



Nature's values in marine resource governance: an ethnographic case study of rockweed in Norway

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Abstract

This article addresses the shortcomings in the governance of the Norwegian macroscopic brown algae *Ascophyllum nodosum* (rockweed) that appeared when approaching rockweed as a socio-ecologic object in the Vega archipelago on the Norwegian Helgeland coast. A common seaweed along the Norwegian coast, rockweed constitutes an important species in Norway's 'blue forests'. Historically, rockweed harvesting was an important source of income for the local coastal population in Norway. Although not comparable to the newer and expanding kelp industry, rockweed harvesting is still profitable along the coast. Despite revived attention from the seaweed industry, state management of rockweed in 2024 is conspicuously absent. Combined with the lack of scientific knowledge of the consequences of rockweed harvesting on the local coastal ecosystems, the responsibility for ensuring sustainable harvesting of rockweed lies with the industry itself. On Vega, however, where rockweed is a highly valued and contested coastal species with a high economic, ecologic, and cultural significance, rockweed harvesting was a conflicted issue. In approaching rockweed as a socio-ecologic object from 'below', the article identifies hegemonic structures and discourses in Norwegian marine governance, suggesting how a narrow definition of 'value' comes to matter—not only for rockweed—but for sustainable governance of all marine and coastal ecosystems. This article is also an important contribution to the burgeoning interdisciplinary research on nature's values, power, and knowledge in environmental management.

Keywords Rockweed · Socio-ecological values · Maritime anthropology · Governance · Norway

1 Introduction

It is late fall, and the water of the northern sea surrounding the windswept islands of the Vega Archipelago is rough. In a small, wooden flat-bottomed boat (tangpram), a father and his two young sons lean heavily over the gunwale. Their hands are submerged deep in the cold water, collecting floating islands of rockweed cut hours earlier at low tide. During the season, this happens three times a week, and they cut, gather, and deliver the rockweed, sometimes as much as 30 tons a week—over 1000 tons a year. When done for the day, they row the heavy load toward a factory on

*another small island, where they are duly compensated for their effort.
(Rockweed harvesting scene, 1950).*

This ethnographic vignette is based on a memory shared by one of our interviewees on Vega, an archipelago comprising 6500 islands along the Northern Helgeland coast in Northern Norway. He was one of many interviewees who fondly remembered how the macroscopic brown algae, also known as *Ascophyllum nodosum* or "knotted wrack" used to grow in abundance along the skerries and islands of Vega. In winter, when the sea got too rough for rockweed harvesting, the manual sickle was left for fyke nets and gillnets, used for the traditional winter fishing after cod, pollock, and haddock in Lofoten. To harvest resources from the sea like this, one could easily sustain over a hundred families like his own on Vega, he told us [Landowner on Vega, (a)].

Over 70 years have passed since the time of this childhood memory. Today, no families on Vega depend on rockweed for their survival. However, the people we interviewed on Vega today still value rockweed highly, and consider it

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a key coastal species. Locals keenly observe its growth and fallow cycles and acknowledge its importance to other species that rely on its existence, particularly concerning fish and seafowl. Many expressed concerns about what to do to sustain its future existence, and the apparent lack of public management and governance was a conflicted local political issue. Yet, despite rockweed's high local socio-economic and socio-ecological value, our research confirms the absence of rockweed in Norwegian seaweed governance and a conspicuous lack of scientific knowledge on both the ecological function and the effect of harvesting. This made us ask: what are the implications of this lack of scientific knowledge and state management on the sustainable development of the Norwegian coastal zone? And does the lack of Norwegian management of rockweed reflect a larger discourse in the Norwegian environmental governance of nature's values?

This article is about understanding why rockweed mattered so much to people on Vega, and why their concerns for mismanagement should matter beyond the tiny North Norwegian Archipelago.

By addressing the concerns of the local population and contextualizing these concerns within a larger, governmental framework of sustainable development of the Norwegian coast, this article identifies an incoherence on two levels. The first relates to incoherence in the regulatory framework, where the geographical distinction between kelp and rockweed habitats has significant implications for the Norwegian government's ability to ensure the sustainability of rockweed harvesting. For the rockweed and for the socio-ecological systems in which it plays a significant role, the consequence is that environmental governance has no tools to sustainably manage a key marine species, and the responsibility for ensuring sustainable harvesting of rockweed has been placed with the industry itself.

The second relates to incoherence between the values of nature recognized by Norwegian environmental policy and the more diverse values of nature recognized "on the ground," be that by scientists, activists, or local citizens. This indicates that if a natural object such as rockweed is devalued in economic terms by the state, scientific research on rockweed is deprioritized, further marginalizing the probability of recognizing the more diverse nature's values and the role of species like rockweed in a larger socio-ecological system. This ignorance may result in a severe deterioration of valuable socio-economic systems, with implications that may hamper true sustainable development beyond local communities. To reach the internationally agreed-upon goals of biodiversity and sustainable development (CBD 2022; United Nations 2023), society needs to better understand the complexity of relationships and structures that parts of nature, such as rockweed, are embedded in. This article argues, in line with the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (Pascual

et al. 2023), that to achieve that understanding, empirical and scientific knowledge must be better integrated and lead to a higher diversity of *nature's values* recognized and integrated in environmental governance. In that, this paper contributes to the burgeoning interdisciplinary research on nature's values, power, and knowledge in environmental management and governance of marine and coastal ecosystems (Gurney 2021; Jones and Long 2021; Osbourne et al. 2021; Roszco 2021; Sanborn and Jung 2021).

