NORWEGIAN BLUE FORESTS NETWORK (NBFN)

TOP TEN TRENDS FROM 2024

Norwegian Blue Forests Network

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Top ten trends from 2024

This is the Norwegian Blue Forests Network's (NBFN) third top trends report. In each report, the headline message has largely been the same: The world is getting warmer. Ecosystems are degraded. Countries are taking action. Will it be enough?

The EU's Copernicus Climate Change Service estimates the average global temperate exceeded the agreed-to limit of 1.5°C above preindustrial levels for the first time in 2024.[1] Last year was also a record-breaking temperature year for the oceans. Amidst this backdrop, countries submitted their first National Biodiversity Strategy and Action Plans (NBSAPs) in response to the 2022 Kunming-Montreal Global Biodiversity Framework. Countries also began submitting their updated Nationally Determined Contributions (NDCs), detailing how they intend to fulfil the Paris Agreement on climate change. According to the UN Climate Change Executive Secretary, these plans are "the final barricade for every nation in its fight-to-the-death against climate impacts getting more brutal each year"[2] (see trends #1 and #8).

For the ocean, a priority in 2024 was to get the High Seas Treaty ratified, with ratification by 60 countries needed for the Agreement to enter into force. By the end of the year, 15 countries had done so.[3] More countries – including Norway – are expected to follow suit. It was hoped that the first ever Global Plastics Treaty would be agreed to by the end of 2024. Unfortunately, negotiators failed to reach a deal. This is concerning for blue forests as marine plastics harm these ecosystems. A new attempt will be made in 2025.

In Europe, the EU passed the Nature Restoration Law (see trend #1). In addition, the JPI Oceans Blue Carbon Knowledge Hub kicked off and started work on a state-of-the-art analysis and gap identification. The Hub is also developing a policy roadmap focusing on whether blue carbon can be suitably managed through existing EU policy instruments (see trend #8).

In Norway, there were a range of positive developments at the local and national level. Parliament passed a resolution calling on the Government to make a national plan for restoring kelp forests; preparations began for the first marine ecosystem accounting pilot; and, for the first time, a fish was given protection status due to its functional role as a predator. See trends #2, #8 and #4, respectively, for details.

2024 was also an important year for natural and social science research. A global synthesis study found that, while MPAs are not a "silver bullet" for kelp conservation, long-term MPAs can be an effective tool to combat kelp forest overgrazing, especially if they are enforced as no-take areas (see trend #4). A number of studies documented the need to consider the role of multiple concurrent stressors in coastal ecosystems, as well as the many ways in which climate change impacts blue forests – from seagrass flowering to mangrove distribution (see trend #5). A definition of "lurv" was also established, which will make it easier to map and monitor this growing threat to seaweed forests and seagrass beds (see trend #6). At the same time, a paper was published that estimates seaweed forests are responsible for 3-4% of the global ocean carbon sink (see trend #8). A review of the carbon dioxide removal (CDR) potential of seaweed farming was also published, whilst the first commercial-scale seaweed farm within a windfarm was deployed (see trend #10).

This report presents a selection of the top national and global trends from the past year, as seen by NBFN. We hope that in highlighting these trends, we can showcase areas where progress has been made and where further collaboration is needed. We conclude each trend by identifying initiatives to follow in 2025 and beyond.

– Norwegian Blue Forests Network

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#1 International policy on restoration: Big ambition meets commitment fears

Global policy progress on nature restoration contrasted sharply with fears of committing funding. Some countries previously at the policy forefront took a step back when asked to put words into action. Yet when major events and reports aligned on issues such as the need to engage indigenous and traditional knowledge in restoration, they seemed to really mean business.

Countries published their first National Biodiversity Strategy and Action Plans ahead of the UN Biodiversity Conference (CBD COP16) in Colombia. By the end of COP16, 44 countries – including Norway – had submitted their action plans.[4] 119 countries have also aligned their biodiversity targets with the Kunming-Montreal Framework.[5] As ever, there are differences in national commitments, with Canada and Ireland lauded as among those with clearly defined plans.[6] The end result of COP16, and indeed the UN Climate Change Conference (COP29), was a familiar refrain from previous COPs: there simply is not enough money on the table to undertake the level of restoration needed on land and at sea.[7] The Nature Positive Initiative estimates the finance gap to achieve the 30x30 target at USD $20 billion per year.[8] Pockets of positive news, such as the announcement of $60 million to protect Gabon's green and blue forests,[9] were augmented by bigger changes. COP16, for instance, ended with a commitment to stronger involvement of indigenous peoples and local communities in biodiversity protection,[10,11] including the creation of a permanent body that will include indigenous people to inform decision making for future biodiversity COPs.[12]

At the tail end of the year, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) launched two much-awaited assessment reports, which will likely have implications for blue forests restoration in coming years. The Nexus Assessment[13] covers interlinkages among biodiversity, water, food, health, and climate change.

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Transplanting seagrass.

The report specifically highlights the restoration of coastal and marine systems, blue forests, and blue carbon ecosystems. Meanwhile, the Transformative Change Assessment[14] examines the underlying causes of biodiversity loss, determinants of transformative change, and options for achieving the 2050 Vision for Biodiversity. It highlights examples of successful transformative change approaches to marine biodiversity protection. Like COP16, the need to include indigenous and local knowledges feature heavily.

Among other notable international events was the UN Ocean Decade Conference in Barcelona, where the main outcome was the Barcelona Statement.[15] The Statement identifies priority areas for action for the Ocean Decade in the coming years, including co-design and co-delivery of science and knowledge to understand global distribution, human health, and ecosystems impacts of marine pollution. Other major areas of agreement were the need for inclusion of indigenous peoples' and local communities' voices, improving ocean literacy, and a mechanism to link philanthropic funding to Ocean Decade Actions.

Within Europe, the European Union passed a landmark law to restore at least 20% of land and sea areas by the end of 2030.[16] The law includes specific targets for marine habitats, e.g. on the restoration of seagrass meadows and kelp forests by reducing pressures on marine habitats, stabilizing the sea bottom, or actively planting. It was only barely voted through, with countries such as Sweden, Finland, and the Netherlands voting against, citing high costs.[17] The resistance contrasts with the EU arguing in favour of ambitious biodiversity goals at the Kunming-Montreal summit in 2022. While the European Commission estimates that every 1 Euro invested into nature restoration adds €4 to €38 in benefits,[18] countries have been battling with fear of domestic backlash against the immediate costs of nature restoration.

It is unsurprising then, that, as predicted in last year's Top Ten Trends report, 2024 has seen increased interest in biodiversity credits, including for marine habitats. Here, links are being made to blue carbon credits[19] and whether these can be sensibly combined. Biodiversity credits are, however, still in the infant stage of development. For more on carbon credits and COP29, see trend #8.

What to expect in 2025

- More talk of transformative change and how to put it into practice.
- Additional countries finalizing their NBSAPs.
- New initiatives to restore marine ecosystems, including blue forests.

