

NORWEGIAN BLUE FORESTS NETWORK (NBFN)

# TOP TEN TRENDS FROM 2023

# Top trends for blue forests in 2023

**2023 was another record-breaking year for global warming, biodiversity loss, and natural disasters, with stark impacts felt on both society and our environment.**

In Norway, Storm Hans wreaked havoc in late summer, bringing the climate crisis close to home. While the impact of these disasters on blue forests are harder to see, the effects are nonetheless there. The warming seas are driving crabs and sea urchins north, into new habitats. Flooding from Storm Hans led to soil runoff into the Oslofjord, darkening the fjord and depleting entire marine ecosystems of the light needed to thrive. The invasive species “Sea vomit”, *Didemnum vexillum*, spread more widely across Norwegian kelp forests, blanketing the coastline and displacing existing species. These disasters exposed the interconnectedness of the climate and biodiversity crises, and emphasised the importance of resilient ecosystems in avoiding the worst consequences for humans and our environment. They also highlighted the need for steps towards future-proofing the role of blue forests in relation to safeguarding biodiversity, sequestering carbon, and supporting human and wildlife resilience to climate change.

Throughout 2023, we have seen significant steps towards securing nature-positive action to safeguard the health of our natural environments. In science-

policy arenas, Norway is among the countries working to implement the UN Kunming-Montreal Global Biodiversity Framework (GBF). The High Level Ocean Panel published the “Blue Carbon Handbook”, the World Bank published comprehensive guidance for governments wanting to invest in blue carbon, and grassroots initiatives such as the Kelp Forest Challenge blossomed. Our understanding of blue forests, the blue carbon cycle, good management practices and supporting technologies progressed, as did efforts to establish and strengthen Marine Protected Areas. In a year of crisis, 2023 was also a year of action.

This report presents a selection of the top ten trends from the past year, as seen by the Norwegian Blue Forest Network (NBFN). It focuses on national, regional and global trends. We hope that in highlighting these trends, we can showcase areas where significant progress has been made, and where further collaboration is needed. We conclude each trend by summarising areas to follow in 2024 and beyond.

– Norwegian Blue Forests Network

## THE TRENDS

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# #1

## Another step up for blue forests

The High Level Panel for a Sustainable Ocean Economy lifted actionable blue forest opportunities onto the global stage through its “Blue Carbon Handbook”,<sup>1</sup> released in June 2023.

While the entry point in this report is the role of blue forests in relation to carbon and climate, the approach explores climate-related funding opportunities to deliver useful action to conserve and restore blue forests for a multitude of purposes. Blue carbon also received increasing attention during the ocean-climate dialogue ahead of UNFCCC COP28, at the COP itself, and at other high-level policy meetings.

In Europe, two major institutions took significant steps to focus attention on blue forests. The European Marine Board delivered an extensive Policy Brief entitled “Blue Carbon – Challenges and opportunities to mitigate the climate and biodiversity crises”.<sup>2</sup> Following a policy dialogue and a scientific workshop, the JPI Oceans decided to start a Joint Action on Blue Carbon,<sup>3</sup> with 13 countries actively participating. In addition to joint calls for projects, this action will develop a Knowledge Hub

encompassing three primary tasks: the development of an open access platform/repository, conducting a state-of-the-art review and knowledge gap analysis, and formulating a policy roadmap.

Nationally, blue forests were highlighted at the One Ocean Week in Bergen by the Norwegian Prime Minister, the Minister of Climate and Environment, and the Minister of Fisheries and Ocean Policy among others. NBFN was also represented on stage during the Norwegian government Ocean Conference.

### What to expect in 2024

- Increased planning, management, and financing of actions on mangroves, seagrass, and salt marshes
- Scientific efforts to clarify if kelp and living biota will qualify for inclusion in the IPCC definition of being “manageable”

