOs, community groups, or individuals. This challenge is the beginning of a 17-year mission to save our kelp forests and anyone and any organisation is invited to participate.

Keywords Kelp forest · Restoration · Marine protected areas · Marine conservation · Conservation targets

Why create a Kelp Challenge?

Across the globe, when issues threaten our cultures, biodiversity, economies, and institutions, coalitions form to enable and accelerate collective action. As a result, we

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have global treaties and ambitions for reducing greenhouse gas emissions (Paris Agreement 2015), limiting CFC production (Protocol 1987), protecting ancient buildings (Meskell 2014), and conserving nature in its various forms (Convention on Biological Diversity 2010). The largest and most recent nature-based policy initiative is the Kunming-Montreal Framework on Biodiversity, which requires that the world protect 30% of global ecosystems and restore 30% of degraded ecosystems by 2030 (Convention on Biological Diversity 2022). Prior to that, there have been initiatives to protect or restore forests (Dave et al. 2017), mangroves (Global Mangrove Alliance 2019), coral reefs (International Coral Reef Initiative 2021), and endangered species from pandas to salamanders (Vié et al. 2009).

These initiatives have been shown to increase awareness and understanding (Hulme 2016), increase funding and research (Schmidt-Traub and Shah 2015), and ultimately spark action to address the issue of concern (Le Blanc 2015; Biermann et al. 2017). For example, at the 2010 Convention on Biological Diversity (CBD), 193 nations agreed to protect at least 17% of their terrestrial area (Convention on Biological Diversity 2010) and by 2020, 17% of global land area was formally protected (Bingham et al. 2021). Similarly, in the 11 years since it was established in 2011, the Bonn Challenge has inspired regional initiatives and pledges to restore over 200 million hectares of forest landscapes (Saint-Laurent et al. 2020; Tedesco et al. 2023a). While terrestrial forests have received significant attention, underwater kelp forests, major marine ecosystems are missing from the current global coalitions to save our vanishing biodiversity and the essential services they provide to humanity (Pörtner et al. 2021).

Kelp forests cover over one-third of the world's coastlines (Jayathilake and Costello 2021) with nearly 750 million people living within 50 km of a kelp forest (Eger et al. 2023). This fact makes kelp forests among the most important marine biomes on the planet (Jayathilake and Costello 2021; Duarte et al. 2022). Across this distribution, kelp forests are ecosystems of high regional importance (Buschmann et al. 2014; Bennett et al. 2016; Blamey and Bolton 2018) and based on three services, fisheries production, carbon cycling, and nutrient cycling, have an annual economic value of 500 billion US$ (Eger et al. 2023). Beyond economic impacts, kelp forests have important cultural significance (Dillehay et al. 2008; Thurstan et al. 2018), are used in art (Vergés et al. 2020), form the basis of myths and lore (O'Connor 2017; Pérez-Lloréns et al. 2020), are places where people can interact with the ocean and thus have their own intrinsic value (Lucrezi 2021). Kelp forests are ecosystem engineers and locally increase pH, possibly altering impact of ocean acidification (Cornwall et al. 2013; Hirsh et al. 2020). By creating habitat, they are home to immense biodiversity and are habitat for over 1,500 species of animals (Eger et al. 2023; United Nations Environment Programme 2023) and numerous primary producers (Pinho et al. 2015). Given their ecological and social importance these ecosystems have sustained cultures and economies for generations (Anderson et al. 2007; Erlandson et al. 2007; Vásquez et al. 2014; Thurstan et al. 2018).

Concurrently, kelp forests are increasingly threatened by a combination of biological, physical, and chemical threats. The key threats to kelp forests include ocean warming (Smale 2020), marine heatwaves (Arafeh-Dalmau et al. 2020), increased grazing pressure due to range expansions (Vergés et al. 2014) and-or predator loss (Atwood and Hammill 2018), increased sedimentation due to land modification and coastal industrialization (Gorman and Connell 2009), and water pollution (Coleman et al. 2008), which has resulted in the degradation of 40–60% of kelp forests over the last 50 years (United Nations Environment Programme 2023) and the total disappearance of others (Moy and Christie 2012; Rilov et al. 2020; Rogers-Bennett and Catton 2019; Butler et al. 2020; Eger et al. 2022b; Tamburello et al. 2022). As with terrestrial forests, these declines are directly threatening the biodiversity and ecosystem services provided by kelp forests and the societies that they support.

