

NORWEGIAN BLUE FORESTS NETWORK (NBFN)

ANNUAL REPORT 2022

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



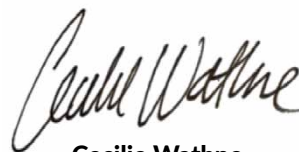
Letter from the Board and Project Leader

The importance of coastal ecosystems, including blue forests, continued to gain prominence in 2022. The UN Climate Change Conference (COP 27) final declaration included, for the first time, a dedicated sub-section on the ocean. Similarly, the biodiversity agreement adopted at the United Nations Biodiversity Conference (COP15) commits members to effectively conserve, manage and restore coastal areas. In Norway, the focus on coastal ecosystems has been similarly pronounced. Indeed, most speakers at the Norwegian Ministry of Foreign Affairs and Norad's first annual ocean conference highlighted the importance of blue forests. Such statements have been backed by concrete action, including efforts to change regulations to define macroalgae as seafood and assess the legal changes required to make climate change a marine protection objective.

Blue forests restoration projects have also been on the rise. These projects have yielded a growing evidence base on lessons learned and common success factors, a topic explored during Blue Forests Week 2022. The private sector has emerged as an eager funder for such initiatives, as more and more companies strive to become carbon neutral and nature positive. This interest opens opportunities for larger scale restoration efforts, but that is not without its challenges. Furthermore, while it is important to restore blue forests habitats, it is both economically and ecologically preferable to prioritise conserving remaining habitats.

The importance of the wide range of blue forests' services beyond carbon sequestration is increasingly being researched and discussed. To facilitate this, in 2022 Norad and NBFN held a joint seminar on blue forests and poverty, touching upon topics such as food security, fisheries, gender equality and livelihood generation.

But despite their importance, blue forests continue to decline and disappear. Reversing this trend is not easy. Some of the causes of their decline – such as ocean warming and heat waves – are beyond the remit of those directly responsible for managing blue forests. Other threats – such as excess nutrient runoff from land, coastal development, and unsustainable fishing practices – are within decision makers' sphere of influence but require difficult trade-offs, such as a willingness to prioritise nature and long-term benefits over short-term economic gain. To make the case for why blue forests are important, we need more and better data on where blue forests are located, what their status is, how they are threatened, and the ecosystem services that they provide. Equally important are efforts to effectively disseminate this information. This is what the Norwegian Blue Forests Network will prioritise doing in 2023. We will synthesize latest research on blue forests, share blue forests knowledge and expertise, and bring the spectrum of actors interested in blue forests together.



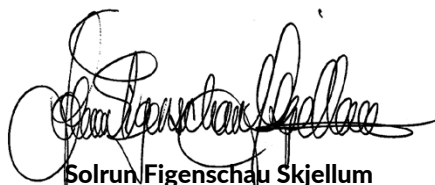
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Pillar 1: Gather

Synthesize latest research on blue forests

The top blue forests trends of 2022 were collated.