1.1 Methodology

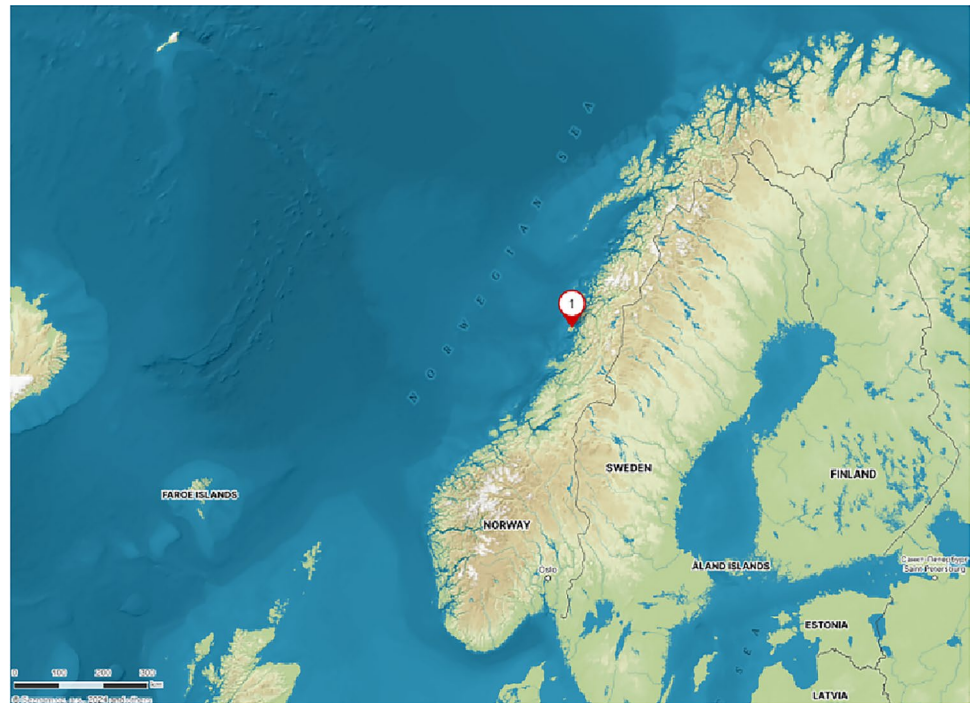
The study is based on critical document analysis of Norwegian environmental, coastal, and marine management plans, complemented by empirical data from interviews and group discussions at the Vega Archipelago in Nordland County (Fig. 1). In total, 15 individuals participated in the study. Among them, five were part of a focus group on Vega in 2019, while 10 took part through semi-structured interviews in 2022. The interviewees represented diverse perspectives, including the public sector (Vega Municipality, County Council), commercial actors (Algea, Polar Algae), activists, and local landowners with rockweed-related interests (see Appendix A). Most interviewees fell within the 40–60 age range, although a few elderly local citizens were aged between 60 and 80. Approximately 70% of the interviewees were males. During the interviews and focus group discussions, participants explored perceptions of rockweed management, the broader societal role and value of rockweed, and its specific significance within the local context. Additional information was gathered through short dialogues with representatives from the County Governor Offices in Nordland, Troms, Finnmark, Møre, and Romsdal, as well as the Directorate of Fisheries (DoF) and the Norwegian Environment Agency (NEA).

2 The value of rockweed: a historical context

Norway is one of the largest commercial actors in the harvesting and processing of seaweeds in the Western Hemisphere,¹ serving a global market with raw materials for animal feed, cosmetics, medicines, and pharmaceuticals (Frangoudes 2011, p. 518; Mac Monagail et al. 2017, p. 371; Ugarte and Sharp 2001). The Norwegian seaweed industry primarily focuses on mechanically harvesting the largest

¹ Globally the seaweed industry is dominated by Asian countries. On the Western Hemisphere, countries like Iceland, France, Russia, and USA have considerable industrial production. There are also minor seaweed industries in Ireland, Spain, Italy, Denmark, and Portugal.

Fig. 1 Map of the Norwegian Sea, indicating (1) the Vega Archipelago (mapy.cz, CC BY-SA 4.0)



and deeper-growing kelp, which accounts for the majority of the 130,000–180,000 tons of seaweed harvested annually. The standing biomass of rockweed, currently estimated at 1.8 million tons, is relatively minor compared to the estimated biomass of kelp. Correspondingly, the annual harvesting of knotted wrack is currently relatively minor, around 17,000–20,000 tons (Directorate of Fisheries 2022; Ministry of the Environment 2009).

Industrial kelp harvesting started in Norway in the late 1960s (Østgaard and Indergaard 2017, p. 203) and is a relatively recent industry compared to the tradition of rockweed harvesting. Historical records indicate that the harvesting of rockweed dates back to at least the Viking Age. As a fertilizer, the harvested seaweed was either tilled into the soil during plowing or left in piled layers to decompose into fertile soil (Østgaard and Indergaard 2017, p. 197). This made rockweed a valuable asset, especially as the rough sea, wind, and rain continuously eroded arable land, leaving little fertile ground for animal husbandry and crop production along the Norwegian North Sea coast. Seaweed has also been commonly used as a nutritional supplement, primarily as winter fodder for livestock. This practice has waned over time, partly due to easier access to supplementary fodder, but also as it became associated with poverty (Bratrein 1974; Brox 1963; Østgaard and Indergaard 2017, p. 198). The old tradition of livestock grazing in the tidal zone is however still practiced along the coast, for instance, with free-ranging sheep (Øpstad and Velle 2009). While seaweed is known to have been used for human consumption in the North Atlantic region, evidence for this in the Norwegian context is scant,

beyond the use of dried seaweed as a source of salt in the diet (Østgaard and Indergaard 2017, pp. 196–198).