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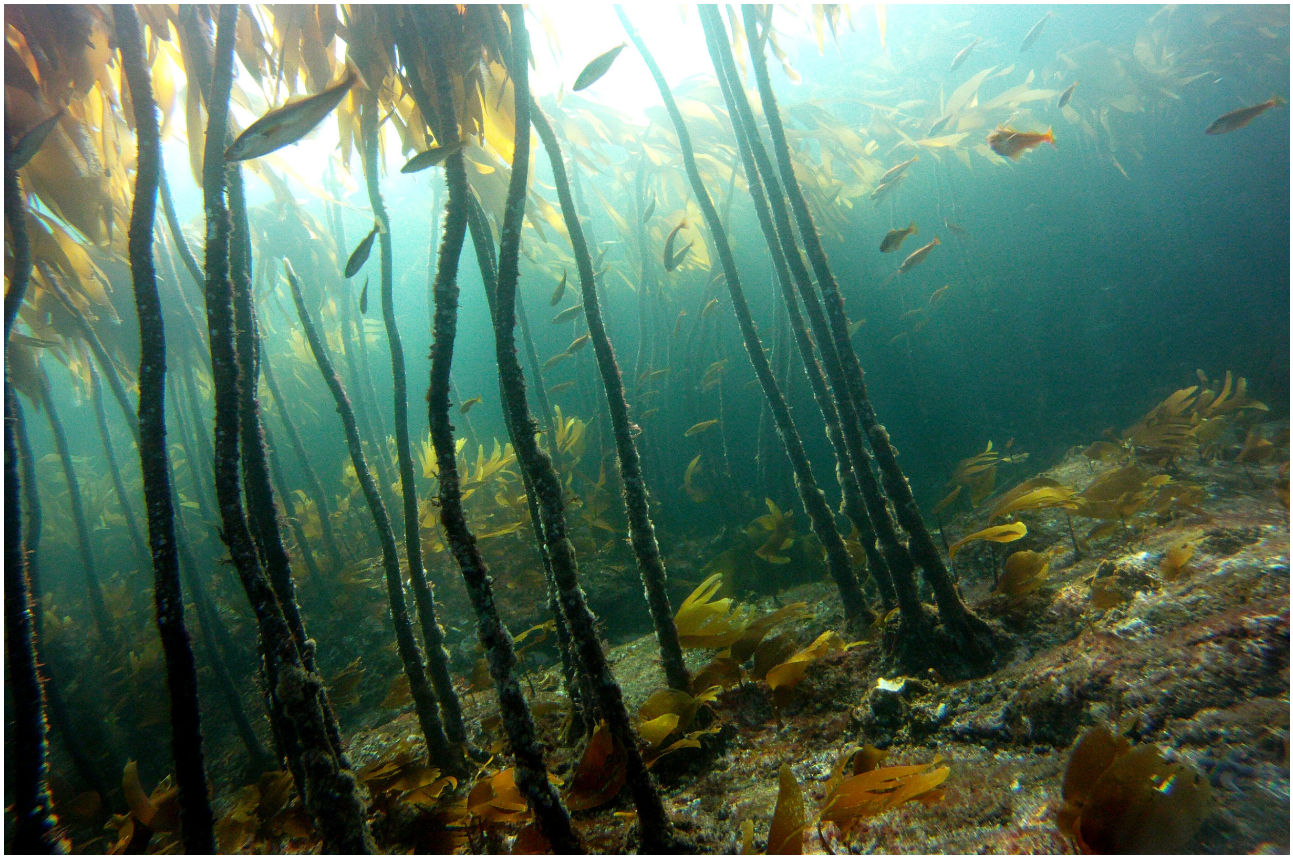
#2 Norway taking action...

Nature was a focus area in 2024 – both in media and in policy. Norway submitted its first Biodiversity Action Plan responding to the Kunming-Montreal agreement; a resolution to restore kelp forests was passed; and interest in blue forests continued to grow.

A big step in 2024 was the publication of Norway's action plan (NBSAP, Meld. St. 35) to operationalise the Kunming-Montreal commitments. In terms of blue forests, the government proposal highlights critical coastal areas such as kelp, eelgrass and seaweed beds, and their importance for biodiversity, carbon storage, and as hunting grounds for commercial species (Section 3.2.1).[20] Conservation of blue forests is also recognised as a nature-based solution to climate adaptation, given its role in preventing coastal erosion and vulnerability to extreme weather and flooding events (Section 6.8.3). While the plan includes some concrete actions and targets, it has come under criticism for not being ambitious and actionable enough – including by delaying setting concrete protection targets for the ocean.[21-24] Hence, Norway's contribution to the global target to conserve 30% of marine and coastal areas, and the global target to restore 30% of degraded marine and coastal ecosystems by 2030, remains unknown.

The plan does, however, include a push to integrate marine biodiversity more deeply into national frameworks like the Norwegian Water Regulation (Vannforskriften). A parliamentary vote on the proposal is expected in early 2025.

The Norwegian Parliament allocated money for nature conservation measures in the 2025 budget, including for restoration and mapping.[25-27] According to the Prime Minister, the scale of funding is unprecedented.[28] However, some politicians and stakeholders argue these funds are insufficient. For example, as pointed out in an interview with NBFN affiliated Institute of Marine Research (IMR) researcher Dr. Moy, financial support to create better maps of coastal ecosystems are needed to stop the 'bit by bit' degradation of the coastline.[29] It is not known whether blue forests will be prioritized in the allocation of the funds.



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The Nature Risk Commission's report on nature risks and Norwegian businesses and sectors was also published last year. The report includes coastal ecosystem priorities such as blue forests' role in carbon storage and erosion prevention.[30]

For blue forests, the biggest event in 2024 was likely the parliamentary resolution (number 789) asking for an action plan for systematic restoration of Norway's kelp forests.[31] The Ministry of Trade, Industry and Fisheries is following this up, in collaboration with the Ministry of Climate and Environment. They have, in turn, asked IMR to work with the Directorate of Fisheries to help develop a plan. The first delivery will be a State-of-the-Art report published in 2025.[32-34]

More and more actors are, in fact, showing an increasing interest in restoring Norway's kelp forests. In 2024, the "NoMaRe" (Norwegian Marine Restoration) platform was launched,[35] with financial support from the private sector,[36] as well as a new marine restoration centre in Lofoten.[37] Several companies are also exploring marine restoration as part of their efforts to contribute to nature positivity. Meanwhile, Tarevokterne continued to spread their message – including to the Crown Prince.[38] Restoration was also the focus of the Tromsø conference hosted by NBFN and partners.[39] The conference, which had participants from 22 institutions including Norad, the Ministry of Climate and Environment, the Ministry of Trade, Industry and Fisheries (NFD), and the Ministry of Foreign Affairs, used a workshop format to collectively explore what it will take to bring back Northern Norway's kelp forests.

A digital handbook for nature-based solutions in the Nordic was developed in 2024[40] with funding by the Nordic Council of Ministers. Researchers from six countries were involved, including scientists from NBFN partner the Norwegian Institute for Water Research (NIVA). The handbook provides guidelines for the practical implementation of nature-based solutions across six ecosystems, including coastal (see Figure 1). In parallel, NIVA coordinated the work on a policy handbook that can support the development of, for example, laws, funding schemes, strategies and information campaigns for nature-based solutions.[41]

What to expect in 2025

- The Parliamentary adopted version of Norway's NBSAP, possibly with more details concerning action steps.
- A report summarizing the NBFN and partners' Tromsø conference.
- Progress on the action plan for kelp forest restoration in Norway.

