



Towards sustainable management of kelp forests: An analysis of adaptive governance in developing regimes for wild kelp harvesting in Scotland and Norway

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ABSTRACT

Kelp forests are highly productive habitats which support important marine species and ecosystem services including coastal protection and carbon storage. Demand is increasing for commercial products from wild and cultivated kelp, however questions remain on how harvesting of wild kelp can be managed and governed in a sustainable and adaptive way. This paper analyses and contrasts the institutional arrangements for wild kelp harvesting in Scotland and Norway by examining three recent governance processes through document analysis and participant observation. We investigate to what extent the regimes display three foundational aspects of adaptive governance: local governance and participation; the use of knowledge; and legal adaptive capacity. Industrial harvesting has been underway for decades in Norway but is not yet practiced in Scotland, although kelp availability and traditional usage are similar. In Scotland, following extensive public objection in response to proposed industrial harvesting, a legal restriction was adopted in 2019 that prohibits industrial harvesting of whole plants, and the regulatory regime remains under review. In Norway, governance of kelp harvesting is designed to be adaptive and inclusive through periodic review of regional harvesting regulations, yet has not been adjusted despite contestation from stakeholders. In both cases, adaptive governance processes are indicated but are not influential on outcomes. Our paper reveals several obstacles to knowledge-based adaptive governance in practice. First, it is insufficient to create the processes of engagement and participation - these must be empowered to influence governance and remain legitimate. In both cases, the regimes remain hierarchical and dominated by central agencies, even though structures for local governance are available. Second, integrating scientific and local knowledge was shown to be difficult, and mechanisms to debate and negotiate risks and benefits were lacking. In each case, diverging perspectives on kelp harvesting were sustained even though final outcomes were reached, and consensus was elusive. Third, adaptive capacity of applicable legal instruments is of crucial importance, with differences apparent in capacity to enable on-going revision (as in Norway) and limit future change (in Scotland). Poor co-ordination between legal instruments also leads to complications between actors with different mandates and policy objectives. Recommendations are made for an adaptive approach to protect and manage kelp as a critical habitat.

1. Introduction

Kelp forests are important ecosystems, providing nurseries for fish and higher predators, coastal protection from erosion and flooding as well as carbon storage (Burrows et al., 2017; Smale et al., 2013). Kelp is also used in commercial applications, primarily the extraction of alginates for food and fodder production, pharmaceuticals, textiles, paper and biotechnology. Most seaweed is used fresh or processed for food and

around 10% is processed to extract hydrocolloids (primarily alginates, carageenans and agars) for use across a range of industries including food, cosmetics, pharmaceuticals and industrial applications (Cheshire et al., 2019). In Scotland and Norway, small-scale use of kelp and seaweeds has been a component of coastal livelihoods for centuries, primarily using harvesting methods of hand cutting and gathering. Driven by increasing demand for products and economic potential, interest in cultivation and harvesting of wild kelp at industrial scale is growing,

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presenting challenges for management. Globally, the vast bulk (96%) of seaweed utilised is currently produced via aquaculture while 4% comes from wild harvests (Cheshire et al., 2019), and approximately 20 countries are involved in harvesting macroalgae, totalling over 620,000 tonnes per year with landings of Chilean and Norwegian kelp accounting for 60% (Mac Monagail et al., 2017). In Europe, commercial harvesting of wild (uncultivated) kelp at large scale is well established in Norway and France (Frangouides and Garineaud, 2015), and at a smaller scale in Ireland (Mac Monagail and Morrison, 2020) and Scotland. The target species for large-scale harvesting are the large brown subtidal kelp *Laminaria digitata* and *L. hyperborea* which form extended monospecific kelp beds and have a high alginate content¹ (Burrows et al., 2018).

Research indicates that a certain level of harvesting of kelp is sustainable but establishing this threshold is exceedingly difficult (Burrows et al., 2018). Industrial trawling methods using vessel-based equipment to trawl kelp from the seabed generally leads to temporary loss of entire plants (Steen et al., 2016) and measurable reductions in associated biota. The effects of kelp removal on the functioning of kelp forests and their capacity to restore biodiversity after harvesting activities, particularly considering other impacts on ecosystems including effects on commercial fish populations, is uncertain (Burrows et al., 2018). The kelp itself recolonises and regrows within a few years but research indicates that it takes a minimum of eight years for the epiphyte communities - the organisms that grow directly on the kelp plants - to recolonise and be fully re-established (Steen et al., 2016). The growth rate of kelps can be rapid, so medium to large-scale harvesting in countries such as Norway (Veaa and Ask, 2011) and France, currently manage these activities based on sequential cropping with a fallow period (typically 3–4 years) to allow the kelp to recover (Burrows et al., 2018).

Uncertainty regarding consequent effects of large-scale kelp removal, along with concern regarding ecosystem effects, and as a 'blue carbon' habitat with a role in climate regulation (Smale et al., 2018), require sustainable management and necessitates an adaptive governance approach. We draw on theories of adaptive governance, which emphasise iterative, learning-based governance which can enable responding to complexity and change under uncertain conditions (Armitage et al., 2009; Chaffin and Gunderson, 2016; Ostrom, 2007; Wyborn, 2015). In this paper, we analyse and compare the institutional arrangements for governance of kelp harvesting in Scotland and Norway to understand if, and how, adaptive governance is developing to support kelp management. These countries share similar ecological conditions, kelp habitats and coastal traditions, but industrial kelp harvesting has taken place in Norway since the 1960s (Veaa and Ask, 2011), while in Scotland, hand harvesting has been practiced for centuries but large-scale mechanical harvesting has not yet taken place. These similarities and differences render a comparative analysis of the governance arrangements for kelp in Scotland and Norway interesting and timely.

In the following, a short theoretical framework is presented based on adaptive governance, followed by an overview of the cases of kelp harvesting in Scotland and Norway. We subsequently provide analysis of the processes of governance in each case and discuss the opportunities and barriers for adaptive governance through comparative analysis of the regimes.

2. Theoretical framework

Governance of natural resource use (or environmental governance) represents the processes of mediating societal interaction with environmental systems (Folke et al., 2005; Ostrom, 1990). This includes the societal processes of decision-making and resolving trade-offs through interwoven institutions of rules, laws, regulations, policies and social norms which steer decision-making. *Adaptive* governance recognises

that in order to be resilient, these processes must recognise complexity and uncertainty and respond to environmental and social change (Chaffin et al., 2014). Adaptive governance is an essential basis for adaptive management (Folke et al., 2005; Hurlbert and Gupta, 2016), where management refers to direct control over human activities (Hatfield-Dodds et al., 2007), and refers to intentional and planned experimentation in decision-making undertaken to promote learning, guided by adaptive governance (Cosens et al., 2018; Craig and Ruhl, 2014). Adaptive management is appropriate when goals are set and the ability to control experimentation is high (Craig and Ruhl, 2014).