From the 1740s, rockweed and other seaweeds that washed ashore after storms could also be harvested and burned to ashes. These ashes were then refined into potash, which was sold for use as fertilizer, as soda for soap, and in the emerging glass industry (Frangoudes 2011, p. 518 Østgaard and Indergaard 2017, p. 199). The harvest must have been significant when large-scale burning and refining of rockweed for commercial markets began in the 1740s (Østgaard and Indergaard 2017, p. 199; Øvereng 1970, p. 1). The burning process produced heavy, smelly smog, leading to local conflicts over the perceived impact of the smog on local fishing and farming, which even led to a government-enforced seasonal ban for summer burning of seaweed between 1760 and 1779 (Johannessen 2020, p. 200). The practice of burning rockweed soon gave way to another industry. In the 1930s, new possibilities for the commercial exploitation of rockweed arose when a discovery in alginate research enabled the extraction of iodine and the applicability of rockweed meal.

Access to rockweed such as the knotted wrack (*Ascophyllum Nodosum*) (Figs. 2 and 3), has been crucial for coastal livelihoods for centuries. So much so, that the landscape where it grows is referred to as “Tangland” (rockweed land). Ownership of this valuable resource has also been contested, and court proceedings concerning ownership rights to “Tangland” indicate that rockweed as a resource was disputed well into the latter part of the eighteenth century (Grude 2016, p. 80; Øvereng 1970, pp. 11–21).



Fig. 2 Knotted wrack, Vega (Rinde, E. - NIVA, 2020)

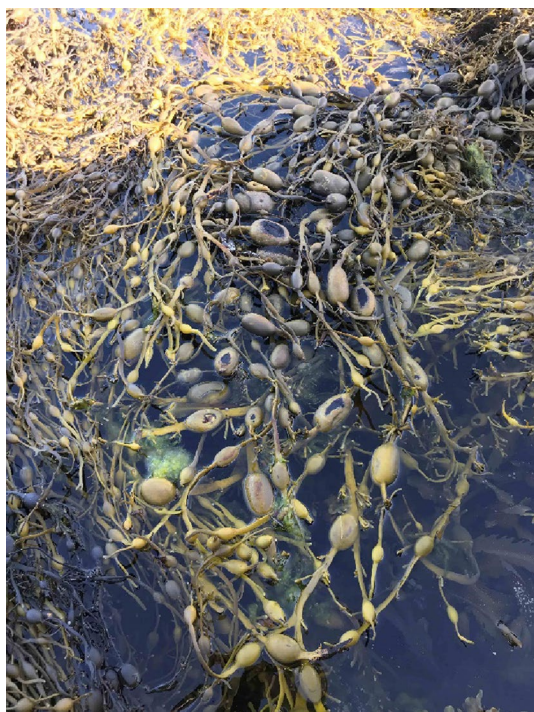


Fig. 3 Knotted wrack, Møre og Romsdal (Bekkby, T. NIVA, 2021)

The company Algea was the first to commercially harvest rockweed for alginate in Norway. Established in 1937, Algea initially harvested rockweed for its alginate-derived iodine in 1942, followed by rockweed meal in the 1950s. Subsequently, the company supplied the market with alginate for use in the medical, cosmetics, and agricultural industries (Algea 2023). The rockweed industry in Norway experienced significant growth after WWII, with 21 rockweed meal factories established along the Central and Northern Norwegian coast in 1954 (Norsk institutt for tang- og

tareforskning 1954). For decades, rockweed was harvested manually, a labor-intensive process described as heavy, tiresome, and time-consuming. Despite the challenges, it was a lucrative endeavor, providing a weekly income of approximately 280–380 Euros, a substantial amount during the post-war era.

Around 1960, declining sealskin prices and a collapse in the cod population prompted many men to seek employment in the rockweed harvesting industry. However, the demand for manual harvesters waned as rockweed harvesting became mechanized by the late 1960s. The introduction of the Norwegian Suction Cutter Jet, a flat-bottomed vessel equipped with a suction motor and swirling blades, revolutionized the industry. The Jet efficiently chopped rockweed to a uniform length of 15 cm before suctioning it onboard into catchment nets. As a result, many workers lost their jobs, and employment around Vega plummeted from over a hundred to approximately 10 workers (Interview with landowner, 2022). The success of the Jet extended beyond Norway, with Nova Scotia experiencing a significant increase in catch from an average of 4000–8000 tons to over 30,000 tons after its introduction in 1989 (Sharp et al. 2006). As the volume of rockweed harvested increased, thanks to innovations like the Suction Cutter Jet, Algea expanded to five production plants and achieved significant international market revenue during the 1970s (Algea 2023, Algea interview b, 2022). However, market dynamics and economic liberalization policies in the 1990s prompted Algea to consolidate its factories, reducing the number from five to one. Eventually, the company transitioned out of Norwegian ownership. Today, the rockweed industry is marginal compared to kelp. Until recently, Algea was the only commercial actor for the last few decades, now under the ownership of the global Agri-FoodTech investor, Syngenta, with 46 employees and 22 boats in active operation along the Helgeland coast.