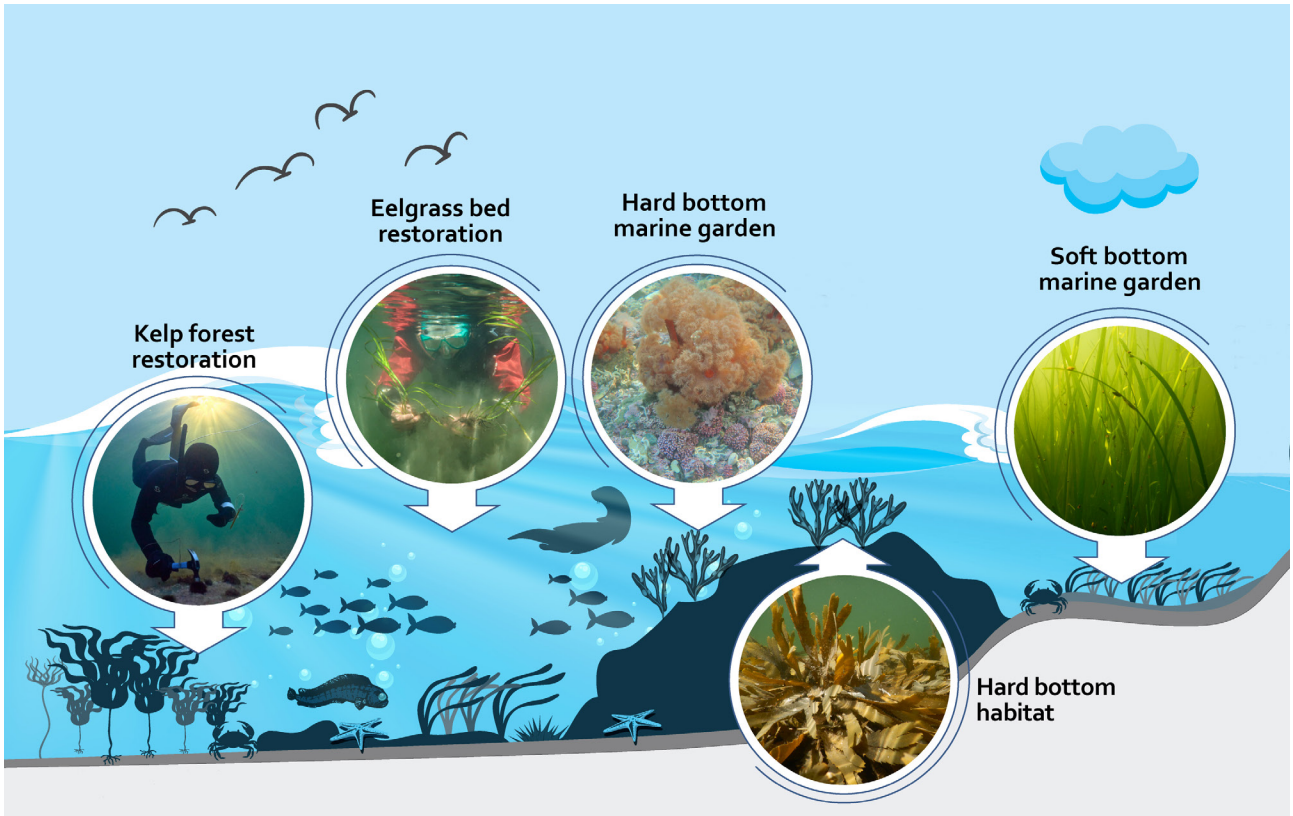

Figure 1. *Excerpt of a graphic from the Nordic Guidance for Nature-based Solutions on coastal ecosystems.*

#3 ...but current policy measures fall short of safeguarding blue forests

A challenge for blue forests in Norway is that they could be managed by various management tools. Perhaps for exactly that reason, they risk falling between them.

As blue forest ecosystems are found close to shore, they fall within the municipal planning territory, which stretches out to 1 nautical mile (nm) beyond the baseline. However, blue carbon from blue forests may be sequestered in soft bottom habitats in Norway's territorial waters (out to 12 nm beyond the baseline), as well as Norway's Exclusive Economic Zone (EEZ, 12 nm to 200 nm). Hence, blue forests and blue carbon management are impacted by various key policy instruments, e.g. the water management regulations, the Nature Diversity Act, and the Plan and Building Act, as well as the National Ocean Management Plan.

The practical protection of blue forests through these regulations remains weak. For example, water management plans typically do not address any blue forest systems. The current water management system also has limitations in terms of reflecting actual ecological conditions in coastal waters. Similarly, whilst MPAs can be established to protect blue forests in the Norwegian coastal zone, they have limited impact on the protection of blue forests unless pressures, both taking place inside of and originating from outside the MPAs, are removed.

In 2024, the Parliament approved new guidelines for "Climate and Energy" as well as "Area use and mobility" under the Plan and Building Act. These guidelines have provisions for protecting carbon rich areas and the areas' ability to sink carbon. However, whilst the Plan and Building Act is valid out to 1 nm beyond the baseline, it is unclear whether the guidelines include sea territories.

The ecosystem-based Ocean Management Plan ("Helhetlige forvaltningsplaner for de norske havområdene") was also updated in 2024.[42] It includes ambitions to protect and restore blue forest, identify areas relevant for restoration, increase knowledge, and evaluate efficient measures. This is an important and promising framework – but concrete actions on how to reach the set goals are not apparent, with critics highlighting, for example, the lack of suggestions when it comes to strengthening the blue economy while simultaneously giving oceans the protection that they need.[43] The Ocean Management Plan also states an ambition to cover

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Figure 2. *Modified slide from presentation given by Frithjof Moy at the NBFN Tromsø conference, highlighting regulations applying to MPAs, where forbidden activities are in green and allowed activities are in red.*

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broader parts of the ecosystems in coastal waters through the water management regulation, which could lead to blue forests achieving a better representation in coastal management in the future.

In Norway's EEZ, there is currently no legal instrument in place that specifically targets the protection of ecosystems or carbon-rich habitats. However, the Government is working to pass a new Ocean Environment Act ("Havmiljøloven")[44] to enable the establishment of MPAs in the EEZ. This act is intended to complement the establishment of MPAs in territorial waters as defined by the Nature Diversity Act (valid only to the 12 nm limit). Blue forest ecosystems are not present in the EEZ. However, blue carbon from blue forests sequesters in soft bottom sediments in the EEZ. While carbon is not listed in the eight proposed MPA criteria, the circulated draft states that "Protected areas can also contribute to the conservation of areas that are important for nature's ability to bind and store carbon." (See trend #4 for more on MPAs).

The Government also drafted Norway's revised NDC and sent it out for consultation.[45] While the document thoroughly describes the current status, areas for improvement have been suggested – such as putting in place more concrete action to include, protect, and increase blue carbon.[46-48] Plans to restore Oslofjord were similarly met with mixed responses: In 2024, more financial support was announced,49 further steps were taken to implement the 2021-2026 action plan, and Parliament passed a resolution asking the Government to conserve and restore the marine environment.[50] However, some argue the incentives are still missing for municipalities to take sufficient action. For more on Oslofjord, see trend #4.