Empirical analysis of adaptive governance requires consideration of attributes of the social system which can enable the ability (capacity and flexibility) to adapt, through learning-based approaches to respond to feedback over time (Folke et al., 2005; Craig and Ruhl, 2014). There is no single model of adaptive governance and its attributes are interdependent, leading to a range of approaches used for its analysis in practice and a lack of consistency in definitions across adaptive governance (Hasselman, 2017; Plummer et al., 2017). Based on the literature, we structure our analysis of adaptive governance in the Scottish and Norwegian cases by focusing on three foundational aspects of adaptive governance: 1) Local governance and participation; 2) The use of knowledge; and 3) Legal adaptive capacity. These interlinked attributes are observed as critical and interdependent within conceptualisations of adaptive governance and are described below.

First, adaptive governance requires engaging a broad set of stakeholders beyond the traditional decision-makers and managers in the process through local governance, participation and inclusivity. This includes polycentric arrangements which distribute decision-making power across multiple scales with co-ordination between them (Ostrom, 2010). In these arrangements, meaningful and legitimate participation and collaboration, supported by self-organisation and leadership, can enable learning and innovation and enhance decision-making in resource management (Sharma-Wallace et al., 2018; Wyborn, 2015; Österblom and Folke, 2013). Here, we analyse the role of stakeholders 'beyond the state' in the governance of kelp harvesting at multiple levels, through formal or informal channels, and the extent to which they are empowered to influence governance outcomes.

Second, since uncertainty and incomplete knowledge are given in adaptive governance, there is a need for learning and adjusting management measures according to new knowledge including different knowledge forms. Data collection, monitoring and sharing of knowledge through review and reflexive processes linked to decision making is necessary to adapt to changing circumstances and to perform well and remain resilient over time (Sharma-Wallace et al., 2018). We investigate here how knowledge is used by different actors to legitimise different stances and outcomes, and the implications for future adaptive management of kelp harvesting.

Third, the role of law in preventing, triggering and facilitating dimensions of adaptive governance (legal adaptive capacity) is a critical underpinning factor (Cosens et al., 2018; Craig et al., 2017; Soinnen and Platjouw, 2018). Legal adaptive capacity refers to the degree of latitude possible within a given governance structure, in the rules, standards, and norms (such as discretion in interpretation, implementation or exceptions and variances) and within procedural requirements such as the rules structuring analytical deliberation and participation, the rights of actors, institutional variety, accountability and mechanisms for dispute resolution (Craig et al., 2017; Cosens et al., 2018). While a balance between flexibility and stability is essential, rigidity in legislative, administrative and judicial decisions mean they are often unable to be amended in light of changing circumstances or learning (Soinnen and Platjouw 2018). Legal adaptive capacity is analysed in our study by considering the policy and legislative conditions of each governance regime and the extent to which they allow for learning-based approaches, where new understanding of social ecological systems and policy responses can lead to management refinements (Soinnen and Platjouw 2018).

¹ We refer to these species collectively as "kelp" in this paper.

In this study, we define and analyse the following kelp governance processes: in Norway, the revision of kelp harvesting regulations for Trøndelag region, and in Scotland, two parallel processes: 1) the regulatory process in response to an application for a license for proposed harvesting activities and 2) the creation of new primary legislation (the *Scottish Crown Estate Act 2019*) through the parliamentary process.

3. Methods

A case study approach was taken (Gerring, 2004) and our analysis of the functioning of these contemporary governance systems for kelp harvesting in Scotland and Norway draws on multiple data sources. The governance system was initially defined by conducting an analysis of the key legislation pertaining to kelp management in each country, followed by document analysis of publicly available information including meeting minutes, consultation materials and responses, policy and environmental reports. The material was analysed qualitatively to describe the governance attributes of interest (local governance and participation; the use of knowledge and legal adaptive capacity). Material was relevant across all attributes, as interdependent features of structure, process and agency. For the Scottish case, we focussed on the parallel processes of the regulatory process and consultation in response to the application by Marine Biopolymers Ltd (MBL) for large-scale harvesting, and the development and adoption process of the Scottish Crown Estate Act through the Scottish Parliament, both in the latter half of 2018. In Norway, we focussed on the process of revising the regional kelp harvesting regulations in the County of Trøndelag through an advisory group consisting of relevant local and regional actors, before the regulations were set by the Directorate of Fisheries (DoF). From January to August 2019, the regional advisory group held six meetings and one of the authors was a participant observer in all the meetings. Although these meetings were not public, the discussions were detailed in a public report. Informal conversations were held with different stakeholders in each case which supported our understanding of the process but were not central to the analysis. Our analysis is based on written reports to document the views of participating actors and enable clear attribution. The use of documents was appropriate for describing the structure and functioning of the governance systems in each case.

4. Overview of case studies

The case studies are presented in Fig. 1 and described below.

4.1. Scotland

In Scotland, small-scale harvesting of seaweeds has taken place for hundreds of years addressing traditional uses such as fertiliser, animal feeds and alginates, and there is increasing interest in biofuels, cosmetics and nutraceutical industries (e.g. dietary supplements) (Angus, 2017).² Raw materials are collected by hand or by using small, specialized cutting and collecting boats. The industry “has potential to thrive” and socio-economic benefits, particularly for rural communities including as a diversification opportunity for fishermen (Burrows et al., 2018). While the raw material is of low economic value, there is potential for higher value further down the chain, if used in the high value manufacturing and pharmaceutical industry (Cheshire et al., 2019). The potential for medium to large-scale harvesting of wild kelp using mechanical techniques is significant - the estimated harvestable biomass of the key kelp species of interest (*L. hyperborea*) is 20 million tonnes of which 6.5 million tonnes are in harvestable densities (Burrows et al., 2018). Kelp forests are particularly abundant on the west coast of Scotland and the major islands of the Outer Hebrides, Orkney and Shetland (Fig. 1).

² The licensing process for small-scale harvesting is described in detail in Angus (2017).

Cultivation of kelp is also being developed and is supported in Scottish policy,³ however, cultivation is currently small-scale projects and “cannot at present be regarded as an alternative replacement to wild harvesting with respect to providing stocks of kelp to support large scale industry” (Burrows et al., 2018:1).

Since 2016, there has been a significant increase in small-scale license applications for seaweed harvesting in Scotland. These are licensed through a process defined by Crown Estate Scotland (CES) or relevant owner of the foreshore where most small-scale harvesting takes place. For large-scale commercial harvesting there is no specific licensing and management regime (Angus, 2017) and no licenses have so far been issued. Large-scale harvesting requires a licence from Marine Scotland, under the *Marine (Scotland) Act (2010)*,⁴ in consideration of other policy and legislation applicable to management of marine activities. This includes protection of the environment and applications should be accompanied by a developer-led Environmental Assessment (or Appraisal) to understand the potential for positive or negative environmental effects.⁵ Kelp is a protected feature under environmental legislation in Scotland recognising its value as a highly productive and dynamic ecosystem.