Despite the convergence of their prevalence, importance, and increasing threats, there are currently no global treaties, laws, or initiatives to protect or restore kelp forests (Techera et al. 2023). While there are regional initiatives such as the Convention for the Protection of the Marine Environment of the North-East Atlantic (de Bettignies et al. 2021), Cystoseira s.l. protection via the Bern convention (Mangialajo et al. 2008), Washington State's 2022 Senate Bill 5619 (Washington State Legislature 2022), and Law N°20.925 in Chile (Biblioteca del Congresso Nacional de Chile 2020), there is a need for national and international attention and action. Without global initiatives, kelp forests around the world may not receive the needed interest and funding for research, restoration, and conservation activities, as has historically been the case (Filbee-Dexter et al. 2022).

The Kelp Forest Challenge is designed to fill the policy and action gap and increase the protection, recovery, and restoration of kelp forests and their associated biodiversity around the world. It is supported by a coalition of restorationists, knowledge holders, businesses, artists, community members, policy makers, and conservationists with the core objective of increasing awareness, funding, and collaboration for kelp forest conservation. The vision of the Kelp Forest Challenge is that by achieving these goals, we can ultimately increase the area, geographies, and ecosystem health of kelp forests, the ecosystem services they provide, and the wellbeing of the communities they are connected to. In this paper, we describe the process through which collaboration and a target to assist these goals has been developed through the Kelp Forest Challenge.

The Kelp Forest Challenge

The Kelp Forest Challenge was conceived by the Kelp Forest Alliance (The Alliance), a research-driven, not-for-profit, and global community of people and organizations working on or in kelp forests in 26 countries (Eger et al. 2022a, Fig. 1). The Alliance currently hosts an online repository of kelp restoration projects, people, and organizations (Fig. 1) and will expand to include protected areas and monitoring sites.

Given the benefit of the knowledge, connections, and lived experiences of the global kelp forest community, the Kelp Forest Challenge was created as a grassroots initiative with open feedback and consultation. The hope was that this process would result in a ground-up vision of what the global kelp community wanted the world to achieve for kelp forest ecosystem conservation. The Kelp Forest Challenge not only includes area-based targets but also highlights the diverse and numerous people and organizations working around the world to protect, restore, or raise awareness about the importance of marine kelp forests. This grassroots approach and progress of The Alliance and the Kelp Forest Challenge has since been recognized and endorsed by the International Union for the Conservation of Nature (IUCN), and the United Nations Decade for Ocean Science for Sustainable Development and Decade for Ecosystem Restoration.

Designing the community consultation

The spirit of The Alliance is to be open and collaborative, and that vision was intended to flow through to the Kelp Forest Challenge. Therefore, the Kelp Forest Challenge was created through broad-scale, open consultation with members of the global kelp forest community. Starting in August 2022, participants were recruited through invitations sent to The Alliance network, an open call on social media, and advertising on the website of the International Seaweed Symposium. Between November 2022 and February 2023, The Alliance convened at eight online workshops and one in-person meeting to discuss the need to set a target for kelp forests, how the target would be determined, what the principles of that target should be, and ultimately what the target values should be. Ultimately, 252 people were engaged with participants spanning 25 countries. There was representation from scientific institutions, businesses, governments, local communities, sea management groups, NGOs, and the arts and education sector. This collective group, as represented by the authors, are referred to as "we" throughout this article.