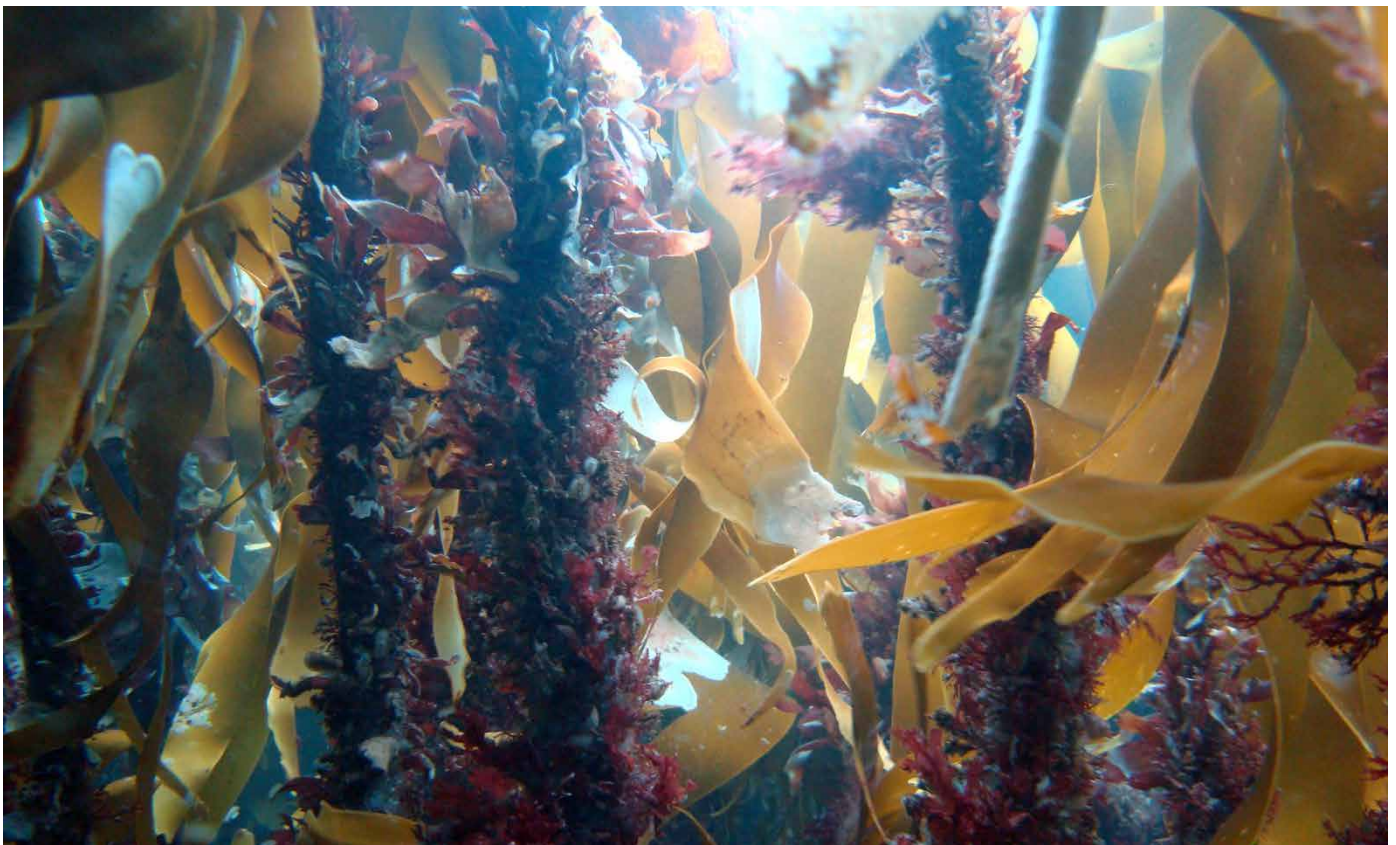
A range of experts on blue forests were surveyed to produce the first ever Norwegian Blue Forests Network (NBFN) overview of what is happening in the field of blue forests. The review ([NBFN 2023](#)) highlighted the following 10 trends:

1. Beyond blue carbon: Increased acknowledgement of the wider ecosystem services blue forests provide.
2. Blue carbon financing is on the rise, despite an opaque carbon market.
3. Is kelp a 'silver bullet' for climate change? The debate continues.
4. The creation of better maps and models – both from the field and from afar.
5. Efforts to restore blue forests surge.
6. The importance of ecosystem-based management is increasingly acknowledged yet understudied.
7. Microbiomes are essential for health and functioning of blue forests.
8. Mapping genes in kelp forests can help future proof species for climate and industry.
9. The European seaweed industry is growing, but not yet soaring.
10. Seaweed will likely be defined as seafood in Norway.

The review concludes by identifying areas to watch in 2023 and beyond. In January 2023, we launched and disseminated the publication via our mailing list, social media, and a seminar in Oslo.

New data on the carbon storage capacity of seagrass in Norway will soon be available.

In 2017, NBFN funded a survey of carbon storage in [southern Norwegian eelgrass meadows \(SEAME\)](#). Researchers from the Institute of Marine Research (IMR) and GRID-Arendal sampled five sites in the Skagerrak, near Flødevigen. To expand the geographic coverage to the whole of Norway, data from three sites was later added: Bodø (data from Nord University), Oslo Fjord and Porsanger Fjord. Final lab analyses of the last cores from Porsanger Fjord are nearly complete. Data analysis of the environmental factors driving the carbon storage potential of seagrass is also ongoing. Once completed, a manuscript will be produced by researchers from IMR, the Norwegian Institute for Water Research and GRID-Arendal and submitted to an academic journal for publication. Preliminary results suggest that the Skagerrak eelgrass meadows have particularly high carbon storage potential. With the Danish eelgrass meadows showing the highest recorded carbon values to date, the addition of the Norwegian sites suggests that the Skagerrak might be a seagrass blue carbon hotspot.