Any activities at sea must also be undertaken in accordance with Scotland’s National Marine Plan⁶ (NMP) which sets out general and sectoral policies affecting the marine area. The NMP supports economic development, where demonstrated as sustainable, while specifically protecting kelp habitats and associated ecosystem services (“GEN 5”).⁷ In the 2018 review of the NMP, kelp harvesting was identified as an emerging activity and specific policies relating to this are anticipated in the next iteration of the NMP (in 2021) (Scottish Government, 2018). Opportunities to grow Scottish seaweed production primarily through cultivation are already supported in the NMP.

In response to increasing interest, a Strategic Environmental Assessment (SEA)⁸ was undertaken in 2016 to assess of the potential effects of large-scale seaweed harvesting in Scotland. This concluded that large-scale mechanised harvesting had the potential to cause significant impacts on habitats and ecosystem services, since plants are damaged or removed (Scottish Government, 2016). Based on the SEA, NatureScot,⁹ statutory advisor on nature conservation, set out specific advice on cutting which aims at ensuring kelp plants can recover, including always leaving the holdfast attached and taking less than one third of a plant to allow for regrowth (Scottish Government, 2016). Current scientific research emphasises the need to: a) define species-specific and site-specific sustainable harvesting levels; and b) that harvesting plans are based on monitoring of effects and recovery, to understand the changes in the ecosystem and to inform management approaches.

In 2018, MBL submitted a scoping document to Marine Scotland for a proposed harvesting operation of 30,000 tonnes per year on the west

³ The Scottish Government published a Seaweed Cultivation Policy Statement in 2017 stating it is supportive of small-medium seaweed cultivation if environmental impacts can be mitigated.

⁴ Under Section 21 (6) of the Marine (Scotland) Act 2010, mechanical harvesting by trawl, sledge or dredge is deemed to require a licence since it constitutes the “use of a vehicle, vessel, aircraft, marine structure or floating container to remove any substance or object from the seabed within the Scottish marine area” (below the mean high-water spring mark).

⁵ To enable a license to be granted, a Habitats Regulations Appraisal (HRA) would be required where there is potential for proposed activity to affect sites and species protected under the EU Habitats Directive.

⁶ <https://www.gov.scot/publications/scotlands-national-marine-plan/>.

⁷ and, in addressing coastal protection, recognise the protective role of “kelp beds, biogenic reefs and sandbanks” (“GEN 8”).

⁸ This was accompanied by a draft Seaweed Policy Statement published in 2013 addressing cultivation only: <https://www.gov.scot/publications/draft-seaweed-policy-statement-consultation-paper/pages/2/>.

⁹ Scottish Natural Heritage was renamed “NatureScot” in 2020.

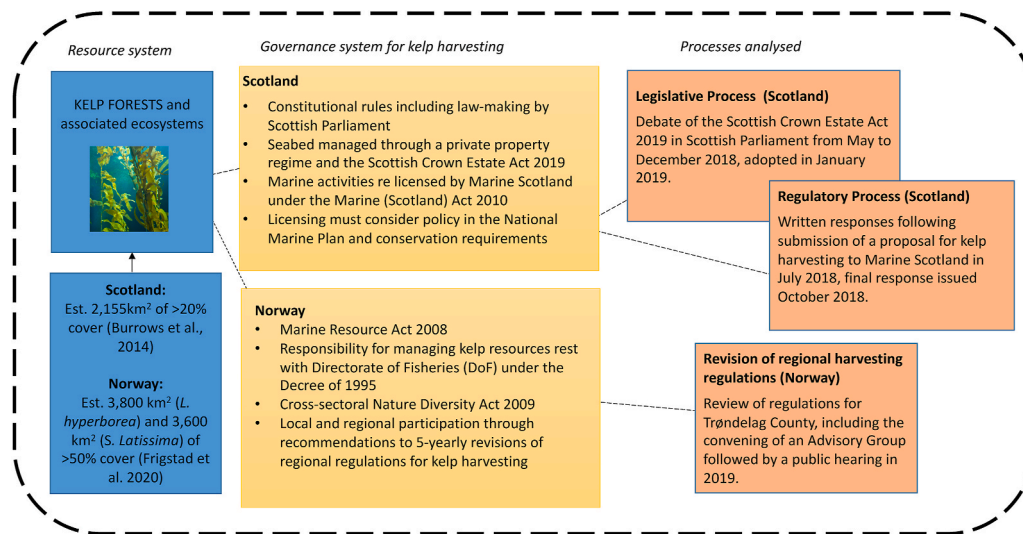


Fig. 1. Overview of case studies in Scotland Norway.

coast, using dredging to remove plants, but this has not progressed. Concurrently with consideration of the proposal through the regulatory system, the Scottish Crown Estate Bill was progressing through Scottish Parliament. This Act (adopted in January 2019) included an amendment which prohibited kelp harvesting where “(a) removal of the kelp would inhibit the regrowth of the individual plant, and (b) the kelp removed is intended for commercial use” (Art. 15) meaning that mechanical kelp harvesting of the type proposed by MBL is now effectively banned in Scotland.

4.2. Norway

In Norway, mechanical harvesting of kelp through dredging has been carried out since the mid-1960s, and focused research efforts and custom-built vessels facilitated steady growth of the alginate industry in the following decades. Kelp is harvested with a rake-type dredge which is pulled by the boat and tears the plants from the rock. Harvesting removes all canopy forming kelp plants in a 4 m wide track, leaving either a barren track or a track with small kelp plants (Lorentsen et al., 2010). Today, *L. hyperborea* is the main source for production of high-range alginate, and around 150,000 tons have been harvested annually for the last decades (TFK, 2019a). Harvesting and cultivation of macroalgae is an important strategic area of focus for the Norwegian Ministry of Trade, Industry and Fisheries and the value-creation in this field has been indicated to reach NOK 40 billion in 2050 (SINTEF, 2012). While industrial kelp harvesting in Norway for decades has been dominated by one main industry actor, 2019 saw the opening of another alginate refinery with an associated fleet of dredging vessels.¹⁰

Since the early 1970s, over 50% of kelp forests in mid to northern Norway were grazed by green sea urchins, which transformed the areas into marine deserts or so-called barren grounds (Sivertsen, 1997), in part attributed to overfishing of predatory fish such as cod and catfish (Norderhaug et al., 2020). However, during the last decade there has been a gradual northwards recovery of kelp, explained in part by the negative effects of ocean warming on sea urchin recruitment (Norderhaug and Christie, 2013) and by increased urchin predation by northward expanding *Cancer pagurus* and *Carcinus maenas* crabs (Christie et al., 2019; Fagerli et al., 2014). State-of-the-art modelling in 2011

¹⁰ Dupont (formerly FMC BioPolymer AS) has up until recently operated the only alginate refinery factory and been the single buyer of kelp raw material in Norway. In 2019, another actor, Nutrimar Seaweed, opened an alginate refinery at Frøya, in Trøndelag County, with new purpose-built dredging vessels.

estimated *L. hyperborea* and *S. latissima* to cover more than 8000 km² of the Norwegian coast (Gundersen et al., 2012). These modelling results were significant with regards to the quantification of macroalgae along the Norwegian coast and are much cited by industry actors to show the potential for harvestable kelp biomass. However, more recent high-resolution prediction models have shown that these estimates were somewhat exaggerated (Frigstad et al., 2020).