Defining Kelp Forests

The Alliance decided early on that the Kelp Forest Challenge would include conservation activities from orders of brown, habitat-forming intertidal and subtidal seaweeds, the two most dominant of which are the orders Laminariales and Fucales. This decision was made with the recognition that in many parts of the world, these groups are referred to as kelp (Fraser 2012; Coleman and Wernberg 2017), provide very similar ecosystem functions, and often overlap in their distribution and co-occur (Fragkopoulou et al. 2022). Namely, these seaweeds provide a unique complex three-dimensional habitat that is anchored to

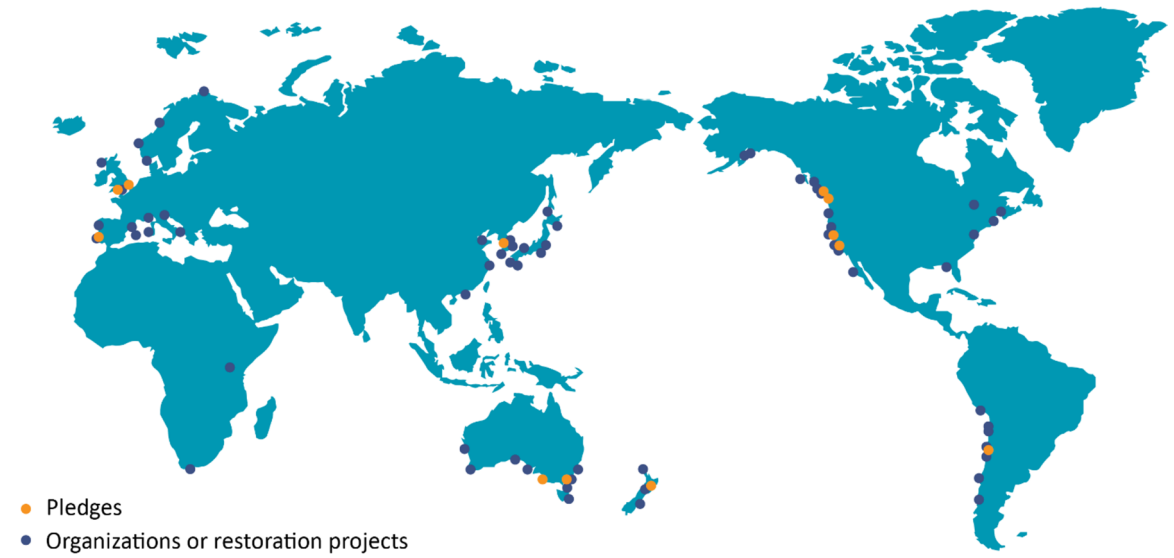

Fig. 1 Map of kelp restoration projects currently tracked on The Alliance website, organizations in The Alliance network (both in dark blue), and pledges to the Kelp Forest Challenge (orange) (Source: kelpforestalliance.com, accessed April 26, 2023). Projects are completed or ongoing restoration actions while pledges are commitments for future actions

rocky reef environments and supports biodiversity (Coleman and Wernberg 2017; Wernberg et al. 2019). As such, pelagic *Sargassum* which are not anchored to the seafloor would be excluded from this challenge, despite falling within the order Fucales. There are currently no known restoration activities related to species in the order Tilopteridales or Desmarestiales but they may also be included in the future if they meet the above criteria. These four orders contain 100 genera of kelp that fall within the scope of the Kelp Forest Challenge (Appendix 1).

How to set a target

We considered best available data and a wide suite of information to determine the target of the Kelp Forest Challenge, including how much kelp forest cover exists today, how much kelp forest has declined or degraded in the past 50 years (Krumhansl et al. 2016; Filbee-Dexter et al. 2022), what the current and future capacity for kelp forest restoration may be (Eger et al. 2022c), and available budgets and resources for conservation (Worldometer 2017; Eurostat 2023).

We compiled different scenarios using low vs. very high categories for each of the different approaches and generated a range of potential values for the target (Appendix 2). Estimating the historical and present global extent of kelp forests proved to be a particularly difficult task. We opted to use the most up to date estimates of observed kelp forest cover because estimates of modeled kelp forest typically reflect the potential kelp habitat, not the realized kelp distribution. We took an average estimation of 10 million hectares of kelp forests around the world based on the best available data and expert knowledge (Appendix 2, Pessarrodona et al. 2018; Mora-Soto et al. 2020; Eger et al. 2023, Pessarrodona et al. Unpublished).