The first global kelp assessment report is ready.

In 2020, the United Nations Environment Programme and NBFN convened a global network of kelp experts to produce the first ever global report on kelp forests. The report synthesizes the state of knowledge on kelp ecology, the pressures on these ecosystems, how kelp protection fits into international policy and law, and how we can best manage and restore these forests. Key outputs include the first digital map of the known distribution of kelp forests across the globe. The report aims to increase understanding of the importance of these ecosystems as well as provide guidance on how policymakers and practitioners can best protect and sustainably manage them. The report was completed in autumn 2022 and will be launched as an official United Nations Decade of Ocean Science for Sustainable Development publication in early 2023.

A synthesis study on macroalgae carbon sequestration is complete.

Over 30 kelp ecologists worked to produce a more accurate global estimate of macroalgae carbon sequestration. The work began with a EuroMarine workshop in 2019 and was furthered by a subsequent NBFN-sponsored workshop in 2020. Using a combination of literature surveys and biophysical and spatial models, researchers have produced three complementary outputs: i) a global overview of the distribution and extent of macroalgae, ii) a global model of net primary production for brown and red macroalgae, and iii) a global model estimating the transport of macroalgal carbon to the deep sea and deep fjord habitats, where it can be sequestered. These data provide the first spatially

explicit global maps of carbon-sink potential for kelp and macroalgal forests, which is critical information for policymakers and managers of blue carbon. A key finding from the study is that Norway's extensive kelp forests are a hotspot for carbon sequestration.

The first two outputs were published as journal articles in 2022 (Duarte et al. 2022; Pessarrodona et al. 2022). A third paper is accepted in the International Council for the Exploration of the Sea Journal of Marine Science (Filbee-Dexter et al. 2022). A fourth paper will be submitted to Nature Geoscience after a final review by co-authors. The findings will be further disseminated through interactive global maps on the NBFN website.

Research by the Global Ecosystem services Assessment for Kelp forests network shows the full value of the world's kelp forests.

Over 50 kelp experts and environmental economists formed the Global Ecosystem services Assessment for Kelp forests (GEAK) network in 2020. The network is conducting the first comprehensive assessment of the ecosystem services provided by kelp forests, including a spatially explicit understanding of the function and services of kelp forests as well as an economic valuation of these services worldwide. The valuation captures both kelp as a harvested resource as well as its importance for fisheries, carbon storage, nutrient filtration, biodiversity, and cultural services.

In 2022, NBFN co-sponsored the network's first in-person workshop in Arendal. This workshop facilitated the coordination of data analyses across regions, as well as the finalization of the global synthesis work. The results will be