After a period of being “just a seaweed,” Norwegian rockweeds such as knotted wrack are however gaining international attention. Under headlines like “Here you can just about pull money straight out of the water” celebrate new business establishments along the coast, harvesting rockweed for its alginate value, or for the red algae (*Vertebrata lanosa*) which grows on knotted wrack (NRK 2022a, b; NRK 2023). All rockweed harvested in Norway comes from wild-growing resources (Mac Monagail et al. 2017, p. 372), and this fact is leveraged as a commercial advantage, emphasizing Norwegian rockweed’s unique purity and health benefits (Algea 2023; Seaweed 2023a, b; Seaweed 2023a, b; Polar Algae, 2023). The products have been met with enthusiasm in the market, with one newly established rockweed harvesting business noting that “people seem to get dollar signs in their eyes when they learn about our location” (Lindi 2017).

At present, Norway’s marine strategy plans recognize the vital role of seaweeds in general—in carbon mitigation,

marine biodiversity support, and their contribution to the country's "Green Transition" through blue growth (Ministry of Trade, Industry and Fisheries 2019 and 2021). Rockweed in itself, however, is a relatively understudied species. We know that the rockweed growth cycle significantly contributes to global climate regulation through carbon storage and sequestration by binding CO₂, like other macroscopic brown algae (Clayden et al. 2014; Frigstad et al. 2020; Kvile et al. 2022). Additionally, it has been documented that rockweed supports both marine ecosystems by providing food, shelter, and habitat for a variety of other species in the sea (Clayden et al. 2014; Lauzon-Guay et al. 2021; Spruzen et al. 2008; Steen et al. 2022) and the terrestrial ecosystem, supporting nutrition for seabirds. Detached seaweed accumulating along the shoreline is also found to be an important feeding ground for birds and contributes to soil fertility through decomposition (Lauzon-Guay et al. 2021, p. 1706).

Yet in reality, kelp is the only macroalgae subjected to governmental management (Steen et al. 2022). Before 2000, both rockweed and kelp were regulated in Norway as harvestable marine resources, overseen by the Directorate of Fisheries (DoF) through Decree No. 642 of 1995, but post-2000, rockweed was excluded, admittedly due to a "lack of scientific knowledge" (Management Plan for Seaweed and Kelp 2000).

To mitigate the effects of climate change and protect the environment in a truly sustainable manner, the empirical social sciences have for decades argued the importance of understanding how nature and culture are intrinsically related and embedded in meaningful relationships attached to specific places, species, or practices (Crate and Nuttall 2009; Descola 2013; Ingold 2000, 2011). One analytical approach to identify that relationship can be through the concept of "value." Value encompasses both broad and immaterial aspects, as well as specific and material dimensions. Values can be instrumental (serving as means to an end), intrinsic (valued for their inherent qualities), or relational (linked to social interaction) (Pascual et al. 2023). However "socio-ecological values" do not encompass the intrinsic value that natural objects may possess, the concept is not apt to describe the worth of an object beyond human needs and desires, a shortcoming that we in this paper are unable to amend. What the concept may yet aid is better acknowledging and understanding the importance of including a wider set of values in addition to the economic and ecological value dimensions in environmental governance. Approaching objects in nature as having "socio-ecological" value, allow the description and recognition of the relational value between nature and society, such as the ritual, symbolic, relational, or emotional properties of nature, as well as the temporal, geographical, and cultural context of these relations (Armitage et al. 2009; Blomley and Walters 2019; Roszko 2021; Sanborn and Jung 2021; Osborne et al. 2021).

Recognizing the "socio-ecological value" of a natural object also represents an effort to counterbalance a prevailing trend in sustainable development research, where socio-economic values often receive disproportionate emphasis (Colantonio 2009; Griessler and Littig 2005). It is also an acknowledgment that socio-ecological environments and relationships are shaped not only by ecosystem functioning and market value but also by their political and economic context in complex socio-cultural histories (Agrawal 2005; Peet et al. 2010; Robbins 2020). It may also aid in reversing the trend in sustainable development research where social sustainability is seen as a mere secondary trickle-down effect of economic growth and not a fundamental pillar of sustainable development (Colantonio 2009; Griessler and Littig 2005).

Rockweed harvesting in the Vega archipelago stands out in two ways: its close historical and cultural relationship to rockweed and due to its specific, local, and area-based regulations for rockweed harvesting. These aspects make rockweed harvesting on Vega an interesting case study for experimenting with what we might learn by approaching rockweed as a "socio-ecological object". Below, we adopt this perspective to approach rockweed as it comes to matter in the local community and contrast it with how it is managed as a natural resource by the state; we are able to investigate which larger structures and discourses govern natural resource management in Norway.

3 A socio-ecological approach to rockweed harvesting at Vega

In the interviews we did with citizens and public sector managers at Vega, it was clear that rockweed was highly valued, often contested, and always enmeshed in a configuration of ecologic, socio-cultural, and economic attributes. The local municipality, the county governor, and the local citizens we interviewed expressed concerns about the impact and sustainability of commercial rockweed harvesting, and the issue was regarded as politically sensitive. Looking at the economic value exclusively, this is surprising, all the while income from rockweed and eiderdown is marginal compared to the agricultural sector in the region (Daugstad and Fageraas 2018). Looking at the socio-ecological value, however, we see more clearly why the harvesting was so contested.