Selecting a target

We then considered all information and scenarios and to understand which of the targets we thought were plausible, ambitious, or unrealistic (Appendix 2). The overarching considerations for setting the target values were: (i) that they should reflect what we thought the world should achieve for kelp forest conservation given the estimated extent of kelp forest, (ii) what will be possible with growing technology and capacity, and (iii) that the targets link to the Kunming-Montreal Protocol and the recently announced 30×30 targets (Convention on Biological Diversity 2022). Together, these considerations helped us generate aspirational targets. While the Global Biodiversity Target requires that 30% of habitat is protected and 30% of degraded habitat is restored by 2030, we opted for an ultimate end goal of 2040. The extended deadline reflects the fact that kelp forest restoration has received much less research and investment than other ecosystems (Filbee-Dexter et al. 2022), can be more costly and difficult (Saunders et al. 2020), and requires new technological developments (Eger et al. 2022c). We also anticipate that, similar to other ecosystems (Saunders et al. 2020), the area under conservation will accelerate as these technologies and policies develop. Therefore the 2030 goal is a lower fraction (one fifth for restoration and one third for protection) of the final target.

The Kelp Forest Challenge is the beginning of a 17-year mission to create a global movement to protect and restore 4 million hectares of kelp forest by 2040. The target consists of a one-million-hectare target for restoration and a three million hectare target for protection of kelp forests by the year 2040, with sub-goals for the year 2030. The subgoal for 2030 is 200,000 hectares for restoration and 1,000,000 hectares for protection (Fig. 2). These values are aligned with the 30% values proposed by the Kunming-Montreal Protocol if we accept an average estimate of 10 million ha of current global kelp extent (Appendix 2) and an average estimate of 3 million hectares of lost kelp forest habitat (Filbee-Dexter et al 2022; United Nations Environment Programme 2023).

Pledges

Saving our kelp forests is not just a mission for governments and scientists. It is an inclusive goal in which anyone can participate. We invite pledges from all sectors of society. In addition to area-based pledges for protection and restoration, the Kelp Forest Challenge actively invites enabling, supporting, or awareness-based pledges. These pledges might not involve conservation directly, but they can help to support conservation programs or organizations to accelerate restoration and protection (Tedesco et al.

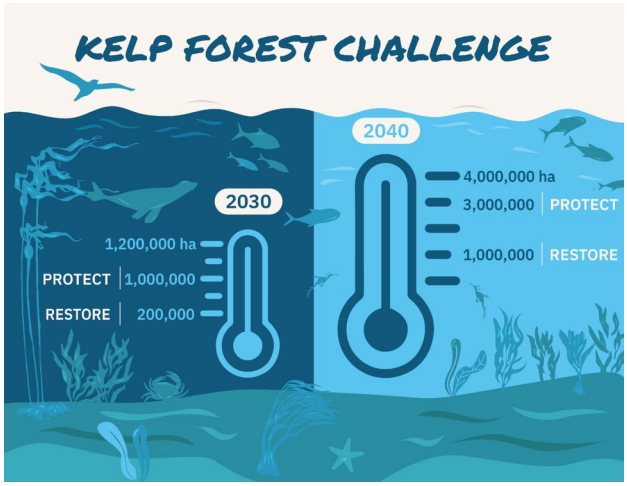

Fig. 2 Target values of the Kelp Forest Challenge

2023b). Alternatively, these pledges may work to increase awareness and understanding of kelp forests and communicate their importance to society. Examples of such types of pledges are researchers that improve restoration methods and reduce costs; businesses that loan equipment, technology, or software to help conservation; community groups assisting projects, professionals that volunteer their services such as legal, accounting, or marketing; artists, photographers, artists, or filmmakers that work to create pieces that communicate the beauty, diversity, or fragility of kelp forests; or organizations that provide funding to complete these projects (Fig. 3).