As a wild, living marine resource, kelp in Norway is regulated under the Marine Resources Act of 2008, where it is defined as belonging to “the Norwegian society as a whole”, while being governed by the Ministry of Trade, Industry and Fisheries (MRA, 2008). Vested in this Act, conditions for kelp harvesting are stipulated by a national decree stating its purpose as “securing that seaweed and kelp is exploited sustainably as part of a holistic management of the coastal resources and natural environments” (NFD, 1995). The 1995 decree states that harvesting of kelp is prohibited but can be permitted at less than 20 m depth by regional regulations defined by the Directorate of Fisheries (DoF). The regional regulations facilitate area-based management of kelp harvesting whereby allocated harvesting areas are open for one year, followed by four fallow years until the next harvesting period. Harvesting is therefore managed through regional regulations which define where and when harvesting of kelp is allowed within the region, within a national legislative framework, without licenses issued at an individual project scale as in Scotland. The regional regulations are reviewed on a five-yearly basis. Harvesters are required to report time, location, and tonnage of harvested kelp annually, while the location of the dredging vessels is monitored by the DoF during harvesting.

At present, harvesting of kelp is allowed under these regulations in four counties along the Norwegian coast; from Rogaland in the south-western parts, through Vestland and Møre og Romsdal, to Trøndelag county in the mid-part of Norway (see Fig. 2).¹¹ Following the northward expansion of kelp forests, the Institute of Marine Research (IMR) have carried out harvesting trials in Nordland county, co-financed by the kelp industry (Steen et al., 2015). This is a first step towards opening this county for industrial harvesting which is likely to be permitted in 2021.

While the Marine Resources Act (2008) is the primary legal mechanism, other national legislation is relevant for the governance of kelp forests in Norway. The Nature Diversity Act (2007) is a cross-cutting piece of legislation which aims to “protect biological, geological and

¹¹ The counties Sør-Trøndelag and Nord-Trøndelag were merged to Trøndelag County in 2019. From 2020 Hordaland County and Sogn og Fjordane County were merged to Vestland County.

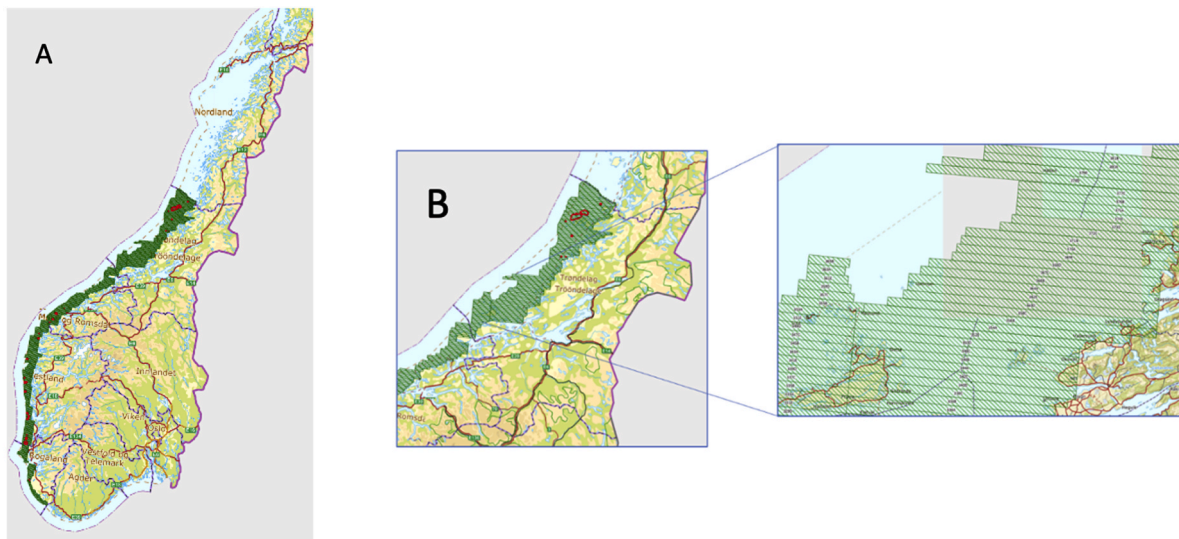


Fig. 2. A) Areas along Norway's western coast with ongoing harvesting of kelp, B) Trøndelag county in Norway, and an example of current zonation for kelp harvesting within Trøndelag (©Kartverket 2020, www.kartverket.no).

landscape diversity and ecological processes through conservation and sustainable use, and in such a way that the environment provides a basis for human activity, culture, health and well-being, now and in the future [...]” (NDA, 2007). The Planning and Building Act (2008) specifies that municipalities have the right to regulate and spatially plan coastal areas extending 1 nautical mile beyond the baseline of the territorial sea. However, despite attempts in 2013 by two municipalities in Trøndelag, they have not been able to curtail kelp harvesting through coastal planning with reference to this Act and have instead been referred to the regional regulation review processes.¹²

5. Results

5.1. Scotland

In Scotland, two parallel processes have recently been influential in shaping the governance of kelp harvesting: the regulatory process responding to the submission by MBL, and the development of new primary legislation in the form of the Scottish Crown Estate Act 2019. These processes occurred within the same governance system but proceeded independently.

5.1.1. Regulation of kelp harvesting through the marine licensing process

MBL submitted a Scoping Report to Marine Scotland Licensing and Operations Team (MS-LOT) in July 2018 detailing proposals to obtain five-year marine licences to undertake large-scale harvesting from a range of locations around the west coast of Scotland. They proposed a rotational harvesting plan across five areas, harvesting an area at a time for a one-year period, allowing a four/five-year period to recover, following the recommendations of a scientific report (Burrows et al., 2018). By year five, they anticipated having the capacity to harvest up to 30,000 tonnes of kelp per year. An ‘Adaptive Management Plan’ was proposed where monitoring would inform adjustment of harvesting activity as deemed necessary by an Environmental Steering Group (Marine Biopolymers Limited (MBL), 2018: 2).

¹² Ministry of Local Government and Modernisation to County Governor of Sør-Trøndelag 07.06.2016 «Roan kommune - innsigelse til bestemmelse om forbud mot taretråling i kommuneplanens arealdel», URL: <https://www.regjeringen.no/>, Accessed: 16.12.2020.