3.1 Perceptions of the value of rockweed at Vega

In addition to sharing the historical use of rockweed with other coastal communities in Norway, rockweed has also been central in the keeping of eider ducks (*Somateria mollissima*) at Vega. The eider duck eggs were important in the local diet, and the sale of eiderdown constituted an important source of income to the small coastal communities (Fageraas

2013). Here, rockweed was both directly and indirectly part of this value chain. Traditionally, women would harvest rockweed and other detached seaweeds from the shoreline and, upon drying them, shape nests that they placed in shelters under driftwood or small eider houses of stone. This way, hundreds of birds would be protected from predators. The eider would also find food in the rich marine life living on and among the rockweeds. The rockweed also offered protection, as when the hatched eider fledglings came of age, they would hide from predators in the rockweed growing along the shore (Fageraas 2013). This tradition played a crucial role when large parts of the Vega Archipelago were designated as a UNESCO World Heritage Site in 2004 (Fageraas 2013; UNESCO 2023).

On the local level, rockweed still holds considerable value in and around Vega. In the interviews, many mentioned the important role of the rockweed as a habitat or nesting ground for smaller marine organisms such as small fish, beach fleas (scuds), red urchins, blue mussels, and crabs. In addition to supporting local life systems in the sea by being central in the food chain, rockweed was also seen as supporting various forms of life on land. Most interviewees addressed the crucial relationship between marine life supported by a healthy rockweed canopy and the decline in seafoam populations. Many also expressed concerns about a perceived decline in birds, which they associated with a decline in rockweed. This concern was mostly about the locally cherished eider. The rockweed was known as the only place the eider fledglings could hide from predatory birds such as seagulls, gannets, and eagles. All seafoams were thought to depend on a healthy rockweed ecosystem. “It is not only the eider. There are less of all kinds of birds; since the 1970s, I would say 95% of the birds are gone. (...), the seagulls—herring gull, the great black-backed gull, the small terns (...); there is a lack of food for them all in the ocean; there is no fish for anyone” (Interviews, 2022). Many expressed concern and sorrow around the loss of life associated with the perceived decline of rockweed, but there was uncertainty about whether it was due to global climate change or to local harvesting practices. This made the commercial harvesting of rockweed a politically sensitive issue revolving around the future of Vega’s economy.

This was reflected in the interviews, where perceptions of rockweed harvesting were contextualized by its contribution to the future local economy—yet whether the rockweed industry was part of that future was debated. One owner of rockweed land, who for the last 25 years had allowed commercial harvest by the industry, explained: “Both rockweed and kelp are important for the industry here along the coast—not everyone can make a living from salmon farming; some work must be left for us, too!” (Interviews, 2022). Even among the strongest opponents of rockweed harvesting, some would, with certain caveats, support a “modest”

industry, but only if the harvesting happened more in line with the manual, hand-harvest tradition. Yet, if the technological and ecological aspects were solved, there were still issues that the locals felt strongly about—workplaces and local development. There was a clear story of loss to be traced in the interviews. Many described the period post-1990s as a time of general decline of both ecological, economic and social aspects of life, and the restructuring of the natural resource-based economy as a deprivation for local communities, a sentiment widely shared in rural Norway (Flø, 2018; Vik et al. 2022). As the industry becomes increasingly automated, socio-economic growth is perceived not as a benefit for all but only for a few. As one interviewee said:

“Everything becomes automatic, it’s like with salmon farming (...) it becomes automated, then there’s just a few guys left [working]. Same with the fishers too, the big trawlers today, they barely need a crew. And out here, what do we need workplaces for anyway? There’s no one left here to work!” (Interview with landowner, 2022).

There was a concern that the rockweed industry, now no longer in the hands of local or even Norwegian owners, might generate substantial revenue for the investors, but that the island community at Vega would see little of the profit. Local concerns about a potential decline in fish or fowl populations due to harvesting, as well as socio-ecological or socio-economic relations at the local level, seem to be of little concern to foreign owners of seaweed harvesting. For some, it was not the harvesting of rockweed itself that was the issue—it was the scale—the extent, frequency, and volume that triggered concern. In particular, the use of the Suction Cutter Jet was a concern to many. A previous rockweed harvester, who had harvested manually up until the mid-1980s, had denied Algea to harvest mechanically on his rockweed land, due to their use of the Suction Cutter Jet. In the group interview, it was argued that the machine would suck up much more from the sea than just the seaweed.

“The machine is like a vacuum cleaner you know, sucking in whatever is there and chopping it to pieces. In the large harvesting nets that they sometimes lose, we opened them up, and found lots of fish and small animals! That will harm the birds you know!” (Interview with landowner, 2022).

The strongest supporters of the rockweed industry argued that the decline was unrelated to the harvest. They would argue that 30–40 years back, when the industry peaked, the coastline was full of rockweed, eider birds, and other seafoams. Over the last 15 years or so, the seafoam population has fallen, and rockweed has given way to barnacles (*Balanidae*), a change that occurred during a period of marginal

harvesting levels. In an interview with the local municipality, it was argued that the viability of the ecosystem was not a concern, as so few people sold the rights to harvesting anyway. When asked why so few people would sell rockweed harvesting rights, the response was that it was due to the low quality of the resource, which, if left untended, made them less valuable to harvest. As with the forest, rockweed should also be cut regularly,” he explained.

“If you let the forest stand there in a hundred years, many trees die. That, again, will cause such a biological diversity! [silence]... which huh ... yes... that is of course a good thing... But there's no price paid for ecological diversity, it is the quality of the timber that pays off” (Interview with Mayor, 2022).

This latter statement brings up another caveat—while the ecological diversity provided by rockweed cannot be subjected to economic transactions, harvesting can. However, to know how to regulate and manage both the extent and form of harvesting in a sustainable manner, the ecological condition and function of rockweed must be scientifically known before rockweed can be included in state and regional management plans as an object of governance.