There was extensive discussion within The Alliance about the nature of the area-based pledges and whether they would be pledges to attempt restoration or commitments to achieve restoration. Ultimately, we decided, as a voluntary initiative, that it was best to encourage positive actions and attempts at protection or restoration while also holding those organizations accountable for reporting the outcomes of their work. Success may also be project specific and we want to give liberty to projects to define success as is appropriate for their local context (Waltham et al. 2020). Further, restoration is an iterative learning process and projects may learn important information from "failed" attempts (Fischer et al. 2021) and we did not want to discourage groups from trying. These cumulative learnings and small-scale, locally defined successes can indeed give rise to global progress in the field (McAfee et al. 2021). Therefore, the numbers in the Kelp Forest Challenge reflect pledges for areas under restoration and a commitment to follow established conservation practices (Gann et al. 2019), including best practices set out in the Kelp Restoration Guidebook (Eger et al. 2022b). Future work will focus on creating standardized monitoring and reporting protocols, metrics of success, and regular reporting on pledge activities to try and ensure the best possible project outcomes.

In the spirit of inclusivity and highlighting the level of activity linked to kelp forests, we decided that pledges do not need to be exclusive or additional. This means that pledges do not need to be exclusive to the Kelp Forest Challenge and may count towards multiple initiatives such as other local, regional, national, or international targets. Similarly, pledges for existing initiatives may also be accepted providing they meet the criteria and principles of the Kelp Forest Challenge. This decision allows stakeholders from diverse backgrounds to participate. Pledges to the Kelp Forest Challenge will be reviewed by a panel of experts from The Alliance community before being formally accepted to ensure that they meet the criteria outlined in this document. Positions on the panel are voluntary and anyone interested in joining may contact The Alliance.

Definition of protection and restoration activities

The Kelp Forest Challenge places conservation actions into two categories: 1) restoration, where the outcome is to restore a population that was lost and 2) protection, activities that positively impact existing kelp populations. The suite of activities that fall under either category is outlined in our kelp forest conservation typology (Appendix 3) which was developed in collaboration with the IUCN and connects to the IUCN's Restoration Barometer for tracking restoration across ecosystems (Saint-Laurent et al. 2020) (Table 1).

Because the level of protection afforded by marine protected areas can vary, entries to the site, area, and habitat protection category are also graded based on its protection status. These levels of protection are established by the IUCN Protected Area Management Categories (Dudley and Stolton 2008) and range from full protection (level I) to different levels of partial protection (level II-VI). If a conservation

Fig. 3 Different types of pledges that may be submitted to the Kelp Forest Challenge

area contains different types of habitats, we will only consider the amount of area that covers the potential niche of kelp forests (e.g., an appropriate depth, substrate, and environmental conditions). The Kelp Forest Challenge will track the amount of kelp forest area protected prior to its launch but will only accept pledges for protected areas that were declared after its launch in February 2023. Restoration areas within protected areas would however be classified as restored pledges.

The global target also explicitly excludes activities that involve afforestation or the creation of kelp forest habitat in an area that previously never had, nor would ever have, a kelp forest. Examples include creating cultured floating arrays of kelp in pelagic habitats (Antoine de Ramon et al. 2012) or creating artificial structures populated by kelp forests across extensive sandy bottoms (Taniguchi et al. 2001). Both are excluded from the Kelp Forest Challenge global targets and the IUCN Restoration Intervention Typology, on the grounds that they are not remedying environmental issues or generating meaningful ecological benefits versus the status quo (Saint-Laurent et al. 2020; Forbes et al. 2022).