# #2

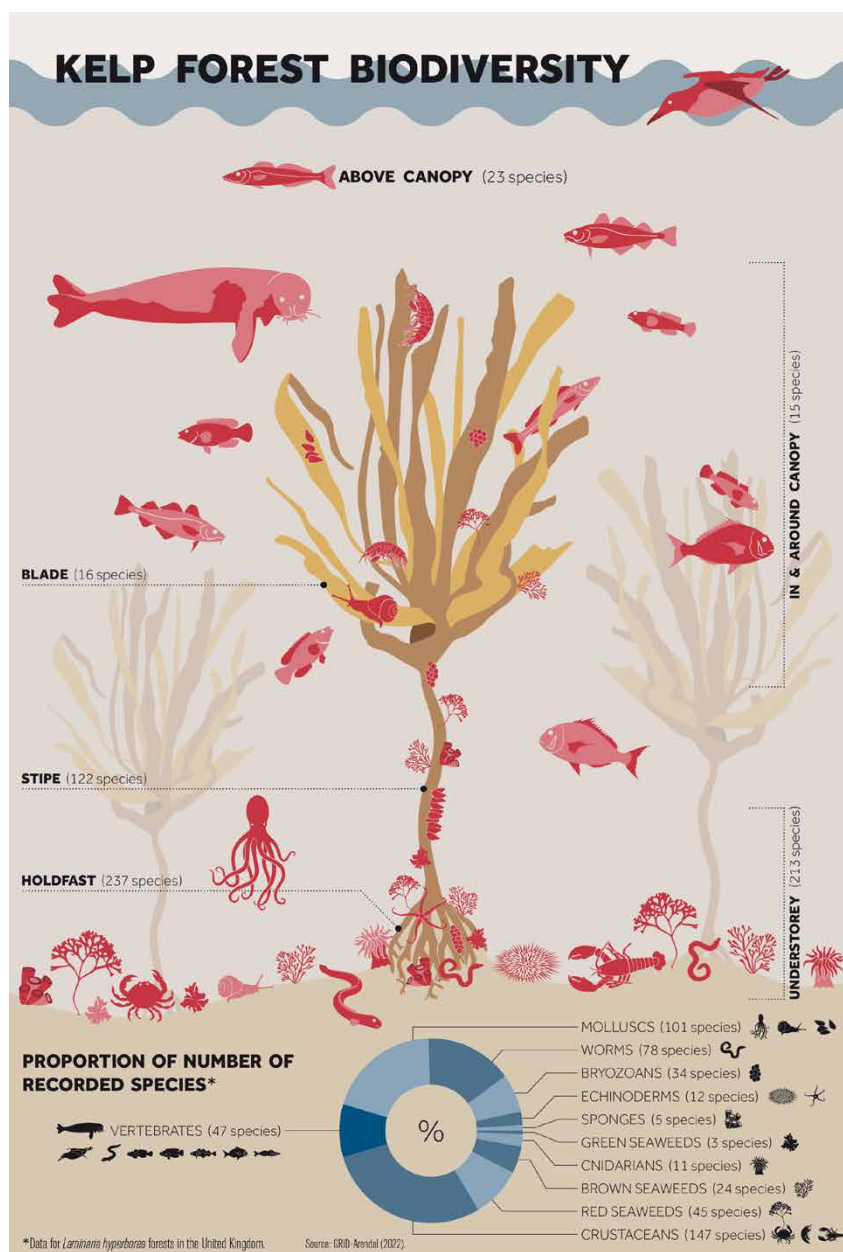
## Biodiversity takes centre stage

2023 saw a major shift within international policy and funding on tackling biodiversity loss, including for blue forests.

In 2022, one of the top global trends was the acknowledgement of the role blue forests play in climate mitigation, through storing and sequestration of blue carbon (see Trend 3). In 2023, we saw an increased focus on the need to tackle climate change and biodiversity loss together, as interlinked global crises.

The UN Kunming-Montreal Global Biodiversity Framework (GBF), signed at the very end of 2022,

has spurred a flurry of activity over the past year. Significantly, 186 countries, including Norway, agreed on the establishment of the newly launched GBF Fund.<sup>4,5</sup> The Fund supports implementation of the Framework through government, philanthropic and private sector funding sources. In response to the GBF call for action to halt biodiversity loss, 163 financial institutions representing €21.7 trillion in assets signed the [Finance for Biodiversity pledge](#), including DNB, KLP and Storebrand in Norway.



Meanwhile, we have seen strengthened research and science communication on blue forests and biodiversity. Two UNEP reports published in 2023 highlighted the value of mangroves<sup>6</sup> and kelp forests<sup>7</sup> as biodiverse habitats. The Research Council of Norway funded the NORSE project<sup>8</sup> to increase our understanding of the drivers, responses and resilience of biodiversity in seagrass meadows, an understudied area so far. Similarly, mapping marine fungi and their importance for blue forest health and carbon cycling is a nascent field and requires further research.<sup>9,10</sup>

### What to expect in 2024

- Publication of the new “National action plan for nature” by the Norwegian government, to operationalise Kunming-Montreal GBF commitments
- Progress on marine biodiversity credit systems, similar to the framework implemented in the UK for land development

Example of the biodiversity value of UK kelp forests. Image by GRID-Arendal. From UNEP-NBN 2023 [Into the blue: Securing a sustainable future for kelp forests](#) report

## #3 Taking nature into account

Continuing the trend of valuing ecosystem services, the development of ecosystem or natural capital accounts and ocean accounts gained momentum over the past year.