Although the importance of rockweed has been increasingly documented in relation to its function in a larger ecosystem (Bekkby et al. 2021), the shortcomings in the natural scientific research on rockweeds such as knotted wrack, as well as on the species or lifeforms associated with them, have been acknowledged for at least a decade (e.g., Steen 2005, 2022). Studies indicate that rockweed seems to adapt fairly well to climate change, as littoral seaweed communities generally experience high variation in environmental conditions (Bekkby et al. 2021; Macreadie et al. 2017). Regarding the effect of rockweed harvesting, we have found little peer-reviewed research from Norway, but there are some from the Canadian and North American regions of Nova Scotia off the Western Atlantic coast. These studies show little impact from harvesting on the regrowth of the canopy itself (Lauzon-Guay et al. 2021, p. 1697); however, harvesting in Eastern Canada is purely manual and has a rockweed harvesting policy known for its precautionary harvesting principle and general conservation principles (Ugarte and Sharp 2001, p. 68). Regarding the wider rockweed ecosystem, there are indications that harvesting is associated with the reduction of detritus, the dead particulate organic material shed from old seaweed, which is an important food for herbivores and microbes in the marine food chain (Mac Monagail et al. 2017, p. 377). Another study showed that in cases where most of the rockweed canopy was removed, birds were affected (Hamilton and Nudds 2003 in Lauzon-Guay et al. 2021, p. 1702). Harvesting in combination with other stressors such as coastal darkening and the increased presence of invasive species is not well understood (Petraitis

and Latham 1999). Along with scientific uncertainty on the effect of harvesting, there has been even less research on the most sustainable technology for harvesting rockweed. While Algea claims that the Suction Cutter Jet provides more optimal regrowth of rockweed, even better than hand-harvesting, the Canadian company Canadian Maritimes abandoned the Suction Cutter Jet in 1994 due to “uncontrolled overharvesting.” Rockweed harvesters in Canada use cutter rakes, arguably a more sustainable choice due to a more moderate impact on the canopy (Mac Monagail et al. 2017, p. 376, Lauzon-Guay et al. 2021, p. 1702–1703).

This lack of coherent and unified knowledge clearly affected the local opinion on rockweed harvesting in and around Vega. Both the Head of Environment in Vega Municipality and the mayor of Vega admitted to having insufficient scientific knowledge of rockweed and its effect on birds and coastal ecology (Interviews, 2022) and requested more knowledge on the role rockweed played in the local marine and terrestrial ecosystems. The Vega World Heritage Foundation also wanted research on the effect on various industries in and around the area. In light of climate change in particular, the locals and the municipal authorities feel equally “at a loss.” This lack of conclusive science does make knowledge-based decision-making a challenge. The mayor of Vega expressed the lack of available science like this: “Had the forest suddenly disappeared, (...) I bet you researchers would immediately stand in the marsh, but in the sea...there is no one to see it [disappear]—you know, it is under water.” Calling for a more comprehensive, holistic management of both the Vega World Heritage Site as well as rockweed harvesting along the coast in general, the mayor of Vega concluded the interview with a sigh: “Right now, there are so many institutions, but there is no coherence—the institutions do not communicate very well” (Interview, 2022).

The mayor does point out two interrelated challenges of governing marine resources like seaweed in Norway, a lack of science that mirrors the sub-surface ecosystem that humans rarely perceive directly and an incoherent governance structure which is unable to adapt local coastal management in line with that science. The next section will address the mayor’s call by looking at the role of science and governance in decision-making processes related to the harvest of kelp and other seaweeds.

3.2 Seaweed governance—a kelp comparison

During the time of interviews for this case study, kelp trawling in and around the Vega Archipelago was something all interviewees referred to when discussing seaweed harvesting. The kelp industry is projected to grow from a current approximate of 150,000 tons to a projected 20 million tons in 2025, in combination with developing the cultivated kelp

industry (Skjermo, et al. 2014; Olafsen et al. 2012, p. 21, 69).

However, if the kelp industry is to reach its projected potential, it will require the utilization of marine areas up to 3000 km² (Broch et al. 2019, p. 13). The industry competes for raw material in what, in the media, has been called “a seaweed fever” (Sjømat 2016), and test trawling had been allowed inside the UNESCO area from 2013 to 2017 to aid decision-making around whether the Helgeland coastline should be opened for kelp trawling. The large kelp forests in Norway have been subjected to research since wild kelp trawling emerged as a viable industry in the 1960s (Sundnes forthcoming), and the knowledge about the state of kelp forests outside the Helgeland coast has been closely monitored since the 1970s when the area was closed to trawling activities due a collapse in the local ecosystem caused by an invasion of green sea urchins. The urchins grazed the kelp forest down and left behind a “marine desert,” with a devastating effect on the local fish stock (Greenhill et al. 2021, p. 4). The loss of kelp and fish, especially of the socio-economically valued cod, induced a recession in the local communities, cementing a local resistance against kelp trawling. However, the last decade has seen a regrowth of kelp forest along the coast—probably due to a waning population of predator sea urchins, the gradual warming of the sea, and the expansion of urchin predator crabs (Fagerli 2014). This prompted DoF to initiate test trawling along the Nordland coast, as well as in and around the World Heritage Site on Vega. The test trawling was closely monitored by scientists at the Institute of Marine Research (IMR). The subsequent IMR reports (Steen et al. 2018, 2020) led DoF to allow kelp harvesting along the Helgeland coast with a differentiated harvesting cycle for kelp, where sectors are harvested with 5–10 years periods of fallow (Regional decree on kelp harvesting, 2022). However, at the local level, DoFs conclusion was disputed. When the public hearing was carried out in 2022 to develop the regional regulations for kelp harvesting in Nordland County, the County Governor promoted caution and decided against industrial trawling for kelp (Nordland County Governor 2022). The County Governor referred to another state directorate, NEA, which in the hearing process had expressed a concern about the lack of research on the long-term impact of the local ecosystem, especially regarding seafoam (Norwegian Environment Agency 2022).