Measuring the benefits for society

Kelp forest ecosystems provide a wide array of benefits and functions for people and marine environments. Simple metrics such as area protected and restored do not capture the dynamism of these benefits and functions. They do, however, provide universal, globally-applicable, easy-to-track, and easy-to-report metrics for assessing success (Dave et al. 2017). While the goal of the Kelp Forest Challenge may be to protect 3 million hectares and restore 1 million hectares, the extended impact of protecting and restoring kelp forests around the globe includes increasing their associated biodiversity, and improving the livelihoods of the people that depend on them. In recognition of the benefits that kelp forests provide, the Kelp Forest Challenge encourages all projects involved to report on and celebrate the ecological and social benefits of kelp forests. While the Kelp Forest Challenge does not set any universal targets for restoring levels of ecosystem function or benefit, Alliance members are able to create goals for specific metrics such as jobs created, cultural ties renewed, or fish and invertebrate species recovered in their local area or region. Participants also have the option to create regional area based targets which are important for global scale success (McAfee et al. 2021). These specific or regional targets would be promoted via the same channels as the Kelp Forest Challenge but would be tracked independently.

Creating a participatory platform

The KFA has an online, freely available data platform for viewing and uploading information about kelp forest conservation projects (see kelpforestalliance.com). This platform will be used to track and monitor the success and outcomes of the Kelp Forest Challenge. On the platform, users can create individual profiles, organizational profiles, restoration and conservation project locations and outcomes, and pledges to the Kelp Forest Challenge will be displayed on the same platform.

Table 1 List of protection and restoration activities that are eligible for the Kelp Forest Challenge

Activity	Example Reference
Natural Regeneration	
Eliminate reef mining	(Støttrup et al. 2017)
Eliminate kelp harvesting	(Steen et al. 2016)
Pollution remediation	(Peterson 2001)
Nutrient enrichment (if limiting)	(Agatsuma et al. 2014)
Reduction of unsustainable kelp harvesting	(Bularz et al. 2022)
Artificial Regeneration	
Restoration or enhancement via seeding or transplanting	(Serisawa et al. 2005; Vergés et al. 2020)
Genetic selection for general fitness, temperature tolerance, etc	(Wood et al. 2020)
Supplementing natural habitat (e.g., adding substrate on existing kelp habitat)	(Eger et al. 2020)
Supplementing existing artificial structures, e.g., seawalls	(Morris et al. 2018)
Land or Water Protection	
Site, area, or habitat protection	(Dudley and Stolton 2008; Arafeh-Dalmau et al. 2021)
Predator population protections	(Babcock et al. 2010)
Invasive or problematic species control	
Grazer management (e.g., sea urchin control)	(Miller and Shears 2023)
Competitor removal, e.g., invasive species	(Gorman and Connell 2009)

The platform tracks the amount of area pledged for protection and restoration as well as the self-reported area restored or protected. There will also be an emphasis for reporting relevant indicators such as the ecosystem services or benefits resulting from that conservation, the number of people involved in the kelp forest community, and non-area-based pledges such as the dollar value of those pledges, the number of person-hours contributed, or the audience reached by an activity. The platform will also serve as a repository of useful documents and resources that can promote kelp forest conservation.

Community of practice principles

Protecting and restoring kelp forest ecosystems is a challenging activity, far more complex than any single one or two goal numbers can capture. Accordingly, The Alliance developed and adopted a set of guiding principles of best practices to ensure ethical and inclusive participation in the Kelp Forest Challenge, and to which participants are expected to adhere. While not exhaustive, these principles provide a basic code of conduct that advocates for inclusive, equitable, and meaningful actions. When making pledges to the Kelp Forest Challenge, organizations and individuals are also asked to pledge to adhere to these principles. A detailed list of the principles is contained in Appendix 4 but they are summarized in Table 2.

Kelp Forest Challenge launch

The Kelp Forest Challenge was launched on February 19th, 2023, at a special event before the 23rd International Seaweed Symposium in Hobart, Tasmania, Australia (iss2023.net). The launch of the event was commemorated with the announcement of the founding pledges. The program was able to launch with 23 pledges from eight countries, tens of thousands of hectares of area for kelp forest restoration, professional photo libraries for communication, specially composed songs about kelp forests, technology companies getting involved in environmental monitoring, and marketing groups helping to communicate the importance of kelp forests (Table 3).