There are also other blue forests bottlenecks that have yet to be addressed. For example, at the Tromsø conference, participants expressed frustration with the difficulty of getting approval to restore seagrass meadows and kelp forests. As it stands, these efforts fall under aquaculture regulation. In MPAs, planting of vegetation is prohibited by default, whilst commercial and recreational fishing is allowed (see Figure 2). Regulatory bottlenecks for the commercialization of sea urchins harvested to protect kelp forests were also highlighted, as was the need for new funding models for restoration efforts.

In 2024, the government's Business plan for Norwegian ocean areas ("Næringsplan for norske havområder") was launched,[51] with a focus on sustainable development and co-existence of marine activities (e.g. offshore wind and aquaculture). The plan states that the Government wishes to support the kelp farming industry. As the focus of the plan is on offshore areas, natural kelp habitats are not included. (See trend #10 for more on the kelp industry.)

What to expect in 2025

- The new Red List of nature types at risk of extinction will be published; look for blue forest habitats.
- The new Ocean Environment Act ("Havmiljøloven").
- A revised NDC for Norway.

#4 Fisheries management and marine conservation remain hot, but contentious, topics

2024 saw hard-won and mixed progress in reconciling fisheries management with marine conservation.

As discussed in trends #1-3, countries are taking steps to restore marine biodiversity, including through fisheries management, MPAs, and other effective area-based conservation measures (OECM). Historic and current unsustainable fisheries and aquaculture practices harm blue forest ecosystems, including by depleting fish populations that keep sea urchins from overgrazing kelp forests[52,53] and filamentous algae from choking seagrass beds.[54]

A 2024 global synthesis study[59] found that MPAs can be an effective tool to combat kelp forest overgrazing – particularly when the parks are long-term and enforced as no-take areas. While MPAs are, on their own, insufficient to address all drivers of blue forest decline, the study found some evidence that MPAs can reduce the impacts of climate change on kelp forests by building resistance and resilience.

Meanwhile, fisheries and MPA research published in 2024 found that:

- More than 80% of European Union MPAs are considered ineffective as they only marginally regulate human activities.[60,61]
- Fully protected MPAs benefit pelagic species and fisheries.[62-64]

The difference between MPAs and OECM

A Protected Area is "a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values."[55,56]

OECMs (other effective area-based conservation measures) are "a geographically defined area other than a Protected Area, which is governed and managed in ways that achieve positive and sustained long-term outcomes for the in situ conservation of biodiversity, with associated ecosystem functions and services and where applicable, cultural, spiritual, socio–economic, and other locally relevant values."[57]

In Norway, MPAs are governed by the Nature Diversity Act (naturmangfoldloven) whilst OECMs are governed by management regulations such as fisheries regulations. In 2024, the Norwegian Environment Agency published a report outlining what qualifies as OECMs under the Kunming-Montreal Framework.[58]

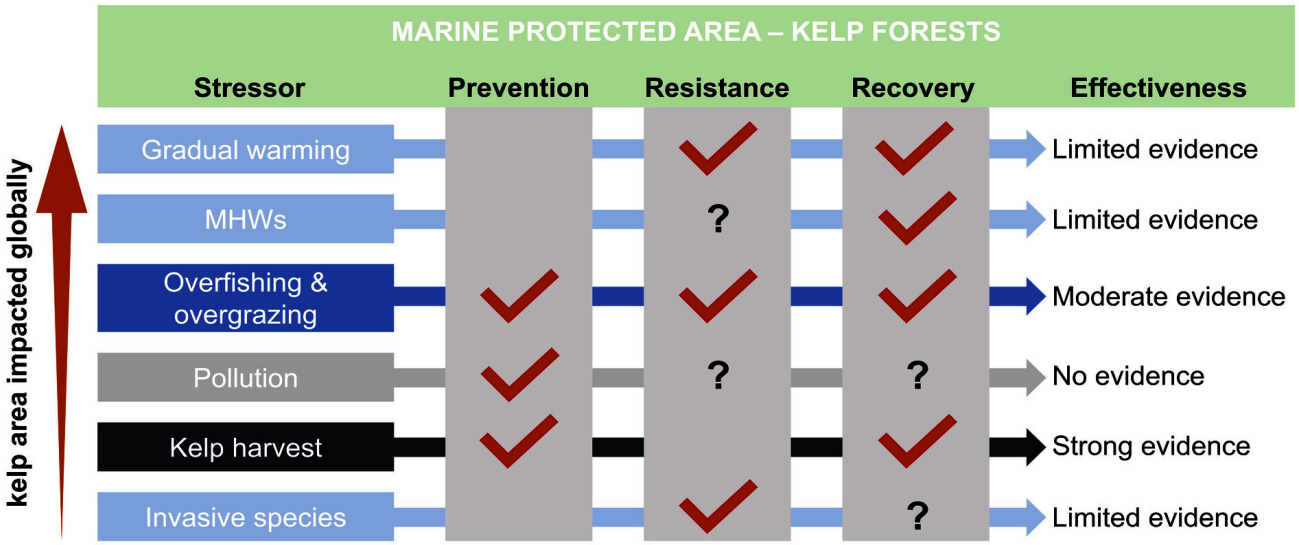

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Figure 3. *MPA ability to mitigate drivers of kelp forests loss through prevention of stressors, resistance to stressors, and recovery following stressors.*

- Genetic biodiversity within fish and blue forest species is essential for their ability to adapt to a rapidly changing ocean. This is not accounted for in the International Union for Conservation of Nature (IUCN) Red List of Threatened Species.[65,66]

A Norwegian Environment Agency commissioned literature review on marine protection and marine conservation by SALT and IMR was also published.[67,68]

In policy, progress in reconciling fisheries management with marine conservation has been mixed. The European Parliament adopted its response to the European Commission package of measures to improve EU aquaculture and fisheries sector sustainability and resilience.[69,70] Parliamentary decisions such as harmonizing nature, fisheries, and climate laws were met with broad support. In contrast, environmental groups expressed disappointment at the Parliament's rejection of the Commission plan to phase out bottom trawling in MPAs.[71,72]

Bottom trawling remains a contentious policy issue both within and between sea-sharing countries.[73-75] In 2024, Greece became the first European country to ban bottom trawling in all MPAs.[76] Sweden became the second.[77] One argument against intense bottom trawling is its impact on long-term carbon storage in seafloor sediments.[78] A 2024 study points to the Norwegian trench as the most important storage of organic carbon in the greater North Sea region.[79] Deep, soft seabed adjacent to coast is the likely endpoint of a considerable amounts of organic carbon, including blue carbon from kelp forests in high latitudes. This may impact marine conservation discussions in Norway. In fact, the draft Ocean Environment Act lists carbon as an additional (though not primary) conservation objective. See trend #3 for details.