Public consultation on the proposal was held during July and August 2018 and MS-LOT received 21 responses from organisations directly consulted and over 2350 representations from the general public in relation to the proposal, from Scotland, UK and abroad (these were not available for analysis but were summarised by MS-LOT in their scoping response). Many respondents objected outright to the proposed activity and would strongly oppose any future planned activity of this type. The major themes of the responses were concerns regarding:

- Impacts on ecology and the environment including climate change
- Impacts on coastal processes including loss of shoreline protection
- Impacts on livelihoods including fishing and tourism; concerns regarding navigation and visual impacts
- Lack of benefits for local economies
- Monopoly by one large company
- Cultivation as a better alternative

Ten respondents out of 21, and 151 representations, outlined the need for an adaptive approach and the need for ‘scaling up’ of operations, and some referred a precautionary approach as supported by the UK High Level Marine Objectives and the NMP.¹³ A small-scale, preliminary pilot or experimental study (potentially non-commercial) was deemed necessary before large-scale harvesting operations. This was proposed as best undertaken collaboratively, involving community, inshore fishermen and environmental stakeholders and other relevant parties and to test a range of harvesting methods. One respondent considered that such testing should still be done “at the expense of those seeking to use a public good for private gain”.¹⁴ Others supported a learning-based approach but considered that this should be managed strategically by government, with opportunity for small scale projects identified according to understanding of the resource at national scale.

The regulator (MS-LOT) provided a formal response to MBL in October 2018 (Marine Scotland - Licensing and Operations Team (MS-LOT), 2018), which presented the consultation responses and

¹³ Scotland’s National Marine Plan states that: “Where evidence is inconclusive and impacts of development or use on marine resources are uncertain, reasonable efforts should be made to fill evidence gaps and decision makers should apply precaution within an overall risk-based approach” (para. 4.81).

¹⁴ Response by Save Seil Sound, appended to MS-LOT, 2018.

recommended a phased approach, where a small-scale operation which could be monitored and scaled-up through subsequent licenses if impacts were acceptable. This would enable adaptive management through sequential licensing, where a license would be granted and monitoring undertaken to inform harvesting expansion, progressed through further license applications. Monitoring would need to demonstrate the sustainability of the agreed harvesting regime, as proposed by MBL, and include independent review by a multi-agency environmental steering group. Difficulties were raised with this approach, including the insufficient knowledge of impacts to provide a baseline for measuring effects; the feasibility of monitoring and detecting change; the lack of ability to define thresholds of kelp extraction and “*lack of any intervention criteria*”,¹⁵ or what the intervention (in terms of mitigation or restoration) would consist of. ENGOs considered that as it is currently not possible to determine ‘national status’ of kelp as a Priority Marine Feature, it is therefore impossible to determine whether the proposed activity will have a significant impact in order to grant a license.¹⁶ Costs and responsibility for paying for the monitoring were also raised as issues.

Other forms of adaptive management were referred to by respondents including a non-commercial, experimental-based approach, perhaps led by public agencies or a community group, but these were not formally articulated by the regulator in their decision-making process. Many respondents considered the importance of justifying how local benefits will be ensured and the importance of local ownership. Opportunities through the changes to management of the seabed, including the Local Pilot Scheme,¹⁷ could address this, with the possibility of devolving responsibility of management and leasing (of the seabed for harvesting activities) to community groups. The principle of subsidiarity was promoted by CES in their response to the proposed harvesting by MBL,¹⁸ to increase local benefits and develop context-relevant management of resources. Regional marine planning was also raised as a framework which should enable debate and negotiation at regional scale but was considered “*yet to materialise in any meaningful way*”.¹⁹

While further applications were not ruled out by the regulator, the strongly negative response from many actors throughout the process, including outright objections, indicate that future proposals are highly unlikely to be acceptable to many consultees. Although informal, the strong public opinion arising through the regulatory process represents ‘rules’ which might steer the future behaviour of the industry.

5.1.2. The development of the Scottish Crown Estate Act 2019

The Scottish Crown Estate Bill was being considered by Parliament concurrently to the consideration of the MBL’s proposal through the regulatory system. Based on a process defined in constitutional law, a new bill is scrutinised by Parliament, usually through committees – in this case the Environment, Climate Change and Land Reform (ECCLR) Committee, which is comprised of Members of the Scottish Parliament (MSPs). This involves three stages: 1) the general principles of the bill; 2) proposed amendments to the bill and 3) further amendments and decision to pass or reject the bill. Once passed, it becomes part of the law of Scotland as an Act of the Scottish Parliament following Royal Assent (approval from the Queen). The Scottish Crown Estate Bill was introduced to parliament on January 24, 2018 with the Stage 1 debate in

June 2018; the Bill was considered at Stage 2 on September 18, 2018 and debated at Stage 3 on 21st November 20, 18²⁰, at which point amendments were voted upon. The Bill received Royal Assent (becoming the *Scottish Crown Estate Act 2019*) on January 15, 2019. Through this process, actors made representations via written evidence which were considered in the debates.

Kelp was not part of the initial Bill or mentioned during Stage 1 of its consideration. At Stage 2, an amendment was proposed that harvesting of wild kelp should be restricted “*where such harvesting would inhibit the regrowth of the individual plant*”.²¹ Following debate in parliament, this amendment was adopted at Stage 3, based on voting in which the division was: For - 3, Against - 0, Abstentions - 6.²² The amendment legally restricts the removal of entire plants including the activities proposed by MBL. Licensing for harvesting might be sought if it can be demonstrated that methods that do not inhibit the regrowth of the individual plant, but large-scale trawling is unlikely to be able to satisfy this requirement.

During parliamentary scrutiny of the Bill, submissions were made by fishermen’s organisations, scallop divers and trawlermen, the shellfish and whitefish sectors, small-scale kelp harvesters, tourism companies, community councils, academics, primary school children and individuals. These included letters and open petitions one of which was signed by 14,000 people based on a campaign led by an oyster farmer from Ullapool and founder of the ‘No Kelp Dredging’ campaign group. Lobbying effort was directed at specific MSPs and the cause was advanced principally by the Green Party MSP who tabled the amendment. A letter from 65 businesses was also submitted to the ECCLR process, supporting the ban.²³ Concerns echoed those articulated in the licensing process, and included ecological effects, indirect effects on commercial fisheries and hand harvesters, and the importance of kelp in climate change, both as a carbon sink as well as protection from coastal erosion and sea-level rise.