Following the launch of the Kelp Forest Challenge, The Alliance coordinated two parallel workshops, one in person and one online. For these workshops we had 44 participants in person and 36 online, working to determine the necessary actions to achieve the ambition of the Kelp Forest Challenge. The workshops asked participants to identify the key barriers to scaling-up kelp forest restoration, the solutions to those barriers, and the priorities and impact of those actions. This input is now being compiled into a roadmap document outlining the priority changes needed to enable global scale kelp forest conservation.

Grounded in science and the International Seaweed Symposium (ISS)

Science based decision making will remain an important philosophy within The Alliance and the Kelp Forest Challenge. To this end, The Alliance hosted two scientific symposia on kelp restoration during ISS. These symposia highlighted progress, breakthroughs, and future directions in kelp forest conservation across the globe and brought restoration into the discussion at ISS. The ten talks featured speakers from Australia, New Zealand, California, Washington State, Norway, Japan, Korea, the Mediterranean, and a global overview. We were also pleased to create the inaugural Kelp Forest Presentation Prize, or "Kelpie," to be given to the presentation which describes a project that best embodies the principles of the Kelp Forest Challenge and its mission to engage multiple segments of society to equitably protect and restore kelp forest ecosystems

Table 2 Summary description of the principles of the Kelp Forest Challenge

Principle
1. Participants treat each other with mutual respect
2. Participants commit to the open and free flow of information that may benefit other projects and accelerate our joint mission
3. Participants respect the intellectual contributions of other participants
4. Restoring and protecting kelp forests should not be used as a substitute for greenhouse gas reductions or the remediation of other human activities that threaten coastal environments
5. Projects will respect and uphold the territorial rights and custodianship of Traditional and Indigenous Peoples, and their knowledge and cultural values
6. Projects will engage a diversity of stakeholders, residents, and voices when developing projects and ensure that benefits of a healthy ecosystem are equitably distributed and accessible
7. Any restoration activities strive to achieve the standards set out by the Society for Ecological Restoration
8. Ecosystem restoration and ecosystem protection are often both necessary, but protection should be prioritized
9. The data needed for science-based decision making in kelp forest ecosystems is currently limited, this gap does not preclude the need to make decisions, but it does stipulate that the advice and recommendations may change in the future as more data are collected

Table 3 Summary of initial pledges to the Kelp Forest Challenge, launched in February 2023

Organization	Country	Sector	Pledge Type	Metric	Pledged Value	Year to achieve Pledge
Korean Fisheries Resources Agency	South Korea	Federal government	Area restored	hectares	30,000	2030
Cascais Municipality	Portugal	Municipal government	Area restored	hectares	1	2025
Ocean Wise	Canada	Not for profit	Area restored	hectares	10	2030
Ocean Wise	Chile	Not for profit	Area restored	hectares	3,000	2030
Department of Natural Resources Washington	United States of America	Regional government	Area restored	hectares	2,023	2040
Puget Sound Restoration Fund	United States of America	Not for profit	Area restored	hectares	1	2028
Giant giant kelp restoration project	United States of America	Not for profit	Area restored	hectares	800	2030
Eastern Zone Abalone Industry Association	Australia	Business	Area restored	hectares	110	2030
Fish Reef Goleta Bay	United States of America	Not for profit	Area restored	hectares	200	2040
The Nature Conservancy	Australia	Not for profit	Area restored	hectares	50	2030
Love Rimurimu	New Zealand	Not for profit	Area restored	hectares	1	2025
The Nature Conservancy-California	United States of America	Not for profit	Area restored	hectares	30	2030
The Kelp Rescue Initiative	Canada	Not for profit	Area restored	hectares	1	2023
Operation Crayweed	Australia	Not for profit	Area restored	hectares	100	2030
Hullbot	Australia	Business	Research and Development	dollars	70,000	2025
Ethicly	United Kingdom	Business	Professional Services	hours	200	2023
Cliona Molins	Australia	Artist	Communication and Outreach	audience	500	2023
Mossy Earth	United Kingdom	Not for profit	Enabling Restoration	dollars	70,000	2023
			Communication and Outreach	audience	400,000	
Kelp Forest Foundation	The Netherlands	Not for profit	Research and Development	dollars	30,000	2025
Jennifer Adler	United States of America	Artist	Communication and Outreach	hours	100	2023
University of Sussex	United Kingdom	University	Research and Development	hours	pending	2023

and the benefits they provide to society. The Alliance hopes to maintain these ties to the scientific community and present this award at future symposia.

