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Striking a Balance: Wild Stock Protection and the Future of Our Seaweed Industries

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Highlights

1. Key challenges must be addressed to sustain seaweed stocks amid increasing demand from wild harvesting and cultivation industries.
2. Seaweeds are highly productive, supporting diverse species and providing essential ecosystem services in coastal environments worldwide.
3. Demand for seaweeds has surged, accounting for over 50% of global marine production, valued at USD 14.7 billion in 2019.
4. Over-harvesting, climate change, invasive species, and pests have severely impacted wild seaweed stocks.
5. Protection measures for wild seaweed stocks are inadequate, necessitating conservation policies, regulations, stakeholder awareness, and capacity building efforts.
6. Conservation measures should align with the Sustainable Development Goals, with focus on rural communities and seaweed farmers as key protectors of wild stocks.

Protection is the key

Seaweeds are vital for shallow marine ecosystem functioning. The habitats that they form are some of the most productive ecosystems on the planet, supporting an immense diversity of marine organisms and providing a wide variety of ecosystem services.

In particular, seaweeds support significantly enhanced biodiversity, with 38% greater species richness in seaweed forests compared to deforested areas. They also play an important role in mitigating impacts of climate change through carbon and nitrogen sequestration, as well as contributing to sulphur and halogen biogeochemical cycles. As major sequesters of carbon, recent global estimates suggest that kelp forests export ~80% of their production (~ 153 million tonnes carbon yr^{-1}) for long-term burial in the deep sea. Seaweeds are also farmed and/or wild harvested in over 56 countries worldwide (Fig. 1), with an annual global production of 35 million tonnes in 2019 worth over USD 14.7 billion.

China, Southeast Asia and Chile are the dominant seaweed producers with production covering 1,000s km^2. The main cultivated species are the large, brown kelp *Saccharina japonica* and the red seaweeds *Neopyropia*, *Kappaphycus*,

Eucheuma, *Gracilariopsis* and *Gracilaria*. Unlike land-based plant production systems, seaweed cultivation requires minimal fertilisers and no freshwater input. Seaweeds can be cultured from shallow nearshore waters up to tens of kilometres offshore, either in monoculture or with other maritime activities, such as finfish aquaculture or renewable wind energy. The sustainable cultivation and harvesting of seaweeds can reduce poverty and generate wealth in coastal communities. It can also restore ecosystems degraded by eutrophication through nitrogen and phosphorus uptake. For example, a study in China showed that the seaweed aquaculture industry removed approximately 75k tonnes of nitrogen and 9.5k tonnes of phosphorus annually, which given the current growth rate, is predicted to remove close to 100% of anthropogenic phosphorus inputs by 2026. Social acceptance for seaweed cultivation is, therefore, typically high compared with other forms of aquaculture.

Wild seaweed stocks and seaweed cultivation, therefore, offer a nature-based, carbon neutral and climate resilient solution to climate change, ecosystem restoration and food security.

Wild seaweed communities, however, are suffering acute declines in regions where they have been historically abundant. To date, seaweeds appear to have demonstrated a high degree of resilience to disturbance due to their fast growth rates and frequent recruitment, in comparison to other marine foundation species such as corals, which have much slower growth rates. Nevertheless, kelp forests in particular are predicted to lose up to 71% of their current distribution under the RCP 6.0 CO_2 emission scenario by 2100. This is in addition to the declines they are already facing through overharvesting for food, and supplying the seaweed aquaculture industry with new stock, coupled with outbreaks of pests and diseases and other climate-driven impacts. Despite their ecological and economic importance, these communities receive minimal or no protection through policies or legislation globally.

This policy brief highlights the challenges facing wild seaweed stocks globally and provides recommendations to incentivise their protection worldwide. These recommendations will help to ensure that the seaweed industry has access to highly diverse wild stocks from which