Other views concerned the potential benefits of economic activities in remote and rural communities, and that a wider consideration of ‘sustainable’ in this context, of balancing socio-economic and ecological concerns would be appropriate^{24,25}. On the basis of the information supplied by MBL, the possible wider financial benefits of the proposal in gross terms could be in the region of £1 million per annum²⁶ and include over 40 jobs in a biorefinery and the wider supply chain. A financial analysis undertaken for the ECCLR estimated that gross revenues to CES could be in the region of £26,400 for a development harvesting 33,000 tonnes wet weight per annum if relevant requirements are satisfied.²⁷ However, MSPs also emphasized the potential of seaweed cultivation as

²⁰ Stage 3: Video and written record of ECCLR committee meeting (Debate of Stage 3 Proceedings: Scottish Crown Estate Bill) during the Meeting of the Parliament 21 November 2018 (cited in results as [initials of MSP] 21/11/18). Online at: http://www.parliament.scot/parliamentarybusiness/report.aspx?r=11794&mode=html#iob_106698.

²¹ Marshall List of Amendments for Stage 2 for the Scottish Crown Estate Bill. Online at: https://www.parliament.scot/S5_Bills/Scottish%20Crown%20Estate%20Bill/SPBill24MLS052018.pdf p.5.

²² ECCLR Committee Meeting Minutes, 25th Meeting, 2018 (Session 5), Tuesday 18 September 2018. Online at: http://www.parliament.scot/S5_Environment/Minutes/20180918_Minutes.pdf.

²³ <https://docs.google.com/document/d/1d7VB25yuBjN7KrdJ8XD> M6sKYeSL08bzGsg7cSbdqfQ/edit- (a further 21 businesses signed after the letter had been sent).

²⁴ “*The proposal would have brought—and still might bring—40 jobs to Mallaig*” (JS 21/11/18).

²⁵ “*Perhaps we should all have a mature conversation about what “sustainable” means and what developments we are prepared to accept in our remote and rural communities.*” (JL 21/11/18).

²⁶ Supplementary Financial Memorandum: https://www.parliament.scot/S5_Bills/Scottish%20Crown%20Estate%20Bill/SPBill24FMS052018.pdf.

²⁷ Angus (2017).

¹⁵ Response by SEPA, appended to MS-LOT 2018.

¹⁶ Response by Scottish Environment LINK, appended to MS-LOT 2018.

¹⁷ <https://www.crownstatescotland.com/what-we-do/local-pilot-scheme>.

¹⁸ “[Crown Estate Scotland] believes that the principle of subsidiarity should be at the heart of policy development giving local communities the opportunity and responsibility of developing initiatives and strategies which meet the needs of the area and ensure sustainable economic growth.” Response by CES, appended to MS-LOT 2018.

¹⁹ Response from Fisheries Management Scotland, appended to MS-LOT 2018.

“a vibrant sector that can create jobs for generations to come”²⁸ including socioeconomic benefits for remote and vulnerable communities in the north-west.

The public campaign was considered scientifically informed²⁹ although its emotive nature and lack of balanced consideration of evidence was seen as problematic. Concern over the process - the lack of evidence and time to consider the issue - was the reason why most members abstained from voting on the amendment which resulted in its passing, rather than voting for or against³⁰. Some considered that the debate had undermined the regulatory process, which should be the appropriate process to control harvesting through consideration of evidence on proposed activities through the licensing process. It was acknowledged that Amendment 42 in fact “cuts across what the Scottish Parliament has already legislated for in the past decade, which is a statutory regime that requires licences to be granted before such activity can be carried out.”³¹

During the debate, the Cabinet Secretary also announced a government-led review of the regulatory regime addressing seaweed harvesting (not just kelp), which is currently underway. This review, attributed to the increasing interest in kelp and “profile of this issue”, suggests potential for future changes to the regulatory regime. The review was also considered by some to undermine the licensing process, leading to questions on whether it is fit for purpose and that the public campaign indicates they have “no faith in our licensing system or in our regulatory bodies and development agencies.”³² “Further policy action”³³ was also announced and national policy will be developed addressing seaweed harvesting (alongside cultivation) in the next iteration of Scotland’s National Marine Plan.

5.2. Norway

In the Norwegian case, we analysed the process of revising the regulation for kelp harvesting in Trøndelag County in 2019. In Norway, the governance of kelp harvesting is a nested process where regulations are set at a national level but defined on a regional basis, and with a regional tier where views and recommendations were gathered from an advisory group.

5.2.1. Revision of regulations for kelp harvesting for Trøndelag County

The establishment of regional regulations for kelp harvesting is the responsibility of the Directorate of Fisheries (DoF). To ensure local and regional relevance and legitimacy, the DoF are however bound to seek recommendations from regional advisory groups led by respective county councils during the revision of regulations every five years (NFD, 1995). The 2019 process of review was designed and led by Trøndelag County Council. Attempting to bridge the perceived democratic deficit of a similar process facilitated in 2013/2014 and the failed attempts by two municipalities to ban kelp harvesting through local planning, it was decided to carry out a broad, participatory process which included developing regional recommendations through an Advisory Group and a public hearing. The following actors took part in the Advisory Group: 3 inter-municipal councils (representing 11 coastal municipalities), representatives of the kelp harvesting industry, regional representatives

from the Norwegian Fishermen’s Association, the County Governor’s environmental section, as well as the regional representative of the DoF.³⁴ The DoF’s national office was also represented by an observer to the group.³⁵ The County Council framed the Advisory Group process as developing joint recommendations based on “the best available knowledge”, primarily knowledge provided by the Institute for Marine Research (IMR) (TFK, 2019a). In April 2019, after four meetings, the Advisory Group produced a draft report of recommendations which subsequently passed through a public hearing to inform the final recommendations to the DoF.

The Advisory Group had two key issues to address: spatial zonation and harvesting frequency. Regarding spatial zonation of the harvesting areas there was general agreement on aligning the harvesting zones in the county with the rest of the Norwegian coast, by having harvesting fields (east to west) with a delimitation of 1 nautical mile (TFK, 2019a). Harvesting frequency was a more difficult issue to reach agreement on. The existing regulations for Trøndelag state the requirement for five-year harvesting cycles, however, IMR reported that their research indicates that recovery of the biological diversity of the kelp forests takes longer: “Although re-establishment of the kelp communities would occur within the five -year harvesting cycle, the kelp ecosystem would have short longevity before it is harvested again. A longer period between harvesting would therefore give the kelp ecosystems better chances of developing to a climax state. IMR would therefore, with reference to the principles of ecosystem-based management, recommend [...] to consider extending the harvesting cycle [...] by at least one year [...]” (Steen, 2018:3, our translation).

These findings were interpreted in very different ways by members of the Advisory Group. On the one hand, the industry argued for a continuation of the five-year harvesting interval. They pointed out that no evidence was presented on negative impacts of present harvesting, and that current harvesting extracts merely 1% of estimated standing kelp nationally (TFK, 2019a: Annex 1). More research, they argued, is needed to conclude whether more intensive harvesting constitutes a danger to epiphyte communities for any given region. On the other hand, the Norwegian Fishermen’s Association argued for increasing to eight-year intervals in areas where there are registered or mapped spawning and breeding ground for fish (which would constitute large parts of the areas open for harvesting) (TFK, 2019a). Referring to the industry’s claim that only 1% of standing kelp is harvested, they argue that it should therefore be possible to identify sufficient areas for harvesting that do not merit to important spawning and breeding grounds. The majority of the Advisory Group, however, supported IMR’s advice of adding one year and the draft report submitted to the public hearing process therefore recommended a 6-year cycle (TFK, 2019a).