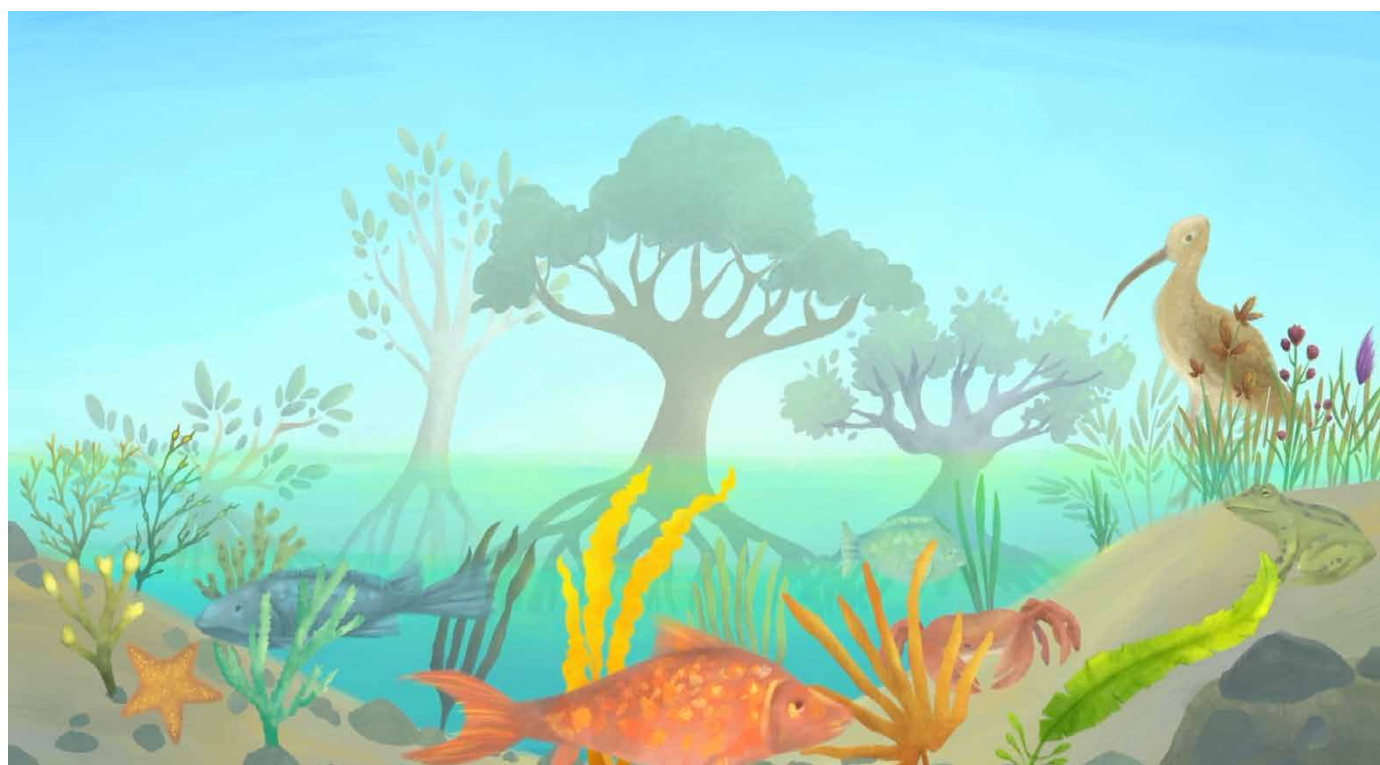
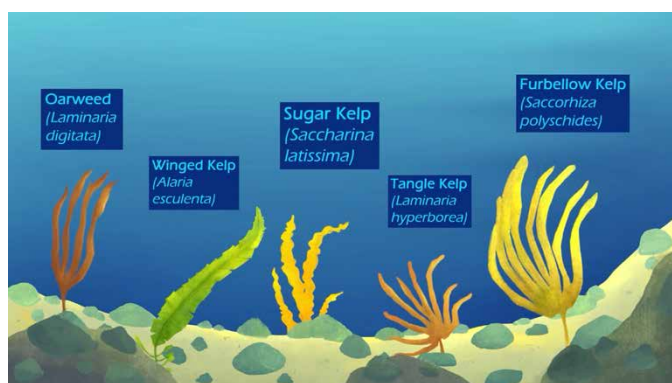
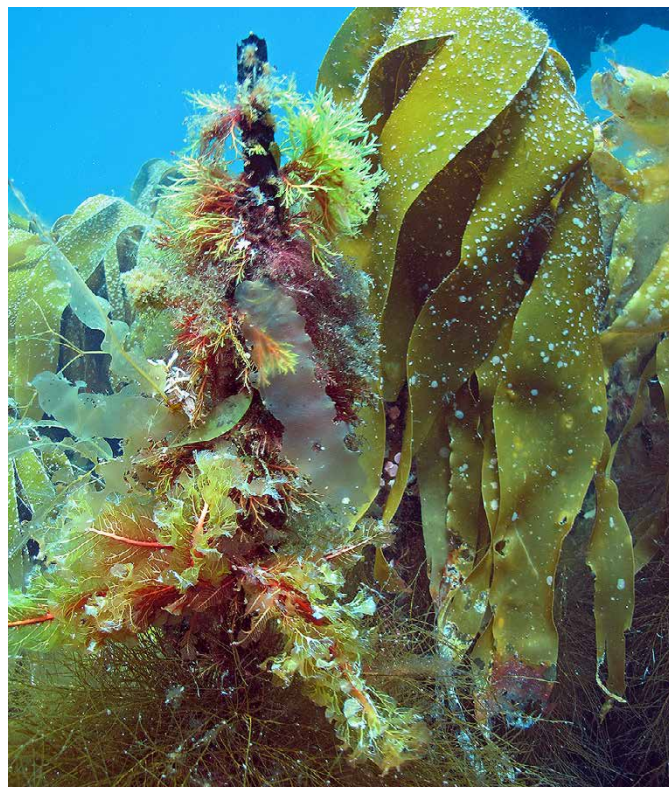