Consequently, in a meeting on the June 23, 2022 between representatives of DoF and NEA, the parties “agreed to disagree,” returning the case for discussion in the established regional working group (DoF, 2022). Responding to this impasse, the Nordland County Council, the Sør–Helgeland Regional Council, and the Vega World Heritage Foundation, all represented in the working group, called for more research and requested DoF for an impact assessment to aid the decision-making process. As this request was declined by

DoF, the Vega World Heritage Foundation and Vega Municipality ordered an independent impact assessment from the Italian company “Instead Heritage” (Court et al. 2022). The report advised against kelp trawling based on the available science and criticized the Helgeland Coastal Plan for having a “one-dimensional” focus, “focusing only on development through the commercial development of aquaculture” (Court et al. 2022, p. 7; Danbolt 2022; Vega World Heritage Center 2022). A closer look at the IMR reports also gives indications of a discursive bias by DoF. The IMR report rightly concluded that, based on their available data, there was no scientific reason to *not* open the test-trawled areas to commercial harvesting of kelp (Steen et al. 2020). However, although IMR seems certain on kelp regrowth—the report is not unequivocal on the effect of trawling upon the larger ecosystem. Steen et al. (2020) point out that the epiphyte structure of the harvested kelp was not fully restored after five years of fallow. Large variations in the catchment data also made it “difficult to detect potential subtle effects from kelp harvesting on fish,” and that “what looks like a sustainable harvest with regard to the re-establishment of the kelp biomass after one round of harvesting can prove to be less sustainable after repeated harvests of the same area” (Steen et al. 2020, p. 40).

Arguably, more scientific research on seaweed’s role in the marine and coastal ecosystem is needed for knowledge-based decision-making on commercial exploitation of both kelp and rockweed. Yet scientific data can only go so far if the governance framework is unable to secure sustainable development in practice. Norwegian coastal governance is notoriously known for being compartmentalized and fragmented (Stokke 2021; Hauge and Stokke 2021; United Nations Environment Program 2023), of which the inability to regulate rockweed harvesting with the same governance tools as is used to regulate kelp is an apt example. While kelp grows in the deeper, sub-tidal part of the Norwegian continental shelf where the Norwegian state has sovereign rights, kelp harvesting can be regulated in regional and state marine management plans in line with the integrated ocean management plan (White Paper. Meld. St. 20, 2020). Rockweed, however, grows in the shallower, intertidal littoral zone of the coast, and thus as a marine resource, rockweed is subject to private property rights, safeguarded in the Norwegian Constitution. The right to private property is set at “marbakke” (a drop of 1:2.5 or to 2 m depth at mid-tide where no steep slope occurs) (Nordtveit 2015, p. 779–780). As the management plan for seaweed and kelp explicitly excludes areas under private ownership from its scope (Management Plan for Seaweed and Kelp 2000), and Decree No. 642 of 1995 excluded rockweed as an object of governance based on lack of scientific knowledge; it is up to the landowner to manage rockweed harvesting within that jurisdiction (Decree on the harvesting of seaweed and kelp 1995).

In Norway, ownership of coastal land is mainly distributed in a mosaic between the local municipality, commercial actors, and individuals (Mo 2022). In the case of private ownership, management appears to rely on informal agreements between individual landowners and the industry itself. According to a focus group interview at Vega, rockweed harvesting quotas are bought and sold in private agreements between the industry and landowners, where landholders receive a compensation of 10,000 Norwegian kroner (approximately 900 Euros) per harvest.

In the case of municipal ownership, rockweed harvesting (and protection) measures can be regulated in municipal coastal management plans extending out to 1 nautical mile from the baseline, after the Planning and Building Act (2008). In the state and local management plans reviewed for this article, however, no one has developed regulations for rockweed harvesting except the Vega World Heritage Center, which is responsible for environmental governance within the UNESCO site. In the Vega management plan, rockweed harvesting is classified as a “traditional practice” owing to its historical significance (Fageraas 2013; Vega World Heritage Site Management Plan 2014), allowing harvesting from August 1 to March 31 (Stiftelsen Vegaøyan 2016; Vega World Heritage Site Management Plan 2014). However, there is no precise definition of what constitutes “traditional” harvesting practices, which allows for the use of the disputed Suction Cutter Jet also within the UNESCO site.

In practice, the government can only assess the sustainability of harvesting by the estimated quantity of rockweed sold, as the weight of harvested rockweed for sale has to be reported to DoF through “Norges Råfisklag,”² following the Fish Sales Act (2014). No by-catch of the harvest is officially registered or reported, and the industry is free to operate without any specific regulations aimed at ensuring sustainable harvesting. How the industry itself defines sustainable harvesting is therefore crucial to address.

4 Toward sustainable rockweed harvesting

Ensuring sustainable rockweed harvesting was emphasized in all the existing rockweed companies’ marketing profiles. Sustainability was also a core concern in the two interviews done with company managers for this paper. To illustrate how Algea ensured sustainable harvesting, the previous manager explained how a system of cyclical zoning based on regrowth and fallow periods was implemented by the business.