IMR initially also recommended that the Advisory Group should consider a completely different management strategy, inspired by terrestrial land use, whereby areas are considered as either “a field to be harvested”, or “a pristine area to be conserved” (Steen, 2019). In certain areas a reduction in biodiversity would be more acceptable and hence harvesting can proceed, while other ‘pristine’ areas are protected to ensure sustained ecosystem functioning.³⁶ Although presented to the Advisory Group, this alternative was not considered further or discussed

²⁸ ME 21/11/18.

²⁹ “We have remarkable people: scientists who have galvanised their arguments intelligently and articulately, and we thank them for that.” “Some submissions are scientific and well referenced, and others are about the right to our kelp forests as a public good.” (JS 21/11/18).

³⁰ We abstained because the process causes us considerable difficulties. – JS 21/11/18.

³¹ RC 21/11/18, who also stated that: “I remain of the view that the Scottish Crown Estate Bill is not the optimal place to control seaweed harvesting.”

³² JS 21/11/18.

³³ RC 21/11/18.

³⁴ Norway is administratively divided into 11 counties, and further subdivided into 356 municipalities. The County council is a politically elected council with an administration, with responsibilities inter alia for regional planning. The County Governor is the state representative at regional level, with a control and appeal function on local and regional decisions.

³⁵ A NIVA researcher (second author) participated as an observer in all meetings.

³⁶ Similar alternative management strategies have been recommended by other research groups in earlier revision processes (e.g. NIVA to Sør-Trøndelag County Council 29.11.2013 “NIVAs innspill i forbindelse med revisjon av Forskrift om regulering av høsting av tare i Sør-Trøndelag fylke”.

in the draft report.

The chair of the Advisory Group initially hoped that by sticking to ‘best available knowledge’ a consensus-based recommendation could be reached. However, the process instead led to a cementation of diverging views and in the report, the participants in the Advisory Group were listed with their respective preferred harvesting cycles (TFK, 2019b). The subsequent public hearing of the draft report triggered a range of reactions, especially to the contested issue of harvesting frequency. Of the twenty responses in the hearing process, most supported following IMR’s recommendation of 6-year rotations or apply even stricter regulations. Only the industry maintained its position for the status quo of five years.

The main industrial actor argued that the long history of mechanical kelp harvesting proves that the practice is sustainable, and that there is enough knowledge to show that today’s practices have no significant effects on kelp ecosystems. They also questioned the additional ecological benefits a fully vs. partly re-colonized kelp forest presents for biodiversity and the sustainability of harvesting. In contrast, the County Governor of Trøndelag argued that the lack of knowledge of the effects on the totality of species found in kelp forests, warranted a precautionary approach and that IMR’s recommendation of allowing more time for recovery should be carefully considered.

After receiving recommendations from the Advisory Group, the DoF were responsible for defining the regional regulations for kelp harvesting for the next five-year cycle. Opening an area for kelp harvesting, which a revised regulation implies, can however only happen after consultation with the Norwegian Environment Agency (NEA) to ensure that the cross-sectoral Nature Diversity Act is sufficiently considered.

In their comments on the draft report, NEA commended the County Council for facilitating a public hearing that “enables broader perspectives and inputs to [the regulation of] kelp harvesting”. However, the NEA asserted that the general principles in the Nature Diversity Act were not duly considered by the Advisory Group, nor by the DoF in their decision-making, taking a different interpretation of the regulations. The NEA considers that the regulations mean that kelp trawling is prohibited but may be allowed in specific areas, but only after sufficient consideration of implications for the ecosystem. This conflicts with the interpretation of the regulations in the advisory group, whereby not opening areas for harvesting would warrant justification. Despite this, NEA supported the advisory group’s recommendation to reduce the frequency of harvesting but considered that 8-year harvesting cycles should be implemented. Lastly, the NEA criticised the consultation process between DoF and NEA, and what they see as weak coordination between the Marine Resources Act and the Nature Diversity Act.

The final revised kelp harvesting regulation for Trøndelag County was issued by DoF on October 1st 2019. In their justification, DoF underlines their mandate to balance economic value-creation and biological sustainability. The scientific basis and approach taken by the Advisory Group is defended based on reference to input given by several knowledge providers (IMR, NIVA and NINA). The new regulation is presented as ‘a new management strategy’ based on the work of the advisory group. However, the five-year harvesting cycle was maintained, contrary to the majority of the Advisory Group, advocating for longer cycles to allow recovery, or IMR’s repeated recommendations that one could, as an alternative to extending harvesting cycles, implement a model with “areas to be harvested” and “areas to be protected” within the harvesting zones. DoF argued that harvesting “actually already takes place after a field vs. pristine forest area principle of an alternative sustainable management model”.³⁷ According to DoF, vessel

³⁷ Harvesting data that is only available to them and was not part of the knowledge base for the Advisory Group.

data shows that kelp harvesting is concentrated to small areas within the available harvesting zones and as a result, large parts of the zones are left untouched.³⁸ Harvesting in practice can thus be interpreted as not as extensive as the plans and regulations allow for, leaving the DoF to conclude that it is biologically sustainable to maintain the current five-year cycle.

There were strong reactions on the new regulation from several members of the Advisory Group. The group’s chairman, representing Trøndelag County Council, made the following statement once the new regulation was set: “We are surprised and disappointed. This time around we thought there would be change, but then we realise that everything is as before [...]. There are a number of municipalities and individuals, practitioners in other sectors and organization that have made well-justified and scientific contributions.”³⁹ This statement indicates the disillusion with the process expressed by several actors and the disappointment that efforts made to advance knowledge and modify the regulation were unheeded.

6. Discussion

Based on the analysis of the developing governance regimes of kelp harvesting in Scotland and Norway, we discuss the results by considering how they reflect identified attributes of adaptive governance: 1) local governance and public participation; 2) use of knowledge; and 3) legal adaptive capacity. An overview of the results is presented in Table 1.

6.1. Local governance and participation

The cases demonstrate different challenges in the inclusion of non-government actors, including civil society, and in ensuring influence on decision-making from sub-national scales. In Scotland, participation and representation occurred through existing rules and mechanisms, and actors became active in response to the proposed harvesting activity through the regulatory regime and, given a ‘window of opportunity’, influenced the development of new primary legislation in parliament. Using social media and other means, civil society actors connected with like-minded individuals leading to the emergence of an informal social network and a public campaign which exerted social and political pressure and resulted in legal restriction of kelp harvesting. The power of individual leadership and networks was evident as is important in adaptive governance (Österblom and Folke, 2013) leading to a system response to societal concerns regarding socio-economic and ecological impacts. However, processes remain largely hierarchical with varying levels of influence from different actors, rather than power-sharing where decision-making is devolved (Greenhill et al., 2020), i.e. ‘weakly’ polycentric (Galaz et al., 2012).