As mentioned in trend #2, the proposed Biodiversity Action Plan for Norway does not include a conservation target for the oceans. In addition, no new MPAs were established in 2024. However, the central and regional governments are working towards establishing new MPAs in 2025.[80] They are also exploring how to improve existing and planned for MPAs, given that many would be classified as "unprotected" using international criteria.[81,82] A 2024 report concluded that the current management of the marine area in Raet National Park is incompatible with effective ecosystem protection.[83,84] A range of stakeholders are working together to address this through the "Bevar Raet" project.[85]

Meanwhile, the Ministry of Trade, Industry, and Fisheries banned the catching of wolffish in the Saltstraumen MPA, due to its importance for kelp forests protection.[86]

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Wolffish in kelp forest.

This is the first time a fish has been protected in Norway to conserve its function as a predator.

As debates around the Oslofjord ecosystem continue, the Directorate of Fisheries and the Norwegian Environment Agency presented NFD with new management advice for the fjord in 2024.[87] Based on this input, NFD and the Ministry of Climate and Environment sent a proposal for consultation in January 2025.[88] The proposal includes establishing three no-take zones. If adopted, it would be the second time Norway implements no-take zones (the first being in parts of the Tvedestrand fjord from 2012-2024).[89]

The conservation and fisheries debate ties in with the global discussion on how – as encouraged by the Ocean Panel – we can sustainably manage 100% of ocean areas. A paper published in 2024 found that the models used to determine fishing quotas have been overestimating the biomass of fish stocks.[90] Another study found that the human impact on marine ecosystems, including fish stocks, is higher than what existing baseline data suggests, meaning we have been altering marine biodiversity for centuries.[91] A third paper challenges us to rethink how to produce quality scientific advice for fisheries management in light of high levels of complexity and uncertainty.[92] This research is of relevance to blue forests given the link between fisheries and blue forests' health.

What to expect in 2025

- Further efforts to expand and strengthen marine conservation, including through MPAs and OECMs.
- New fishing restrictions in Oslofjord.
- A Directorate of Fisheries-commissioned report on the level and quality of marine protection in Norway.
- Blue carbon increasingly becoming a focus area in marine protection.[93]

#5 Climate change, multiple stressors, and resilience

The more we learn about the impacts of climate change on blue forests ecosystems, the more we realise that its effects cannot be understood without being placed in a broader ecological and socioeconomical context.

In 2024, we saw a continued focus on understanding the impacts of climate change and heat waves on coastal ecosystems, including the start of a new research project called BLUEARC,[94] funded by the Norwegian Research Council. Several reviews of the impacts of climate change on blue forest ecosystems were published.[95-98] In addition, new studies on the impacts of climate change on different aspects of blue forests, such as seagrass flowering,[99,100] kelp growth and photosynthesis,[101] salt marsh dynamics,[102] and mangrove distribution[103] came out.

In recognition of the importance of understanding how ecosystems respond to and adapt to climate change, as well as the role healthy ecosystems play in climate change adaptation, the Norwegian Parliament approved the government proposal to expand the national goal for climate adaptation from "society must prepare for and adapt to climate change" to "society and ecosystems must be prepared for and adapted to climate change."[104,105] The Norwegian Environment Agency also published an updated strategy and action plan for climate adaptation.[106]

In addition to climate change impacts, there has been growing recognition of the role of multiple concurrent stressors in coastal ecosystems.[107-110] For example, turbidity can exacerbate the effects of heatwaves in kelp forests;[111] warming and nutrients have a combined effect on the nitrogen sink role of salt marshes;[112] climate change promotes the invasion of invasive species in seagrass meadows;[113] and heat waves along with diseases alter seagrass metabolism.[114]

Studies from 2024 have also added to our understanding of the critical importance of biotic interactions and biodiversity in shaping the response of ecosystems to stressors and their resilience,[115-118] as well as how continued and multiple stressors can overwhelm natural resilience and feedback mechanisms.[119-121] New projects launched in 2024 aim to explore and quantify the impacts of multiple stressors on blue forests, and their resilience to future environmental conditions. NORSE[122] and GECOKELP[123] are exploring the interactions of climate change and other stressors such as nutrient

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enrichment and coastal darkening, and the role of the biodiversity and genetic diversity in providing resilience to these multiple stressors in seagrass and kelp, respectively. Both projects are funded by the Norwegian Research Council and have a focus on Norway. The EU project ActNow, which includes Norwegian partners, assesses cumulative impacts on European marine biodiversity, ecosystem functions and services for human wellbeing.[124]

What to expect in 2025

- Governments increasingly focused on ecosystem adaptation and resilience.
- Preliminary results from experiments in the NORSE, GECOKELP and ActNow projects on seagrass and kelp responses to multiple stressors.
- Further research on additional potential stressors such as microplastics and diseases, which could impact future conservation and restoration efforts.