Participants at the GEAK workshop in Arendal.

written up and disseminated via a scientific paper on the overall findings; a scientific paper on the importance of kelp forests for global fisheries; and a popular science piece. A Scandinavian version of the analysis is also planned. The objective is for the results to be used in future research, policy and management decisions regarding kelp forests and coastal ecosystems more broadly. See the [NBFN blog](#) for more information.

Videos and animation were produced to convey knowledge.

Aware of the limited time that policymakers and practitioners have, NBFN produced several videos that conveyed the importance of blue forests in a concise, engaging manner. The English animation videos "[What are blue forests?](#)", "[Why are blue forests useful?](#)" and "[How are blue forests threatened in Norway?](#)" were remade in Norwegian. In addition, a video [introducing new audiences to NBFN](#) and a video on [empowering women through mangrove ecotourism](#) were developed. The latter was launched at a Norwegian Agency for Development (NORAD) and NBFN event.



Pillar 2: Share

Share blue forests knowledge and expertise

A seminar highlighted the links between blue forests and poverty.

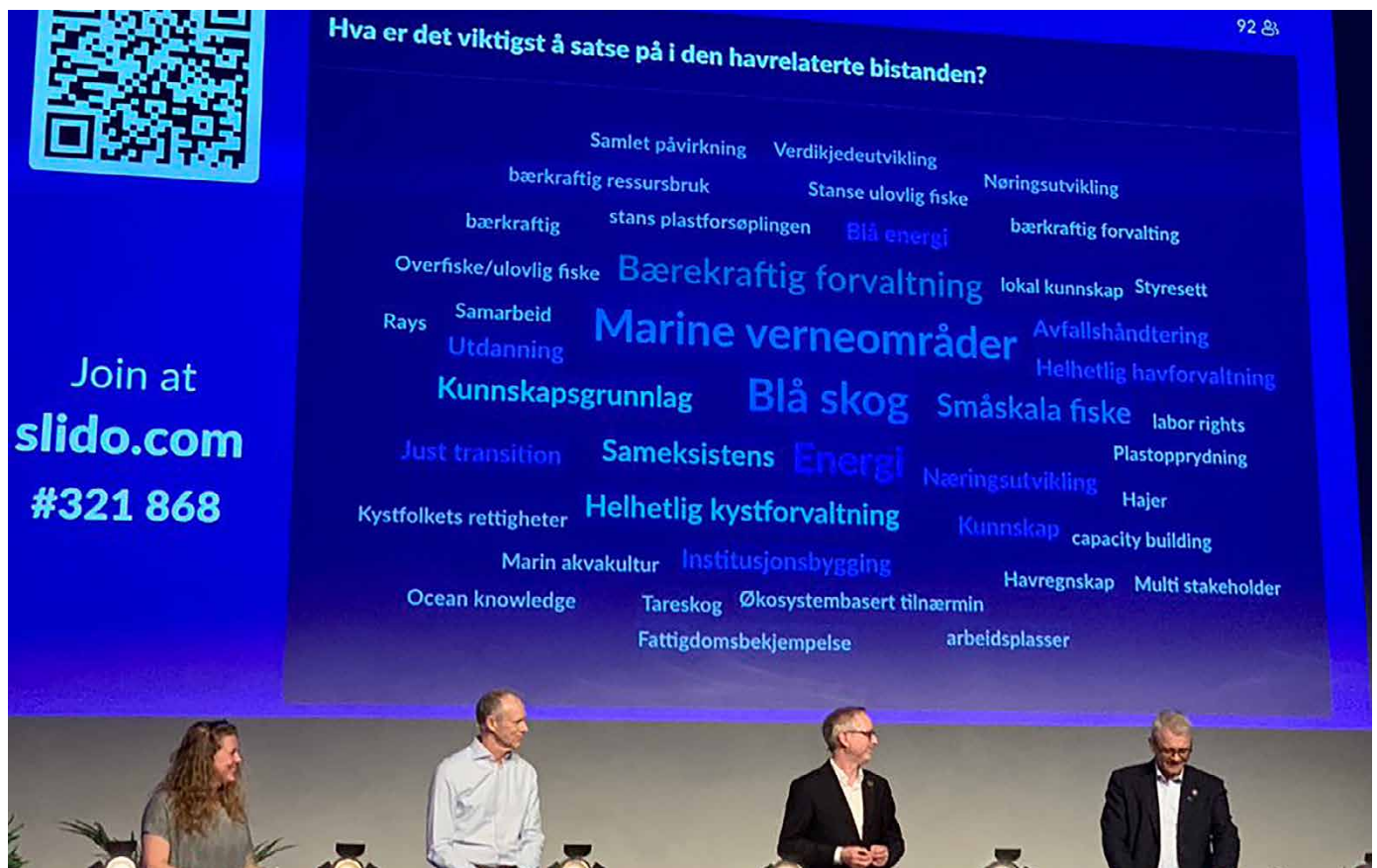
In March, Norad and NBFN co-hosted a hybrid seminar on blue forests and poverty, in coordination with the Norwegian Ministry of Foreign Affairs and Norad's first annual ocean conference. Attended by approximately 180–200 participants, the seminar touched on a range of topics including food security, gender equality and livelihood generation. The event culminated in an [editorial](#) on the Norad website, a translation of which is available [here](#).