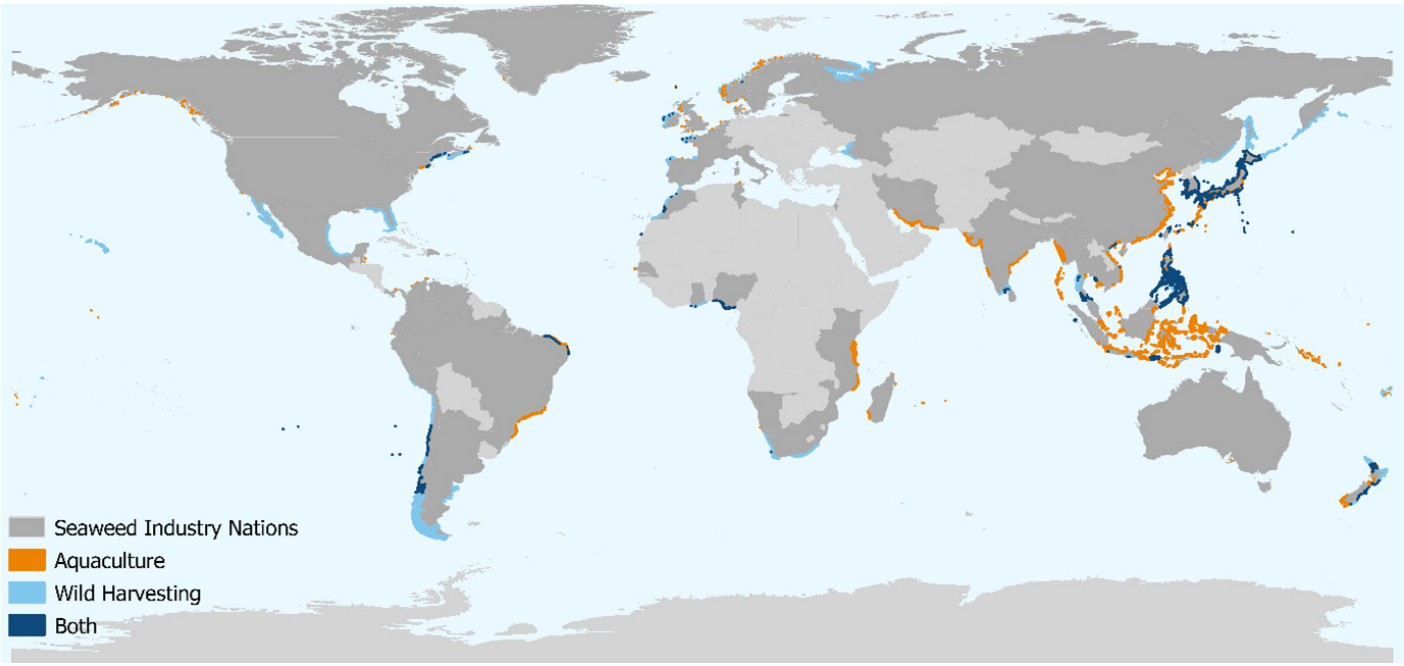

Figure 1. Spatial distribution of the global seaweed industry. Nations with seaweed industries are marked in dark grey, those with seaweed aquaculture areas highlighted in orange, with wild harvesting in light blue or with both in dark blue.

Source: Mallinson et al. (unpublished data).

Seaweed farmers returning their harvest to shore in Malaysia. Photo: P-E Lim/University of Malaya

to develop new cultivars and can improve the long-term resilience of wild stocks to climate change and other human-induced threats. They also promote seaweed habitats as areas in the ocean, which can provide a nature-based solution to ocean restoration within the ocean economy agenda and function as a key contributor to the UN Decade of Ocean Science for Sustainable Development (2021 – 2030).

The decline of wild seaweed stocks and the wider consequences

Wild seaweed stocks provide both direct and indirect benefits to the surrounding environment on both a range of spatial and temporal scales. These benefits include: i) the provision of nursery habitats and food resources for a multitude of species including commercially valuable fish and crustaceans, ii) the removal of dissolved nutrients, iii) the protection of underlying seabed and adjacent coastal shores through the mitigation of wave action and iv) the provision of a rich genetic diversity of species, which can provide a source of new cultivars for the seaweed aquaculture industry. These wild seaweed stocks and their wider ecosystem services, however, are under increasing threat from direct and indirect anthropogenic activities. Physiological and ecological responses to climate change and other stressors are being increasingly seen. This is particularly the case in the tropical cultivated seaweeds, which are showing a greater susceptibility to disease, pests and invasive non-indigenous species. Seaweed-dominated ecosystems are also shifting poleward, retracting or even disappearing worldwide. These threats, however, are not being addressed in many countries, since baseline species check-lists, consistency in the naming of seaweeds by the industry and the routine monitoring of wild seaweed stocks is minimal if present at all. The under-reporting of wild seaweed harvesting globally has also led to a lack of international awareness regarding the extent of the problem. This ultimately threatens the long-term future of the seaweed aquaculture industry and the critical ecosystem services provided by wild seaweed stocks.