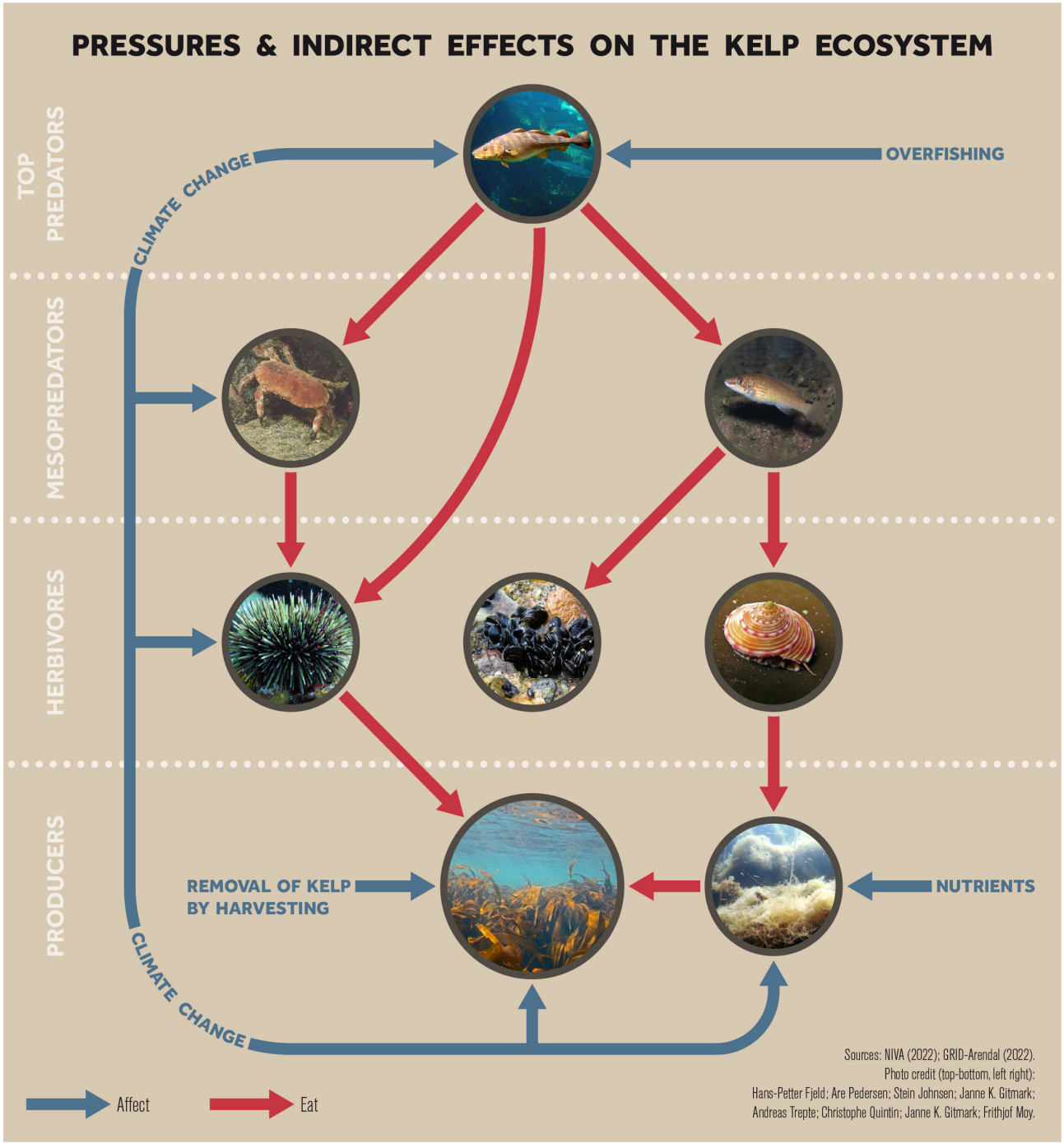

Figure 4. *Pressures and Indirect Effects on the Kelp Ecosystem.*

#6 “Lurv” – finally a definition of this growing threat to blue forests

Lurv is an increasingly reported threat to blue forests at a national and global scale. In 2024, the phenomenon was finally defined for Norway. This is fundamental to achieve a standardised mapping of this frequently-used indicator for the ecological state of coastal ecosystems. Lurv is sometimes translated into English as “turf.” However, the terms are not fully synonymous.

Lurv is reported to scientists and the media when mass blooms of filamentous algae form mats on the ocean surface, creating unpleasant conditions for humans on beaches and in marinas. From an ecological perspective, the effects these algae have on the state of the ecosystems are more concerning. Lurv creates a suffocating layer on top of seagrass beds and seaweed forests, which reduces the seagrasses and seaweed’s photosynthesis and hence poses a threat to their existence.

Lurv is caused by eutrophication and is enhanced by ocean darkening, ocean acidification, ocean warming and overfishing. Lurv used to be a problem restricted to the southern part of Norway (i.e. Skagerrak and the North Sea) but in recent years lurv is increasingly reported in more northern regions as well.[125]

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Cod among filamentous algae growing on top of rockweeds in one of NIVA’s large-scale tidal mesocosm basins at Solbergstrand, Drøbak.

The term lurv has been used as an indicator of poor ecological status in Norway without being clearly defined. On behalf of the Norwegian Environment Agency, NIVA has clarified and defined the problem, the algae species forming lurv, and whether lurv always indicates poor ecological status.[126]

According to the report, all filamentous, opportunistic red, brown, and green algae can occur as lurv. An occurrence is categorised as lurv when the filamentous algae form shapeless masses of intertwined filaments. The presence of lurv indicate poor ecological status if it occurs in high density on rocky or soft substrates, on seaweed, kelp, or seagrass, or if it completely replaces these native, perennial habitat-forming species.

The international equivalence to lurv is “turf”. In contrast to lurv, “turf” encompasses species that do not indicate a reduced ecological state, e.g. calcareous algae, leaf-like algae, and naturally short-growing algae. Moreover, “turf” is sometimes restricted to densely packed and short-growing occurrences of algae.

The report provides an overview of the species that can be expected to form lurv in marine habitats in Norway and will serve as a useful reference for mapping marine habitats in accordance with NEA’s guidelines, which are scheduled to be completed in 2025.

What to expect in 2025

- Increased occurrence of lurv along the Norwegian coast.
- More knowledge about lurv among marine habitat surveyors and more standardised mapping of lurv as an indicator of ecological status in Norway.
- Increased focus on mapping and monitoring of lurv, and more knowledge of lurv as a threat to blue forests.

#7 Connectivity: No habitat stands alone

What happens to a single species or habitat has a ripple effect across the wider ecosystem. Yet marine management often fails to recognise this. The evidence base for why this must change is growing.

Ecological connectivity, or the degree of connection between different habitats within a larger area, is an important consideration for how we assess the impacts of stressors and manage ecosystems at different scales. Yet, as touched on in trend #2, impact assessments don't sufficiently take this into account – leading to the 'bit by bit' degradation of the coastline.

A policy brief published in 2024 by the SAMSKAG project, funded by the Nordic Council of Ministers, outlines the importance of connectivity for marine conservation and has pushed the importance of connectivity into the spotlight in the Nordic countries.[127] This brief, along with the associated pre-print,[128] shows the importance of adaptive management strategies that take into account both connectivity and population structure in several key species, including seagrass and macroalgae, across the Skagerrak, Kattegat, and Baltic Sea region. It also points out the need for better estimates of connectivity. Another 2024 study showed how spatial connectivity between fish populations can affect resilience to regime shifts that can affect coastal blue forests in the Baltic Sea.[129] The EU Horizon research project, MARHAB,[130] was also launched, studying connectivity within the Skagerrak and Kattegat and how to improve the status of coastal habitats in this region.

The importance of connectivity in marine systems has also been noted beyond northern Europe, with a special issue focused on marine functional connectivity in the journal Marine Ecology Progress Series in early 2024.[131] The issue, among other aspects, compared approaches for measuring connectivity between kelp forests in Canada in order to provide outputs at the appropriate scale for management.[132] It also explored the role of fish in facilitating connectivity between seagrass and coral habitats in the Caribbean.[133] A review on how to improve recovery, restoration, and MPAs in coastal habitats by incorporating connectivity and dispersal was also published.[134] Connectivity was also included in several priority research questions for seagrass.[135] Meanwhile, quantifying connectivity in blue forests using different methods, such as genetics and modelling has been ongoing for several coastal habitats around the world. This includes kelp,[136,137] seagrass,[138] and blue mussels,[139] as well as interconnectivity between different types of habitats,[140] especially with the aim of improving conservation and restoration outcomes.[141]

What to expect in 2025

- Publication of the current preprint on genetic connectivity of key species between the Skagerrak, Kattegat, and Baltic Sea.
- Results from the ongoing genetic diversity and connectivity of kelp and seagrass research in Norway.

Longer-term, we also anticipate increased consideration of connectivity and links between habitats and ecosystems in impact assessments and management plans.

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Seagrass alongside kelp.

#8 Blue carbon: From global rhetoric to national action

Interest in blue carbon remains high. The scientific underpinnings needed to turn this interest into concrete national action is growing. However, hurdles remain.