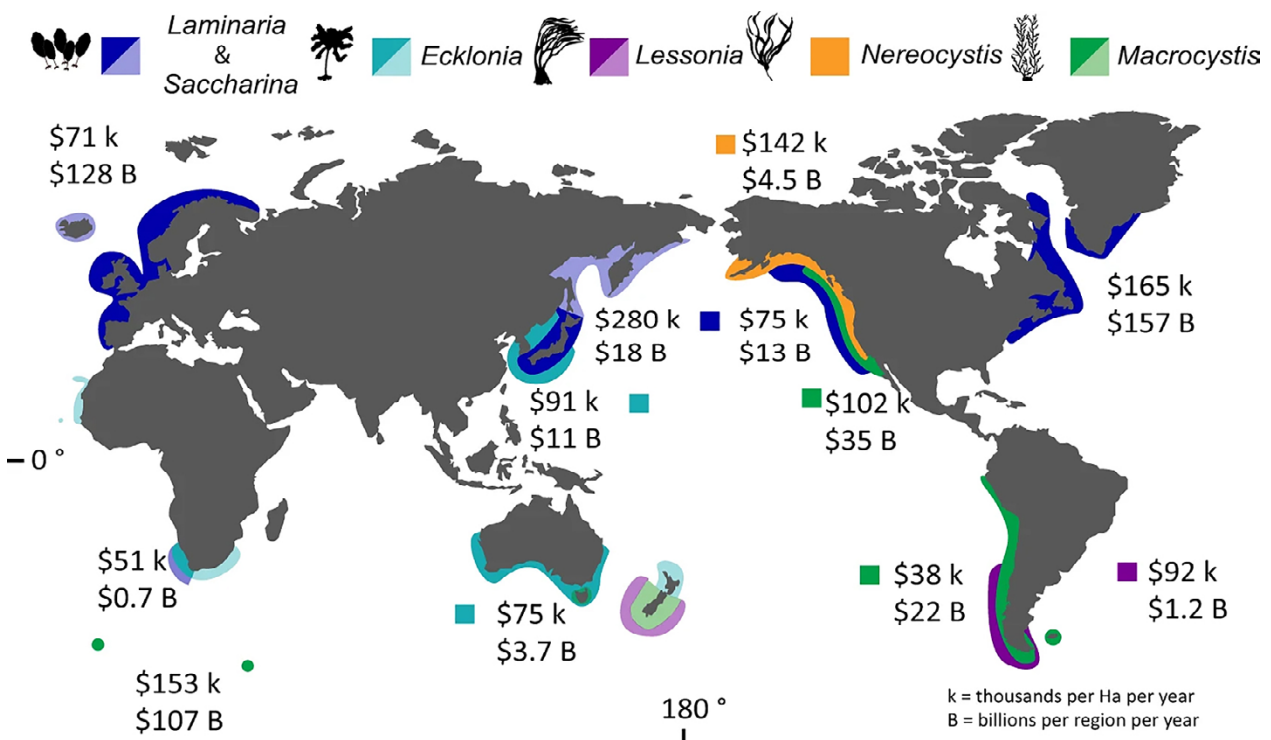
The Norwegian Environment Agency (*Miljødirektoratet*) started the process of creating Norway's first ever ecosystem account (*naturregnskap*),<sup>11</sup> building on the UN standard of environmental-economic accounting (SEEA).<sup>12</sup> The aim is to calculate the importance of ecosystem services, helping weigh the price of losing a piece of nature. Getting methodologies accurate enough to effectively support decision making, for example on marine spatial planning (*arealbruk*), will take time. Globally, 41 countries are implementing ecosystem accounts based on SEEA. All EU Member States must report their first versions in 2026.