Global conservation status of wild seaweeds and their habitats

The International Union for the Conservation of Nature (IUCN) Red List of Threatened Species is an authoritative tool in biodiversity conservation, which is used to assess the risk of species extinction. Whilst the IUCN criteria are intended to be objectively applicable to all species of plants and animals, particular challenges are found in applying these to seaweeds (see Did You Know box). The Red List, however, remains a useful tool in the conservation toolkit due to its wide global acceptance and objective approach. Applying the IUCN criteria to vulnerable seaweeds (i.e., wild seaweed stocks identified as being over-harvested), for example,

would provide critical information and raise awareness on the perceived risk to certain seaweed species in the wild. The listing of these species, would, therefore, help support protection measures, although the long-term monitoring and accurate species identification tools needed to carry out these IUCN assessments is often lacking.

What conservation measures exist for other marine species and their habitats?

Numerous examples exist globally of species being over-fished/harvested to extinction or near extinction. Long-term data sets, collected predominantly through fisheries monitoring programmes, suggest that worldwide, over one-third of fish stocks have been harvested beyond biologically sustainable limits. These datasets have also provided the evidence to support the introduction of national and international regulatory frameworks (e.g., to protect high risk fish stocks). For many species, however, particularly marine invertebrates and seaweeds, the lack of baseline distribution data and long-term harvesting records, mean that tracking any decline in stocks through over-harvesting is typically only done at local or regional scale. For example, the white abalone was over-harvested to near-extinction on the Pacific coasts of the USA and Mexico and the American

DID YOU KNOW?

- Approximately 200 seaweed species are harvested from the wild and over 80 species are reported as currently farmed commercially worldwide.
- A very low proportion of seaweeds have been assessed for the IUCN Red List (423 species worldwide) and taxonomic uncertainties remain with a number of these species.
- The presence of a species on the Red List does not infer conservation protection.
- Almost no seaweed-specific legislation exists globally and there are almost no Marine Protected Areas (MPAs) (or equivalent) specific for seaweeds or their habitats with statutory status, despite many MPAs overlapping with the seaweed industry (Fig. 2).
- Designated MPAs (or equivalent) rarely mention seaweeds or seaweed habitats directly.
- International database reports for wild harvesting and/or cultivation of seaweeds lack consistency in naming seaweed species, leading to inaccuracies and under-estimation of quantities harvested or cultivated.