As described in previous top trends reports, there has been considerable progress in strengthening the focus on ocean-based activities in mitigation and adaptation efforts. This progress continued in 2024. At the Ocean and Climate Change Dialogue, countries were encouraged to adopt the IPCC (Intergovernmental Panel on Climate Change) Wetlands Supplement in their national greenhouse gas inventories and to consider including blue carbon ecosystems in their NDCs and national adaptation plans (NAPs).[142] Blue carbon was similarly highlighted as a key mitigation approach in the UNESCO Consolidated Outcomes of the Vision 2030 Process Report.[143] A number of additional 2024 events and papers explored how blue carbon ecosystems can be included in countries' plans, including several side events at COP29.[144-146]

Many coastal countries already include blue forests in their NDCs, including the Seychelles, Kenya, China, India, and Indonesia. However, it is anticipated that the revised NDCs, which are due in February 2025, will have an even greater – and hopefully even more concrete – focus on these ecosystems. Japan has taken this one step further: In 2024, the government declared it was the first country to include carbon sequestered by seagrass and macroalgae (including kelp) in its National Inventory Submission to the U.N. Framework Convention on Climate Change (UNFCCC).[147,148]

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Seaweed transported to the ocean floor where the carbon may be locked away.

The Intergovernmental Panel on Climate Change instructed the IPCC Task Force on National Greenhouse Gas Inventories to convene an Expert Meeting in 2024 and to provide a Methodology Report on Carbon Dioxide Removal Technologies and Carbon Capture, Utilization, and Storage by the end of 2027. The report from the Expert Meeting recommends that blue carbon ecosystems, including macroalgae, be considered for further work, including by updating the IPPC classification and reviewing existing guidance.[149]

Unlike other blue forests, macroalgae is considered an "emerging" rather than "actionable" blue carbon ecosystem due to insufficient evidence (although research is ongoing) and the absence of guidelines for macroalgae in the Wetland Supplement. In response, a series of papers were published between 2022-2024, in part with NBFN support.[150] The final paper in this series, 'Carbon export from seaweed forests to deep ocean sinks', estimates that seaweed forests are responsible for 3-4% of the global ocean carbon sink.[151] For seagrass, an article focused on Norway found that seagrass meadows in deep, muddy areas near river mouths tend to have the richest carbon stocks.[152]

In addition to the launch of a database on blue carbon in Europe,[153] two research projects on the mitigation potential of "polar blue carbon" were funded by the European Commission (SEA-Quester[154] and POMP[155]). The EU funded C-BLUES project,[156] along with a sister project in China, was also started. C-BLUES will develop spatial maps, best practices, and standard procedures for quantifying greenhouse gas emissions and carbon sequestration, as well as inform revisions to the 2013 IPCC Wetlands Supplement.

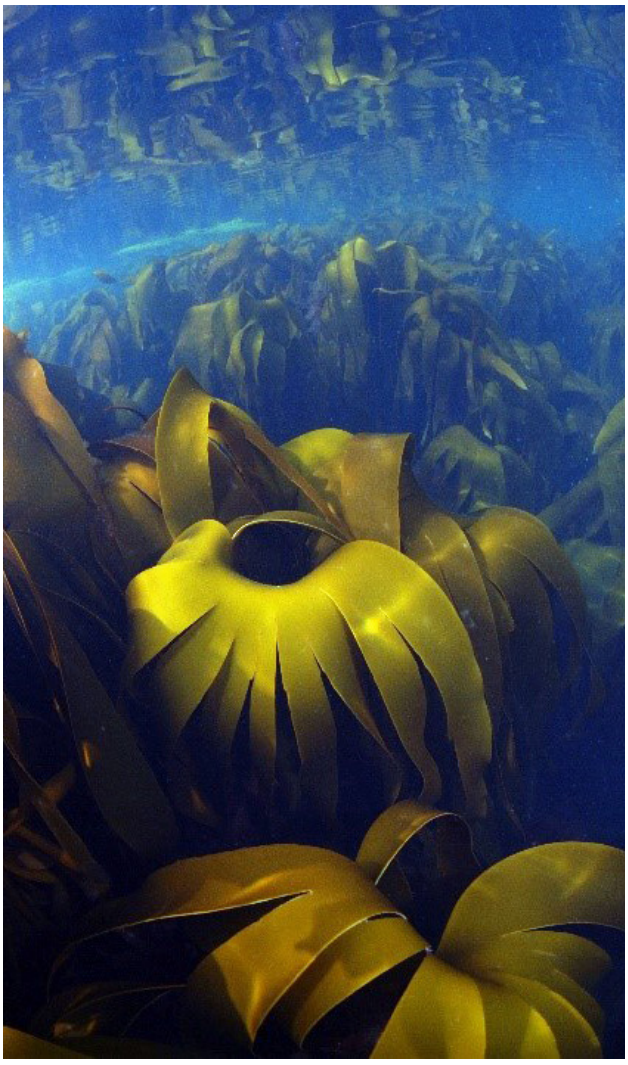
In 2024, the JPI Oceans Blue Carbon Knowledge Hub kicked off and started work on a state-of-the-art analysis and gap identification to form the foundation of a research call.[157] The Hub also began the development of a policy roadmap focusing on whether blue carbon may be suitably managed through three key EU policy instruments: greenhouse gas (GHG) reporting through the EU LULUCF directive (Land Use, Land Use Change and Forestry), the Marine Strategy Framework Directive, and the Nature Restoration Law. All NBFN partners participate in the Knowledge Hub. NIVA will lead the work on blue carbon reporting through the EU LULUCF directive.

Discussions on whether, and if so how, to finance blue forest restoration through blue carbon credits also continued.[158-163] A key milestone for carbon credits in general was the COP29 agreement on carbon market standards.[144]

It is important to note that while the knowledge base and interest in blue forests' ability to sequester carbon is growing, in 2024 some parts of the scientific community continued to call for a more nuanced understanding and precautionary approach as to when – and to what extent – blue forests can significantly contribute to climate change mitigation.[164,165]

What to expect in 2025

- Greater inclusion of blue carbon in the next round of NDCs and NAPs.
- More research on factors affecting carbon uptake in a changing climate.
- More research on the relationship between kelp forests, carbon-rich benthic sediments, and long-term carbon sequestration.
- JPI Oceans policy briefs on possibilities for including blue carbon reporting in the EU's policy instruments.
- The IPCC considering the outline for the 2027 Methodology Report.
- NEA producing an overview of existing knowledge on the uptake and release of CO2 in the ocean.[166]



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#9 Ecosystem accounting for the ocean

Accounting for ocean ecosystems picked up the pace in 2024, though blue forests are still lagging behind their green counterparts.

Ecosystem accounting is a spatially explicit framework for tracking changes in ecosystem extent, condition, and services provided. It highlights how the health of ecosystems is linked to the important contributions they make to economic welfare and societal wellbeing. Thus, ecosystem accounts provide a better basis for sustainable decision-making. In 2021, the United Nations Statistical Commission adopted the System of Environmental Ecosystem Accounts – Ecosystem Accounting (SEEA EA), which provides an internationally agreed standard for ecosystem accounting.[167] The SEEA Ocean Working Group is working to specify how these standards can be applied to ocean ecosystems.