Several countries are actively working on the Ocean Accounts, a framework developed by the Global Ocean Accounts Partnership<sup>13</sup> in parallel with the SEEA EA, including Norway with the MAREA project in the Oslofjord.<sup>14</sup> In terms of research, a variety of projects are working towards evaluating ecosystem accounting cases,<sup>15,16</sup> converting blue forest ecosystem services into monetary value,<sup>17</sup> and linking a healthy global economy to healthy ecosystems.<sup>18</sup>

Within both policy and business, “nature positivity” has been a buzzword. We saw the launch of the Nature Positive Initiative,<sup>19</sup> and IUCN published guidance for nature-positive contributions<sup>20</sup> and a technical paper for business.<sup>21</sup> The term still lacks the detailed definition needed to make it an implementable concept across research, policy, and business.<sup>22,23</sup> In the meantime, the new EU directive on corporate responsibility, where companies must submit sustainability reports, entered into force.<sup>24</sup> This comes in addition to the expectations set by the Norwegian government on state-owned companies.<sup>25</sup>

### What to expect in 2024

- The assessment of how Norwegian industry and sectors are affected by nature and biodiversity loss, due to be published by *Naturrisikoutvalget* in February 2024
- Pilot project start-up on creating ocean ecosystem accounts using the SEEA EA standard in Lofoten



Map of kelp distribution, total economic value per m² per year (k), regional value (B). Lighter shade colours are for regions where distribution estimates were not available. From Eger et al. 2023 [The value of ecosystem services in global marine kelp forests](#).

## #4 Deep dive: Decoding Norway's blue carbon cycle

The ocean plays an important role in regulating climate globally and has a significant potential for carbon storage.<sup>26</sup>

While the carbon sequestration and storage potential of marine habitats such as mangroves has been relatively well understood, the blue carbon cycles of habitats important to Norwegian coastal ecosystems – such as kelp – less so.<sup>27</sup> The mapping of these “emerging habitats” in relation to blue carbon took a leap forward in 2023.

Seaweed and kelp forests globally cover an area equivalent to the Amazon rainforest and have a carbon uptake of the same magnitude.<sup>28</sup> In mainland Norway, around 10,000 km<sup>2</sup> of the seabed along the coasts is covered by blue forests,<sup>29</sup> corresponding to an area the size of all cultivated land in Norway. Seaweed, kelp and eelgrass (seagrass) bind approximately 22 million tonnes of CO<sub>2</sub>e in the vegetation and in shallow bottom sediment.<sup>30</sup> The seabed, where most carbon absorbed in marine habitats will eventually end up, is estimated to store 137 million tonnes of carbon in the upper 25 cm of the Norwegian territorial seabed.<sup>29</sup> Research on pathways between kelp and sequestration in deep sea sediments is progressing,<sup>27,30</sup> but the concept has not yet been established.<sup>31</sup>

In 2023, research from NBFN partners on blue carbon in Norway demonstrates the threats to short- and long-term carbon stores in marine vegetation and soft bottom sediments.<sup>32,33</sup> The brief highlights the dangers caused by coastal development, bottom trawling and climate change, and how a lack of understanding of the importance of blue forest ecosystem services has traditionally resulted in the prioritisation of human activity. However, this shows signs of changing, as Norway has become one of the driving forces for inclusion of blue forests conservation in ecosystem accounts, on par with terrestrial forests. The Research Council of Norway-funded project [BlueARC](#) also kicked off in 2023 – aiming to discern how climate change can impact blue carbon sequestration in the Arctic.

### What to expect in 2024

- Research publications on carbon sequestration of blue forests both in Norway and globally, including a more nuanced understanding of how sequestration differs according to geography