Dissemination and outreach continued to be a priority area for NBFN.

The network continued to extend its reach through social media, primarily engaging with key audiences through Twitter. In 2022, NBFN authored 80 tweets, resulting in over 40,000 impressions, 12,000 profile visits and 65 new followers. The [NBFN YouTube channel](#) was also periodically updated with recordings from Blue Forests Week 2022 and various videos that can easily be viewed and shared. Additionally, the network's mailing list increased by 35 per cent. The NBFN Blue Forests Blog was established this year to disseminate information on the

latest events and stories concerning blue forests, including a [post](#) on the ocean and blue carbon-related side events that took place at the twenty-seventh Conference of the Parties of the United Nations Framework Convention on Climate Change (COP 27).

NBFN also continued to prioritize direct engagement with stakeholders. The findings of the kelp carbon sequestration research were presented at the Norwegian Academy of Science and Letters' blue forests seminar in March 2022. Similarly, the importance of a healthy ocean for the blue economy was communicated via a presentation and panel debate at the North Atlantic Seafood Forum in June 2022. During Arendalsuka, a presentation on blue carbon was given at the World Wide Fund for Nature event "Climate Politics 2.0: Natural carbon sinks". NBFN-affiliated researchers also provided input on the Norwegian-Portugal Boosting Blue Forests Education and Capacity Building project, the JPI Oceans' blue carbon scoping process, and the Blue Carbon Initiative's scientific working subgroup on macroalgae. Input on these projects and processes was not financed by NBFN funding; however, they were partly made possible through the collaboration and connections that the network facilitates. A complete list of NBFN-affiliated talks is provided at the end of this report.



Blue forests were a key topic at the Norwegian Ministry of Foreign Affairs and Norad's ocean conference, as exemplified by the event poll.

Pillar 3: Convene

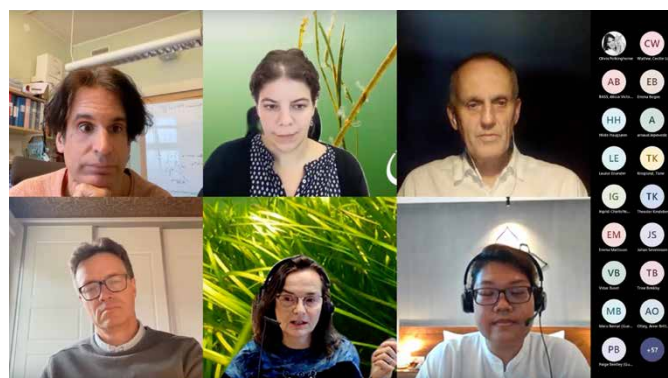
Bring the spectrum of actors interested in blue forests together

The third Blue Forests Week was held.

[Blue Forests Week 2022](#) brought a range of stakeholders interested in blue forests together for a three-day conference between 29 November and 1 December. The event began with two international webinars on seagrass meadows. We explored their ecosystem services, the reasons for their continued decline, and how best to conserve and restore them. The week concluded with a hybrid seminar in Oslo, which aimed to answer four questions: What are we doing to protect and restore blue forests in Norway? What are the plans going forward? Is this enough? If not, what else can and should we do?