For blue forests, ecosystem accounting means mapping their distribution, their condition, and their contribution to carbon sequestration, carbon storage, and nursery habitats, among other things. Since the framework is spatially explicit, ecosystem accounting could, for example, help assess where important blue forests are being lost and where restoration efforts should be prioritized.[168]

In June 2024, international experts and practitioners came together in Bali for the 5th Global Dialogue on Ocean Accounting from the Global Ocean Accounts Partnership. The conference highlighted the growing recognition of ocean accounts as a key tool for achieving global commitments on sustainability, climate change, and biodiversity. Ecosystem accounting for blue forests was a central topic.[169]

As mentioned in trend #2, Norway's national budget for 2025 includes funding for improved mapping of nature – maps that will form a basis for ecosystem accounts.[170,171] For 2024, the Ministry of Climate and Environment's letter of allocation to the Norwegian Environment Agency listed the establishment of ecosystem accounts as a priority in preparation for upcoming reporting requirements to the European Union.[172] While the main focus is on terrestrial ecosystems, the letter called for progress on the pilot for marine ecosystem accounts, the Lofoten Pilot. The pilot itself will start in 2025. However, preparatory work, such as collecting existing data for the pilot area, was ongoing in 2024.[173]

Image of the Norwegian coastline taken by a SeaBee drone near Runde in 2022.

©Eli Rinde/NIVA

In light of this, the Norwegian Environment Agency invited stakeholders to an input day ("innspillsdag") to discuss the way forward in mapping Norway's ecosystems in line with the UN standards for ecosystem accounting.[174] This day confirmed that there are significant gaps in data and knowledge on blue forest ecosystems in Norway, and that much more effort is needed to move marine ecosystem accounts forward. NIVA presented one way forward for the spatial mapping of coastal ecosystems by using drone images and upscaling these with the help of satellite images.

The Norwegian Government is also interested in how accounts can contribute to municipal management and at project level.[175] These topics are explored in recent and ongoing projects.[176,177] The private sector is also showing an increased interest. At the project level, ecosystem accounting could provide a tool for companies to meet the growing environmental reporting requirements, for example under the Corporate Sustainability Reporting Directive (CSRD)[178] and the Taskforce on Nature-related Financial Disclosures (TNFD).[179]

In addition, during the past couple of years, NBFN has contributed to the GEAK network (Global Ecosystem services Assessment for Kelp forests). The aim is to produce the first global comprehensive assessments of the economic values from ecosystem services provided by kelp forests. The valuation covers kelp as a harvested resource as well as its importance for fisheries, carbon storage, nutrient filtration, biodiversity, and cultural services. A scientific article is soon to be submitted, and a Norway-only version of the study is on the way.[180,181] In 2024, the MAREA-project also continued the work on ecosystem accounting in the Oslofjord.

What to expect in 2025

- The start of the pilot on marine ecosystem accounts in Lofoten.
- Significant political push for ocean accounts towards the United Nations Ocean Conference and One Ocean Science Congress in in June.[182]
- Private sector interest in ecosystem accounting to comply with reporting requirements.
- Publication of the global GEAK kelp forest assessment and valuation findings.

#10 Norway's kelp farming industry: Breaking the vicious circle

Kelp industry insiders are calling the phase they are in right now the "valley of death." If things don't improve, bankruptcies are expected. The discussion around deep sea sinking for CO_2 sequestration seems to have dissipated, whilst interest in co-use of space continued.

In Norway, 2024 harvesting yields were roughly half of the 2023 record-breaking yields of around 600 tons wet weight of kelp (according to data collected by Norwegian Seaweed Association). This was not due to poor growth or low-quality seaweed. In fact, growth and quality were very good. However, in contrast to previous years where farmers aimed for the biggest possible production even if they didn't have buyers lined up, in 2024 most producers chose to only harvest the amount they predicted could be sold, as storage of unsold produce is expensive. The remaining seaweed was left in the sea.

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Harvesting winged kelp with Artic Seaweed AS in 2024.

The industry seems stuck in a vicious circle, both in Norway and many other Western countries, with kelp producers waiting for customer demand before scaling up, and potential customers waiting for upscaling and lower prices before committing to buy. This may have been part of the reason that Orkla Ocean, a major player in the food industry, ended its seaweed activities in January 2024. Another company moved from kelp production to producing, rigging and harvesting farms in Norway and abroad.

An important step towards scaling up kelp farming is to get more reliable and cost-effective seeding. So-called 'direct seeding' proved successful and cost-effective in 2024, with one company providing this service for other companies as well. The industry also continued working to develop a larger market. One product that is gaining attention is a burger where seaweed material is replacing 20 % of the meat, hence reducing the CO_2 footprint of the burger and increasing health benefits.[183]

Expanding production to more than a few species is also a way to diversify and create different market segments. Nordic Seafarm in Sweden has, for example, shown that sea lettuce can be cultivated commercially, in a similar fashion to sugar kelp and winged kelp.[184] The industry is also working to expand into international markets, now also with assistance from the Norwegian Seafood Council since seaweed is now defined as seafood. To facilitate this, the Council started inviting the industry to market their products at events in Europe. The Council's support for the industry has, however, not gone beyond this as the funding for their support is tied to a fee every exporter pays. With low export numbers, the funding is small. This is another vicious circle.

As predicted in last year's report, energy companies and kelp farmers continued to explore establishing offshore kelp farms as part of multi-use sites in Norway. The aim of multi-use is locating different industries within the same space, such as offshore wind and kelp cultivation. Doing so would provide more space for larger seaweed farms and a possibility to expand the industry. However, with the current market challenges, the profitability of offshore farming is uncertain. There are also several added challenges related to offshore cultivation and multi-use – including delayed progress in offshore windfarm licencing, the added time spent traveling to the farms, and the added difficulty of mooring farms in deep waters. Despite these challenges, offshore cultivation is being tested in other countries, including in the Netherlands, Germany, and Denmark.[185-187] The first commercial scale seaweed farm within a windfarm has also been deployed (North Sea Farm #1).[185]

In 2021-2023, there was a lot of excitement about cultivating seaweed as a carbon capture solution. One proposed (and piloted) method was to sink the harvested seaweed in the deep ocean, where the carbon could be stored long-term. This method received a lot of push-back, and – as a result – seems to have faded away.[188] Efforts to instead use the harvested seaweed to replace carbon-intense products remain ongoing. A SINTEF-led consortia, including NBFN partner NIVA, is, for example, testing turning seaweed into biochar, which can be used for soil improvement.[189] In 2024, a review of the carbon dioxide removal potential of seaweed farming was published.[190] The forthcoming IPCC Methodology report for CDR is expected to shed further light on this topic. For more on carbon sequestration, including the IPPC report, see trend #8.

What to expect in 2025

- The fate of the industry in Norway is too unclear to make a prediction. It could take off, remain small, or collapse. For industry actors that would like to use seaweed products in the future, now might be the time to get involved.

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Cultivated sugar kelp.

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Norwegian Blue Forests Network

A competence network established by the Norwegian Institute for Water Research (NIVA), GRID-Arendal, and the Institute of Marine Research (IMR)

Contributing authors:

Cecilie Wathne (Norwegian Blue Forests Network), Gro Njølstad Slotsvik (GRID-Arendal), Paige Hellbaum Eikeland (GRID-Arendal), Solrun Figenschau Skjellum (NIVA), Eli Rinde (NIVA), Sunniva Tangen Haldorsen (NIVA), Ragnhild Ryther Grimm Torstensen (NIVA), Barbro Taraldset Haugland (IMR), Karine Gagnon (IMR), Arne Duinker (IMR), Even Moland (IMR)

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