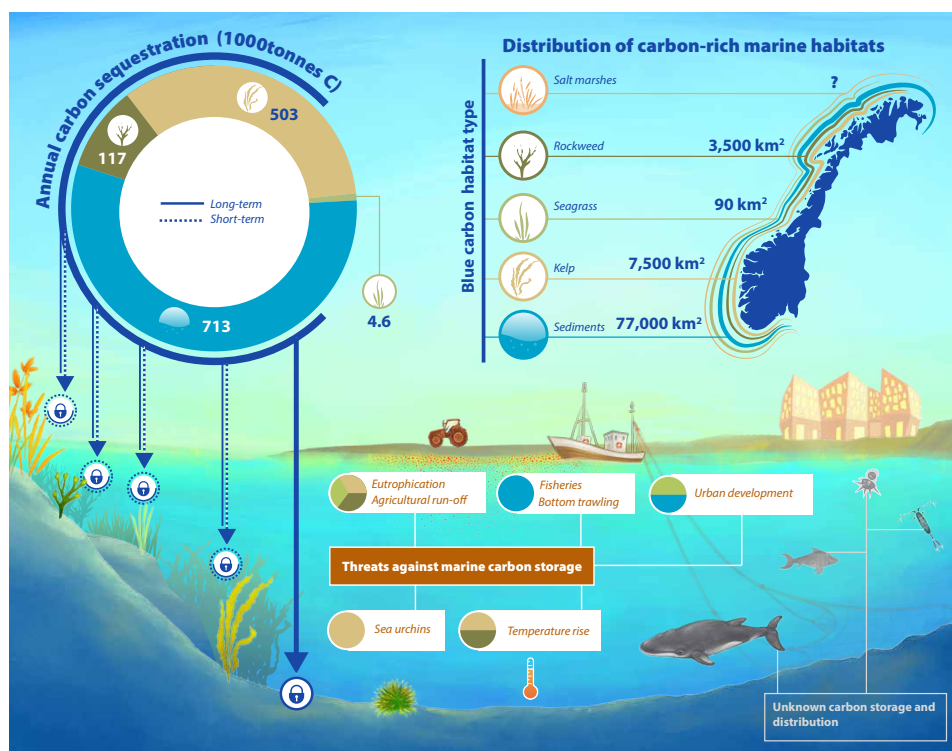


Image by Syed Hasan Abbas, GRID-Arendal. Based on NIVA [Kunnskapsoppsummering om marine områder som er viktige for karbonlagring 2023](#).

# #5

## Blue carbon in high demand, but market issues prevail

Building on last year's [Top Trend #2](#) of blue carbon financing being on the rise, 2023 saw an intensifying debate around building high-integrity blue carbon markets.

The year started with revelations by The Guardian of terrestrial carbon market integrity failures,<sup>34,35</sup> which spurred a flurry of activity on the need for transparency and integrity in nature-based carbon offsetting. In September, the World Bank published its blue carbon investment readiness framework for governments,<sup>36</sup> and [blue carbon featured heavily at the UN climate conference COP28](#)<sup>37</sup> at the end of the year.

Among many blue carbon and carbon market side events at COP28, a premier event on [Partnerships to Improve Blue Carbon Market Integrity](#)<sup>38</sup> was held at the UNEP Pavillion, coordinated on behalf of UNEP by GRID-Arendal. Within the wider COP28 discussions, Norway was among the many nations pledging funds to

support global mangrove conservation – the so-called 'Mangrove Breakthrough'.<sup>39</sup> This commitment supports a goal of 15 million hectares of mangroves being protected or restored, underpinned by investments totalling USD 4 billion, by 2030.

However, international carbon market issues prevail. At the COP, countries failed to agree on key rules to trade offsets bilaterally and to kickstart a long-awaited global UN-sanctioned market. Market integrity remains the major issue, leaving carbon markets in limbo.

### What to expect in 2024

- High-level international calls for increased blue carbon market transparency and integrity



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From the premier event at UNEP Pavillion, COP28, on Partnerships to improve blue carbon market integrity. From left: Fegi Nurhabni (MMAF, Indonesia); Victor Gustaaf Manoppo (MMAF, Indonesia); Grace Catapang (GFCR, Philippines); Jane C. Glavan (Distant Imagery, United Arab Emirates); Al Binger (SIDS Dock); Steven Lutz (GRID-Arendal, Norway).

# #6

## Record year for Norwegian seaweed industry ...

As predicted in the Top 10 Trends 2022 report, 2023 was the year macroalgae were classified as food and included in the legislation for export of fish (*Fiskeeksportloven*).

This was a win for the industry, as they can now benefit from the services of the Norwegian Seafood Council on product promotion abroad.<sup>40</sup> The cultivation of seaweed has steadily increased, with an all-time high of 600 tons wet weight,<sup>41</sup> up from around 340 tons in 2022.<sup>42</sup> These numbers are low compared to the 130–180 000 tons of *cuvie* (*stortare*) trawled annually, but trends point towards continued increased harvest from cultivation.

By comparison, the global production of seaweed was 36 million tons wet weight in 2020,<sup>43</sup> with Asia representing over 98 % of the produced seaweed. However, both Asia and other regions of the world are facing challenges. Issues include ocean warming negatively impacting kelp yields, increased costs, and seed quality.<sup>44</sup>

As in previous years, 2023 was a year of novel research and development. This includes better use of marine space by co-production with other species,<sup>45</sup> a break-through on commercial direct seeding by Arctic Seaweed AS in addition to solving bottle necks with processing, development of new products and markets,<sup>46,47</sup> and a better understanding of biological aspects.<sup>48,49</sup> Other interesting developments included kelp farming in more exposed areas and increased knowledge on carbon capture and storage.<sup>50</sup> Common for all R&D activities in the sector is the need for patience, due in part to the seasonal nature of the harvest, which for instance offers only one shot at testing of new harvesting equipment each year.