The event highlighted a range of efforts to restore and protect blue forests, from the ResilienSEA conservation project in West Africa and the ZORRO eelgrass restoration project in Sweden to initiatives to better map and include blue forests in coastal zone planning in Norway. It also drew attention to lessons learnt, success factors, and common challenges. Key takeaways from the week include: 1) It is important to restore blue forest habitats where the conditions for success are present. However, it is both economically and ecologically preferable to prioritize conserving existing habitats to avoid the need for restoration in the future; 2) Blue forests are more likely to be prioritized and protected if decision makers know where they are, what their status is, how they are threatened, and how significant their ecosystem services are; and 3) Knowledge dissemination is key – necessary information needs to be given to the right people, at the right time and in the right format.

Three hundred and ninety people signed up for Blue Forests Week, the majority of whom registered for multiple



days. One hundred and seventy-three people attended the first webinar, while 163 attended the second webinar. Approximately 35–40 people attended the seminar in person, and an additional 50 watched the seminar's live stream via YouTube. Data on how many watched live via the NBFN website are unknown. As of February 2023, the event recordings have been viewed over of 400 times on YouTube. They are available here:

- [“Unsung heroes: The hidden value of seagrass meadows”](#)
- [“Learning from the meadows: Pathways for seagrass conservation and restoration”](#)
- [“Norwegian blue forests: What is being done, what more is needed?”](#)

The event was made possible thanks to the contribution of 24 speakers and 4 moderators. Nineteen of the speakers were from organizations outside of NBFN. Similarly, 19 of the speakers presented at the Blue Forests Week for the first time. Fourteen were based in Norway, while 10 represented international organizations. This was the result of a conscious effort to bring together a diversity of expertise and perspectives.



Publications

The following publications were fully or in part made possible with NBFN support. The list includes papers published in 2022 and papers on track for publication in 2023.

Duarte, C.M., Gattuso, J.-P., Hancke, K., Gundersen, H., Filbee-Dexter, K., Pedersen, M.F. *et al.* (2022). Global estimates of the extent and production of macroalgal forests. *Global Ecology and Biogeography* 31(7), 1422-1439. <https://doi.org/10.1111/geb.13515>.

Filbee-Dexter, K., Feehan, C.J., Smale, D.A., Krumhansl, K.A., Augustine, S., de Bettignies, F. *et al.* (2022). Kelp carbon sink potential decreases with warming due to accelerating decomposition. *PLOS Biology* 20(8), e3001702. <https://doi.org/10.1371/journal.pbio.3001702>.

Filbee-Dexter, K., Pessarrodona, A., Duarte, C.M., Krause-Jensen, D., Hancke, K., Smale, D.A. *et al.* (2022). Seaweed forests are carbon sinks that may mitigate CO₂ emissions. Preprint. https://www.researchgate.net/publication/360502222_Seaweed_forests_are_carbon_sinks_that_can_mitigate_CO2_emissions.

Filbee-Dexter, K., Pessarrodona, A., Pedersen, M.F., Duarte, C., Wernberg, T., Hancke, K. *et al.* (forthcoming) Carbon export from seaweed forests to deep marine sinks. *In prep for Nature Geoscience*.

Krause-Jensen, D., Gundersen, H., Björk, M., Gullström, M., Dahl, M., Asplund, M.E. *et al.* (2022). Nordic blue carbon ecosystems: status and outlook. *Frontiers in Marine*

Science, 9, 24. <https://forskning.ruc.dk/en/publications/nordic-blue-carbon-ecosystems-status-and-outlook>.

Kvile, K.Ø., Andersen, G.S., Baden, S.P., Bekkby, T., Bruhn, A., Geertz-Hansen, O. *et al.* (2022). Kelp forest distribution in the Nordic region. *Frontiers in Marine Science*, 9. <https://doi.org/10.3389/fmars.2022.850359>.

Macreadie, P.I., Robertson, A., Spinks, B., Adams, M.P., Atchison, J.M., Bell-James, J. *et al.* (2022). Operationalizing marketable blue carbon. *One Earth* 5(5), 485-492. <https://doi.org/10.1016/j.oneear.2022.04.005>.