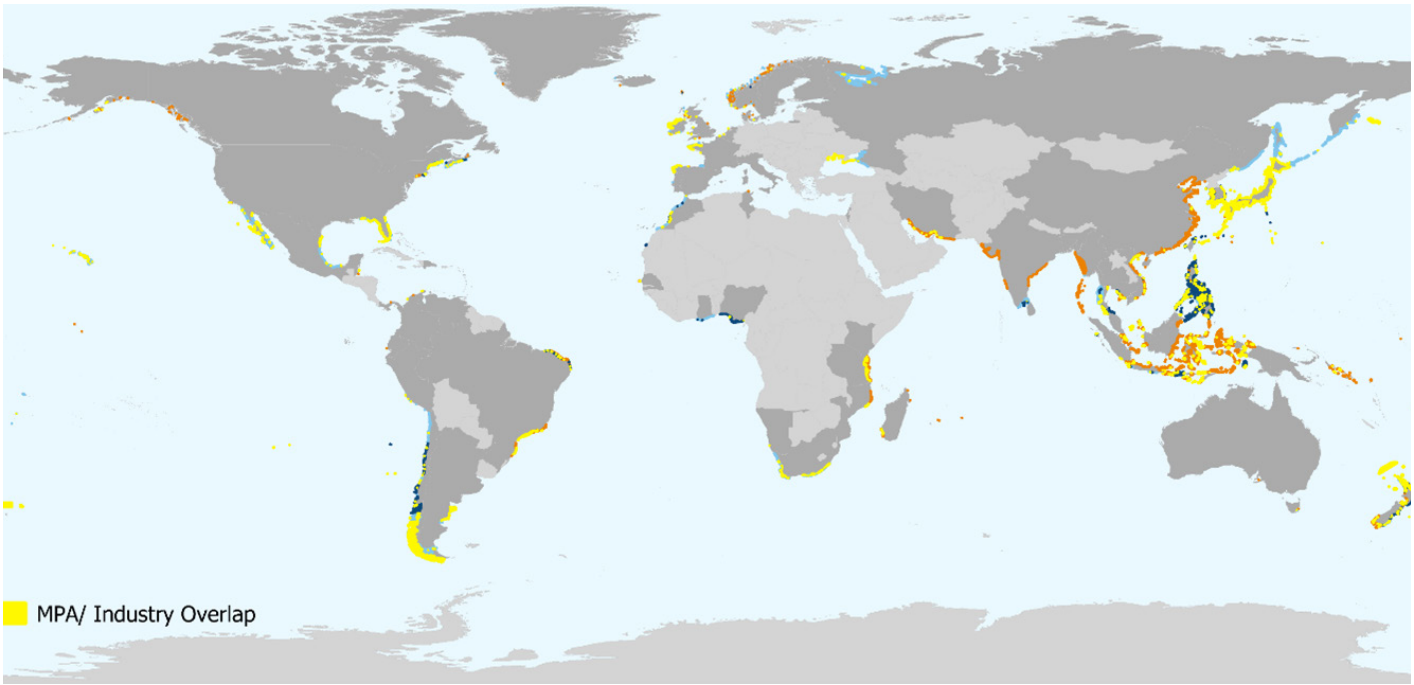

Figure 2. Spatial distribution of areas where Marine Protected Areas (MPA) and the seaweed industry overlap, as marked in yellow.
Source: Mallinson *et al.* (unpublished data).

lobster *Homarus americanus* was also severely overfished in the early 1900s in north-east USA. Introduced regulations, subsidies and conservation measures, however, have halted the decline of these and other species and helped both their recovery and that of their wider environment. These measures have included minimum and maximum sizes for harvesting (e.g., American lobster, Blacklip abalone), fishing licences, protection of breeding females, no-take zones, closed seasons, re-stocking programmes and sustainable aquaculture practices, which have reduced the pressure on wild stocks.

There is now a growing awareness of the importance to protect and restore seaweeds and their associated habitats, as well as the wider environment (see UN Biodiversity Conference – COP 15). Bangladesh introduced a ban on the harvesting of wild seaweeds in St Martin's Island in 1999, sustainable harvesting practices were introduced for wild *Sargassum* in the Philippines and the giant kelp forests near Tasmania, Victoria and South Australia were granted endangered status in 2012. Restrictions on mechanical harvesting of seaweeds in northern Spain have been introduced and local non-governmental organisations in Ireland opposed the introduction of this type of harvesting following the registration of Natura 2000 sites in Europe. Most recently, the protection and restoration of kelp forests were specifically highlighted in an US Executive Order released in 2021 on tackling climate change. There is no coordinated global effort, however, and further work is urgently needed to ensure the long-term sustainability of wild seaweed stocks for food production, income, carbon mitigation, climate change adaptation and to support the livelihoods of communities worldwide.

Policy recommendations

The need for evidence-based policy decision making and sector management is paramount across each of the following five policy recommendations. These recommendations should be acknowledged as crucial components for striking the balance between protecting wild seaweed stocks, whilst supporting the sustainable development of the seaweed industry globally.

1. Establish an international seaweed conservation strategy to protect vulnerable seaweed species and their habitats, with guidelines based on the precautionary approach. This will involve developing a task force of stakeholders, including seaweed farmers, local indigenous communities, fisheries and government agencies.
2. Develop a standardised, industry-wide naming procedure for seaweeds and the tools to apply these names correctly, that are underpinned by science and support international policy mechanisms and datasets. This will enable the identification of high risk species and the long-term monitoring of wild seaweed stocks and their habitats.
3. Establish robust ways to identify and designate statutory Marine Protected Areas to protect vulnerable seaweed species and/or their habitats based on a scientifically-proven evidence base.
4. Develop regional and national seedstocks and biosecure nurseries to conserve genetic diversity and minimise pressure on vulnerable wild stocks and their habitats.
5. Establish a capacity building and awareness raising programme to ensure seaweed farmers and coastal communities are fully engaged in sustainable farming and harvesting practices.

Further Reading

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Wild harvesting of seaweeds by farmers in Malaysia. Photo: P-E Lim/University of Malaya

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