Next steps

Launching the Kelp Challenge is the beginning of a global movement to protect and restore 4 million hectares of kelp forest. Achieving this goal will require significant investments but if it is successful the result will be richer ecosystems, empowered communities, and benefits for society into the future. Some of this work is currently actionable while other elements require new research and development. All this work will require considerable resources and support, far more than any one organization or indeed country can achieve on its own. Creating a global community through the Alliance and movement through the Kelp Forest Challenge will hopefully encourage its participants to share in this task, pool resources, work across cultural and professional boundaries, share information, and jointly work towards our shared goals. Specific next steps include the above-mentioned roadmap which summarizes the key strategies and actions that are required to scale up kelp forest conservation as well as new working groups to help address key concepts.

The Kelp Forest Challenge extends a broad invitation to add new local, regional, and national level pledges to the Kelp Forest Challenge. Many of the initial pledges received were for the restoration of kelp forests, but it is important that we expand this work to collect more pledges for the protection of kelp forests. Achieving this aim will require us to better connect with fishers, tourist operators, and environmental government agencies, which are often responsible for managing protected areas (Day and Dobbs 2013).

As the Kelp Forest Challenge progresses, it is important that the progress is openly and accurately monitored. Yearly progress updates are requested and they will be openly accessible on The Alliance website. We are also continuing

the development of monitoring and reporting standards for kelp ecosystems and associated ecosystem services. This work will be done in collaboration with the Kelp Forest Alliance community and will help ensure a gold standard of data collection and allow for better data aggregation and comparison. This standardized and aggregated data can then help guide future decision making, enable large scale synthesis, benefit researchers, and communicate the importance of kelp forests to the public (Adams and Sandbrook 2013). National pledges will also be included in the IUCN Restoration Barometer.

Conclusion

Kelp forests are one of the fastest declining coastal ecosystems on the planet (Krumhansl et al. 2016; Feehan et al. 2021), leading to economic, ecological and cultural losses (Grover et al. 2021; Hynes et al. 2021). Urgent actions are needed to prevent losses wherever possible while restoring areas that are unable to recover without assistance. While kelp forests have been historically underappreciated and have received less attention than other ecosystems (Arafeh-Dalmau et al. 2021; Filbee-Dexter et al. 2022), there is a growing momentum of activity and interest in kelp forests.

The Kelp Forest Challenge was created with the intention to direct the growing interest in kelp forests around the globe and generate positive conservation outcomes while also benefiting and enriching the people and organizations around the world who are involved in kelp protection and restoration. An international alliance and target can help reduce knowledge gaps, increase inclusivity, and strengthen collaborations between countries and their citizens. It is hoped that the Kelp Forest Challenge can help achieve the same types of successful outcomes that were sparked by other international initiatives and targets. While it is no longer possible to say there is no global initiative for kelp forests, there is a significant amount of work remaining. We are confident that with collective action, we can be successful in our goal to increase cultural appreciation for kelp forests, increase the area of kelp forests that are protected or restored, and ultimately elevate kelp forests in the global conservation narrative.

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Authors' contributions AME and AV conceived the Kelp Forest Challenge through the Kelp Forest Alliance. AME coordinated the development of the Challenge and drafted the first version of the manuscript, including the figures. All authors participated in developing the Kelp Forest Challenge, reviewed and edited the first version of the manuscript.

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Declarations

Competing interests AME is the Founder and Program Director of the Kelp Forest Alliance, a not for profit in Sydney, Australia.

AV is a member of the Board of Directors of the Kelp Forest Alliance.

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