Norad and Norwegian Blue Forests Network (2022). Blå skog – verdifull natur som bidrar til matsikkerhet og hjelper mot klimakrisen og fattigdom, 23 March. <https://www.norad.no/aktuelt/nyheter/2022/bla-skog-og-fattigdom/>. Accessed 3 February 2023.

Norwegian Blue Forests Network (2023). Top ten blue forests trends of 2022, 17 January. <https://nbf.no/ttt-22/>. Accessed 3 February 2023.

Pessarrodona, A., Filbee-Dexter, K., Krumhansl, K.A., Pedersen, M.F., Moore, P.J. and Wernberg, T. (2022) A global dataset of seaweed net primary productivity. *Scientific Data* 9(1), 484. <https://doi.org/10.1038/s41597-022-01554-5>.

United Nations Environment Programme (2023). *Into the Blue: Securing a Sustainable Future for Kelp Forests*. Nairobi, Kenya.

Talks

The following talks were presented fully or in part on behalf of NBFN:

Bryan, T. (2022). Healthy blue forests: A closer look at food security projects across the globe. Norad-NBFN seminar Blue Forest and Poverty - the role of blue forests in international development: From food security to climate change. Oslo, 8 March.

Filbee-Dexter, K. (2022). Kelp forests as a natural climate solution. Norwegian Academy of Science. Havets vegetasjon – Hva skjer med den blå skogen? Oslo, 20 April.

Filbee-Dexter, K. (2022). Healthy blue forests: A nature-based solution to climate change. Norad-NBFN seminar Blue Forest and Poverty - the role of blue forests in international development: From food security to climate change. Oslo, 8 March.

Filbee-Dexter, K. (2022). Operationalizing seaweed blue carbon. Korean Oceanographic Society, Pohang University of Science and Technology. Republic of Korea, November.

Gundersen, H. (2022). Understanding the threats to blue forests and how to address them. Norad-NBFN seminar Blue Forest and Poverty - the role of blue forests in international development: From food security to climate change. Oslo, 8 March.

Gundersen, H. (2022). Presentation of the Norwegian Blue Forest Network (NBFN). Internal NIVA workshop about blue forests. Oslo, 19 April.

Haugan, P. (2022). Blått karbon: Hva vet vi om karbonlagring i sedimenter og biomasse i havet? World Wide Fund for Nature event Klimapolitikk 2.0: Naturlig karbonlagring, Arendalsuka, Arendal, 17 August.

Knutsen, J.A. (2022). The Norwegian Blue Forest Network (NBFN). Blått forum Agder meeting, Arendal, 9 March.

Lutz, S. (2022). Harnessing the value of blue carbon to protect and restore blue forests. Norad-NBFN seminar

Blue Forest and Poverty - the role of blue forests in international development: From food security to climate change. Oslo, 8 March.

Norderhaug K.M. (2022). Blue Forests. Norwegian Academy of Science. Havets vegetasjon – Hva skjer med den blå skogen? Oslo, 20 April.

Norderhaug K.M. (2022). Algae aquaculture – a new blue industry in Norway. The Royal Swedish Academy of Sciences.

Norderhaug K.M. (2022). Blått karbon og naturbaserte løsninger. Nordisk fagkonferanse om havforvaltning og klimaendringer. Oslo, 18 October.

Skjellum, S.F. (2022). Why are healthy blue forests so important? Norad-NBFN seminar Blue Forest and Poverty - the role of blue forests in international development: From food security to climate change. Oslo, 8 March.

Wathne, C. (2022). How can we ensure that ocean health and ocean wealth go hand in hand? A blue forests perspective. North Atlantic Seafood Forum. Bergen, June.

Wathne, C. (2022). The Norwegian Blue Forests Network (NBFN): About the organisation and thoughts on the way forward for blue forests. The India – Norway collaboration on Marine Spatial Planning Workshop. 17 June.

Wathne, C. (2022). Norsk nettverk for blå skog: Hvem er vi og hva kan vi bidra med? The Seaweed Cluster webinar. 7 September.

Wathne, C. (2022). The Norwegian Blue Forests Network (NBFN). Boosting blue forests education and capacity workshop. Arendal, 10 November.

Wernberg, T., Pessarrodona, A., and Filbee-Dexter, K. (2022). Seaweed Blue Carbon: global significance and knowledge gaps. Korean Oceanographic Society, Pohang University of Science and Technology. Invited plenary. Republic of Korea, November.



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