² Norges Råfisklag: A sales organization representing fishers and harvesters.

“It is important not to overharvest one area, just imagine—if you harvest everything close to Brønnøysund one year, then next year will be expensive because then you have to travel far away. So, you need to have one zone close by and one zone further away; then you can spread the expenses” (Algea Interview b, 2022).

Considering that the North Sea coastal areas have experienced unprecedented stress to their ecosystems due to warmer sea temperatures, loss of biodiversity, ocean acidification, eutrophication, pollution, and coastal and marine construction (White Paper No. 29, 2021; Pascual et al. 2023), the question should perhaps not be whether the rockweed industry sees itself as contributing to sustainable development, but what kind of sustainability rockweed harvesting supports, and sustainability for whom. For the industry, sustainability in this context was narrowly defined as maintaining a healthy, regenerative stock of rockweed, because the regrowth of rockweed was essential for making a profit.

The two Norwegian coastal and marine governance institutions DoF and NEA operate with a somewhat wider conceptualization of sustainability where the health of a larger ecosystem is considered; however, there was a clear conceptual discrepancy between how the government agencies related to scientific uncertainty on long-term ecosystem effects in the scientific assessment of kelp harvesting. While NEA leaned toward ecological considerations underpinning the conceptualization of sustainability, DoF seemed to make decisions where economic sustainability carried more weight, aligning more with the purely commercial rockweed actors. Neither directorate seems to recognize the more qualitative or socio-cultural values of seaweed. The interviews, however, show that rockweed and kelp are inseparably related to the cultural, ecological, and economic life at Vega, as illustrated here by an interviewee observing trawling inside the UNESCO heritage site.

“The other day, a gigantic trawler came into our waters. It was 130-140 feet, and throwing its net, the ship filled the whole bay. And I... never imagined they knew we existed! You know what I mean? Imagine—that they would find us here? On this teeny-weeny island on this teeny-weeny place...? But there they were, and they filled the entire bay and threw their trawl. It... hurts, you know? It feels terrible, that’s how it feels”

Interview with landowner, 2022.

When approaching rockweed and kelp through local perceptions of their “socio-ecological” value, the sectorial and managerial disconnect dissolves. Here, the trawling of kelp evoked sentiments of uncertainty, fear, and vulnerability, closely related to the historical and political context of the health of the coastal ecosystem being closely related to

the health of the community itself. When nature's values associated with social sustainability, such as the cultural, relational, and non-material, go unaddressed in the environmental policy of the governing institutions, their absence indicates not merely a management "gap" or "void" but a contested space of "friction" between hegemonic discourses (Foucault 1980, 1984, Tsing 2005, Brightman and Lewis 2017; Sachs 2019). Presently, seaweed is governed by both DoF and NEA within an instrumentalist value discourse, where the only nature's values recognized are the ones which provide economic or ecological services to society. In this, both directorates are reflecting larger and more powerful global and national discourses on climate, environment, and development where socio-cultural and non-material values, such as sentiment and trust, are overlooked and ignored (Brightman and Lewis 2017; Sachs 2019; Robbins 2020).

Albeit more coherent governance tools and frameworks could do much for Norwegian coastal resource governance, a policy shift alone might not foster sustainable development. In addition to producing more knowledge and a wider and more explorative collaboration across sectors and institutions, one approach to improving seaweed governance could be to critically address the attribution of values (and the scope of these) in decision-making processes in seaweed governance. As we see from the interviews, both empirical and scientific knowledge inform the emic perceptions of the functions and values rockweed has, giving rockweed its socio-ecological significance. This process of "valuation," we argue, is thus equally important to address, on par with aspects of economic loss and benefit from harvesting seaweed and the effect it might have on the wider ecosystem. Identifying and assessing a wider scope of values associated with the coastal marine ecosystems as called for by IPBES (IPBES, 2022) will however require a substantial effort. This should however not be a task delegated to the industry itself, but by holistic and coherent governance (CBD 2022, IPBES 2022, IOC-UNESCO 2023). There is, at the time of writing, no consensual approach that can encompass a wider range of values than what is typically represented in the management of natural resources (Blomley and Walters 2019; IPBES 2022), yet we encourage researchers to identify and investigate the diversity and role of nature's values and to explore and assess ways to recognize and integrate less recognized values into environmental policy and governance, targeting "socio-ecological" values to reveal structural mechanisms of market economy, political power, and global discourses that guide the visions of both scientists, politicians, and civil society. By integrating the empirical social sciences in environmental management, one might better approach environments, landscapes, or even species as they are empirically embedded and perceived, in a common effort to promote and facilitate just and sustainable development. In this article, we have taken one step in this direction, by letting local

perceptions of rockweed illustrate the complexity of relationships and structures that rockweed embeds itself in.

Appendix A

Interviews

Focus Group Interview on Vega, 2019:
(landowners, World Heritage Center representatives)
Telephone interviews, September 2022:
Environmental manager Vega Municipality
Mayor of Vega
Algea interview a (regional representative)
Algea interview b (retired manager)
Polar Algae
Troms og Finnmark County Governor
Landowner on Vega (a)
Landowner on Vega (b)
Environmental manager (retired) and historian
Vega World Heritage Center manager

Author contributions Aase J. Kvanneid collected primary data. Both authors contributed to design, analyses and writing.

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Declarations

Conflict of interest The authors declare no competing interests.

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