### What to expect in 2024

- Initial results from the [JIP Seaweed Carbon Solutions](#) project on carbon capture and storage, turning offshore cultivated kelp into biochar to use as soil enhancement
- More reliable numbers on harvesting, as the industry continues to develop and improve its reporting standards

*Winged kelp ready for harvest at farm west of Askøy.*



# #7

## ... but challenges remain

While 2023 was a boom year for the Norwegian seaweed industry in many ways, the industry still faces challenges related to high costs, consumer awareness and spatial planning.



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Two producers went bankrupt and Orkla Ocean was liquidated. With signs that investors are getting impatient, results from seaweed sales are needed more than ever.

An important challenge for the scaling-up of production, and a topic that received significant attention at the [Seagriculture EU 2023 event](#) in Trondheim, is the lower prices that can be expected when production occurs at larger scale. At the present stage, products are sold at higher prices than what can be expected with a more mature industry. The efforts initiated by the Norwegian Seaweed Association (NSA) to monetise seaweed farms' contribution to ecosystem services, such as water quality and potentially biodiversity, are more important than ever. Such reductions in production costs could help putting products on the market with more competitive prices. Mussels with nitrogen quotas from Denmark have for example become affordable to the point of being used in feed trials. The low trophic aquaculture industries in Norway may need similar stimuli. As discussed during Arendalsuka 2023,<sup>51,52</sup> access to production sites can be a challenge for an area-intensive industry, especially with a crowded coastal zone. Applications for space in municipal spatial plans (*kystsoneplaner*) risk rejection due to seaweed cultivation facing the same regulations as fish farming.<sup>53,54</sup>

In terms of seaweed's newfound status as food in Norway, consumer studies reveal that lack of information is an important limiting factor for adopting seaweed as food. In addition, NSA identified the need for recognised industry standards and has launched its "Seagreens of Norway" certification, requiring certain quality standards from producers to use the brand.<sup>55</sup> Meanwhile, work in the European Food Safety Authority on risk assessment has shown little progress this year, and it may take some years before regulatory levels and recommendations on intake are implemented.

### What to expect in 2024

- Producers partially moving from food to other products and markets, such as bio stimulants
- Further discussions on moving kelp farms offshore, to ease spatial planning

# #8

## Guardians of the blue: Efforts to strengthen Marine Protected Areas

Nationally, the Norwegian government spent 2023 consulting for the national biodiversity action plan (*Nasjonal handlingsplan for naturmangfold*) ahead of the 2024 deadline for national plans to operationalise the Global Biodiversity Framework (GBF).

GBF, known colloquially in Norway as the “nature agreement” (see Trend #2), obliges member states to protect at least 30% of the ocean and ensure that 30% of degraded areas are under effective restoration by 2030 (“30x30” biodiversity target). Protection and restoration are key outcomes of MPAs.

At the local level, Raet national park started to strengthen sustainable management of its marine ecosystem through the *Bevar Raet* initiative.<sup>56</sup> Pilot projects to restore marine habitats in the Oslofjord proved successful,<sup>57</sup> and sugar kelp forests were proposed to be added to the national list of protected habitats.<sup>58</sup>

The Norwegian Environment Agency is considering carbon as a marine protection objective<sup>59</sup> locally, and nationally, in recognition of the interlinked climate and biodiversity crises.

Internationally, research and management has focused on how multiple stressors, such as climate change and biodiversity loss, intersect with the needs of fishing industries and local communities in new and existing MPAs. The European Commission published the EU Action Plan to protect and restore marine ecosystems for sustainable and resilient fisheries.<sup>60</sup> The Norwegian government announced 20 million kroner of funding for the Blue Action Fund to support MPAs abroad, with the explicit purpose of improving livelihoods and food security. Globally, NBFN-affiliated researchers have contributed,<sup>61,62</sup> which has the mission of saving kelp forests by 2040. This brought protection and restoration of marine areas to the fore for many groups from school children to policymakers.

### What to expect in 2024

- Further announcements on strengthening MPAs in Norway following publication of the national biodiversity action plan



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# #9

## Tech waves: Mapping and monitoring blue forests

Building on the 2022 trend of improving marine mapping and monitoring, as well as this year's increased focus on Marine Spatial Planning and Marine Protected Areas, 2023 has seen an increase in advanced mapping methods to effectively identify high-value areas, like blue forests.

These methods map valuable ecosystems faster,<sup>63</sup> cover larger areas<sup>64</sup> and provide more accurate and detailed information.<sup>65</sup> This has been acknowledged both internationally and nationally, and large funding pots have been allocated through the Horizon EU funding programs. One example of this is through calls asking specifically for “next-generation fit-for-purpose tools”<sup>66</sup> for more effective mapping and monitoring of important habitats with one of the ultimate aims to establish MPAs. Several projects under this call were kicked-off last year.

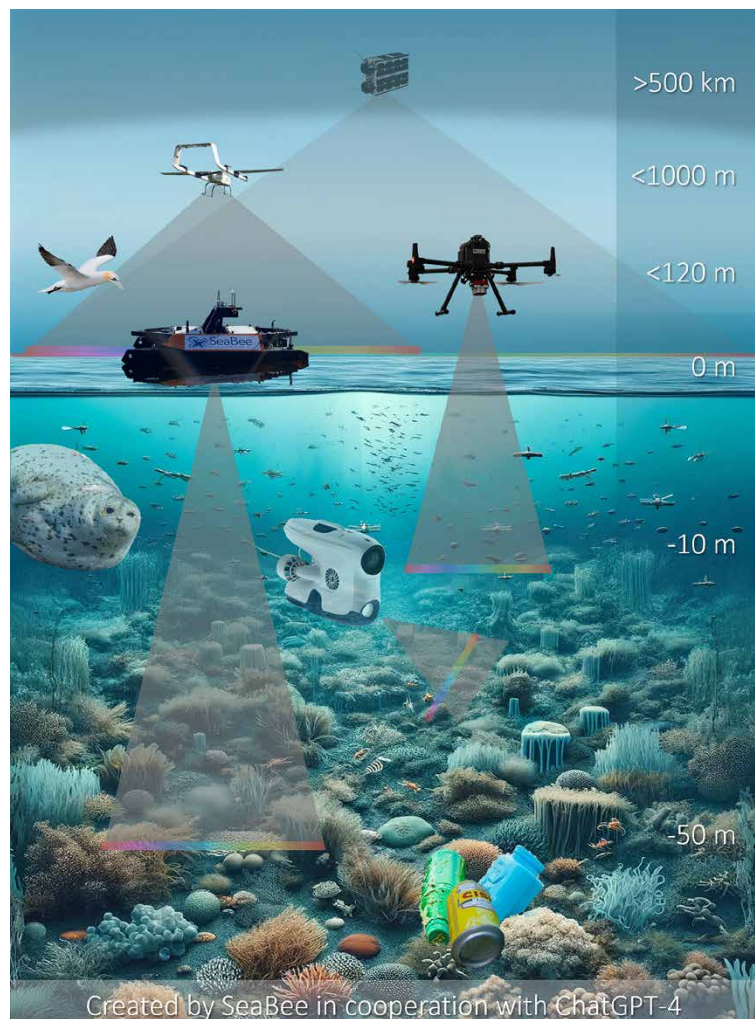
One example is [OBAMA-NEXT](#), a project exploring innovative technologies for more effective mapping and monitoring of blue forest habitats and other marine ecosystems. These include environmental DNA (eDNA) and flow cytometry (FCM), methods which allows for a more rapid species detection of both macro- and microorganisms. Citizen science is also used to gather extensive data. Finally, satellites, drones, and uncrewed vehicles help analyse coastal habitats using methods like Machine Learning.

Nationally, the Research Council of Norway-funded project [SeaBee](#) took a leap forward. SeaBee uses drones and artificial intelligence (AI) to create high-precision and high-resolution maps of blue forest habitats.<sup>67</sup> 2023 saw SeaBee

Research Infrastructure successfully validate automated drone image uploads and processing, habitat classification,<sup>68</sup> upscaling using satellite images,<sup>69</sup> and sharing outputs in a user-friendly way. It is designed to save field personnel, researchers, and modelers hundreds of hours compared to more traditional methods.

### What to expect in 2024

- Higher resolution and better connection between land-based and satellite data coverage



*The SeaBee concept: Flying, surface and underwater drones, equipped with sensors for mapping, monitoring and research applications, supported by satellite data. Image courtesy of SeaBee, 2023.*

# #10

## Tug-of-war with sea urchins: The battle to restore kelp forests

Broadcaster NRK introduced, in an article that soon reached national audiences, the successful work by volunteers from the “kelp guardians” Tarevoktere, who spent two years destroying the sea urchins that are razing the northern Norwegian kelp forests.<sup>70</sup>

The global decline of kelp forests, and attempts to restore this diverse and complex habitat, are not new phenomena.<sup>71</sup> However, the increased visibility of the destruction of coastal habitats has spurred action for kelp restoration in Norway and beyond.

Sea urchin barrens cover around 5,000 km<sup>2</sup> along the coast of northern Norway. The recent publicity and engagement have helped establish Tromsø as a hotspot for kelp restoration initiatives. These activities are run through research projects (e.g., [Atlantisk](#), [Arktisk Agora](#), [OceanGreen](#)), volunteer and non-profit organisations (e.g., [Tarevoktere](#), [Wild Lab Projects](#)), and industry players (e.g., [Urchinomics](#), [HAVUR](#)).

Removal of the spiny herbivore has shown rapid and successful restoration outcomes, both for kelp recovery and for associated ecosystem and socioeconomic services.<sup>72</sup> What's more is it can be done using simple and relatively cheap methods, such as culling, chemical treatment with quicklime, or harvesting by divers, baited traps or remotely operated vehicles.

However, kelp restoration by sea urchin removal is not straightforward. Firstly, profitability can be challenging for the labour-intensive work of gathering seafood that is not yet popular on the Norwegian market. Secondly, urchin removal does not address the root cause of deforestation. The likely cause is overfishing of key urchin predators half a century ago,<sup>73</sup> where the continued absence of predatory fish facilitates and maintains the barrens. To restore and future-proof kelp forest ecosystems, marine management needs to include reintroduction, protection, or sustainable fishing of apex predators to keep sea urchins at bay.

### What to expect in 2024

- Stronger public and private collaboration for kelp restoration, including addressing the underlying causes of deforestation

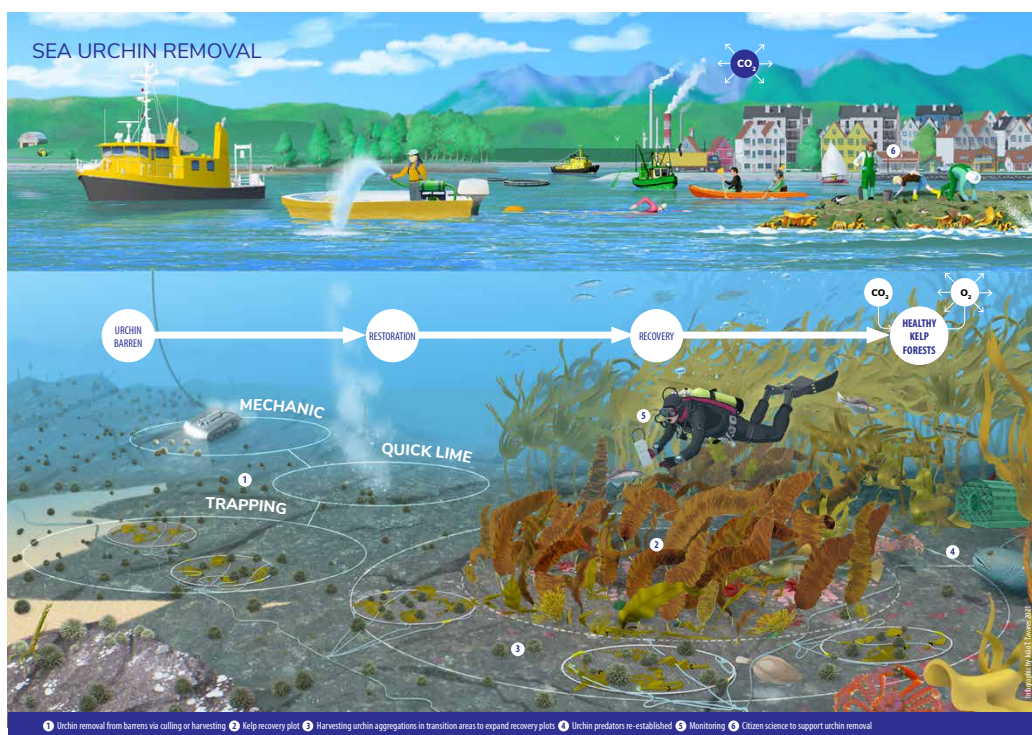


Figure: Verbeek, J., Louro, I., Christie, H., Carlsson, P. M., Matsson, S., Renaud, P. E. (2021). Restoring Norway's underwater forests. A strategy to recover kelp ecosystems from urchin barrens. SeaForester, NIVA & Akvaplan-niva, Report, 2021

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**Contributing authors:**

Barbro Taraldset Haugland (Institute of Marine Research), Peter Haugan (Institute of Marine Research),  
Arne Duinker (Institute of Marine Research), Camilla With Fagerli (NIVA), Sunniva Tangen Haldorsen (NIVA),  
Lorna Little (GRID-Arendal), Steven Lutz (GRID-Arendal), Hege Gundersen (NIVA),  
Gunhild Borgersen (NIVA), Gro Njølstad Slotsvik (GRID-Arendal)