In Norway, the revision of regional regulations in 2019 included broader participation in the governance process following critique of the lack of local influence on kelp harvesting practices in previous revision rounds. Involvement of local authorities and stakeholders in the advisory group and the public hearing brought in new knowledge, perspectives and experiences, specific to the regional context, in line with adaptive governance. However, although participatory, the regional recommendations from this process were not duly reflected in the new harvesting regulations established by DoF. This led to frustration and disappointment among regional actors who proved to have little

³⁸ Directorate of Fisheries to Trøndelag County Council [and others], *Ny forskrift om høsting av tare i Møre og Romsdal og Trøndelag med ikrafttredelse 1. oktober 2019*, 27.09.2019.

³⁹ «Frykter livet på tarebankene raseres – mener Fiskeridirektoratet opptrer udemokratisk», NRK 16.12.2019 https://www.nrk.no/trondelag/fiskere_-fagfolk-og-politikere-ville-ha-mindre-taretraling_-fiskeridirektoratet-var-ikke-enig-1.14825027.

Table 1
Overview of adaptive governance in kelp harvesting management in Scotland and Norway.

Dimension	SCOTLAND	NORWAY
Local governance and participation	National, hierarchical processes prevail but participation of civil society and other actors is evident and influential. Civil society responded to a 'window of opportunity' presented by legislative development in Parliament, leading to regime change and strict controls on harvesting. Public campaign based on leadership and networking between individuals and groups operating across scales to influence governance. Potential for collective decision-making at smaller scales possible but not implemented. Lack of consensus-building.	Revision of regional regulations included broader participation of local authorities and stakeholders, through an advisory group and public hearing. Recommendations from the regional participatory process was overruled by the mandate and jurisdiction of the Directorate of Fisheries in setting the final regulation. Power and authority did not change – legal provisions necessary to legitimise the participatory process. Mechanisms for local governance not used. Lack of consensus-building.
Use of knowledge	Highly precautionary approach due to scientific uncertainty regarding ecosystem recovery. Public campaign well-informed but emotive and based on opinions developed through media and social media. Lack of evidence and mechanisms to debate and consider evidence of ecological and socioeconomic effects, to negotiate the risks and benefits.	Five-year review of regulations provides an adaptive process for incorporating new science. Scientific evidence was contested and used to argue for different positions. Wider participation brought in local knowledge but this were not considered in decision-making. Difficulties in integrating local knowledge and scientific findings at different scales. Different views of a 'precautionary approach' and how to proceed given high uncertainty.
Legal adaptive capacity	Highly dynamic process with governance evolving rapidly in response to proposed activity and societal concerns. Adopted amendment potentially 'maladaptive' as it precludes any future adaptive management of commercial kelp harvesting. Experimenting with high uncertainty is incompatible with conservation legislation. Poor coherence between the new Scottish Crown Estate Act 2019 and existing licensing under Marine (Scotland) Act 2010	Legal process for revision of regional regulations represents adaptive capacity for amending rules over time. Legally-required co-ordination between two government departments (DoF and NEA) problematic due to overlapping responsibilities for kelp – as an economic resource or conservation feature, respectively.

influence on decision-making and policy outcomes. The regional revision process was designed to open up and include multiple perspectives but was overruled by the mandate and jurisdiction of the DoF, which is not legally bound to follow the recommendations in their final decision. By maintaining the status quo on harvesting cycles, DoF thus undermined the legitimacy of the regional participation in the process.

Neither case demonstrates the empowerment of actors in collective decision-making at smaller scales deemed essential for adaptive governance. Yet, in each country there are existing and developing mechanisms intended to enable planning and management of coastal activities

at regional scale. There is a policy trend towards local governance in Scotland and a key aspect of the wider SCE Act specifically promotes devolved ownership and management of certain marine assets, including kelp forests, but these have not yet been meaningfully implemented (Greenhill et al., 2020). Partnership-led regional marine planning is also being implemented in Scotland and is designed to increase local ownership of decision making, but it has been shown to be of limited influence in relation to government-led top-down policy, planning and management processes (Greenhill et al., 2020). Similarly, the spatial planning powers granted to municipalities under the *Planning and Building Act (2008)* in Norway can in principle devolve authority to local and regional governance body for more localized kelp management. However, previous local attempts to manage marine resources has been thwarted by national authorities, and the outcome of the regional kelp regulation reinforces the dominant power of the national level in governing marine resources under the Marine Resource Act. The limited empowerment of local processes and the engagement of local stakeholders in decision-making, presents a missed opportunity for adaptive governance of kelp harvesting in both cases.

This underlines a classic critique of participation, namely that active involvement of stakeholders must also allow for actual influence on decision-making to be considered legitimate (Rydin and Pennington, 2000). Without this, the willingness of local actors to engage in similar processes in the future may be compromised and may in turn influence the long-term adaptive capacity of the system as relevant experiences, knowledge and perspectives are not incorporated into decision-making. In Norway, the reactions to the final regulation, from both local and regional actors who had taken part in the revision process, are testament to the unmet expectations and disappointment with the participatory process.

Further, the governance processes did not support consensus-building and collective decision-making and rather sustained diverging perspectives on kelp harvesting. In Norway, local and regional interests, and the industry clashed in the advisory group and tensions persisted, and were even reinforced throughout the process. The notion that the process would enable bridging fundamentally diverging perspectives on the kelp resource is thus highly optimistic (Cleaver and Whaley, 2018). Similarly in Scotland, the influence of the public campaign on the parliamentary process was criticized for being unbalanced in terms of available evidence and the time to debate and consider it fairly. In the regulatory process the multiple opinions and perspectives of consultees are all presented by the regulator with no mediation of how these conflicting views can be addressed in a management decision. Achieving consensus is shown to be problematic (and likely an unrealistic goal in adaptive governance) but governance processes could more effectively consider and mediate different perspectives to ensure fair outcomes.

6.2. The use of knowledge

In adaptive governance, the role of knowledge and how it is used including in experimentation and learning is critical (Sandström et al., 2020), but the use of knowledge, particularly scientific, emerged as a key challenge in Scotland as well as Norway. As described in 6.3, the ambition of the Norwegian advisory group to revise the regulation using the best available scientific knowledge was shown to be complicated and rife with tensions. The same scientific knowledge and recommendations from IMR were contested and used strategically, across the board, to argue for respective positions rather than as a basis for unanimous recommendations.

The question of what constitutes relevant knowledge was also contested in the Norwegian process. The local knowledge of fishermen and other local resource users was reduced to anecdotes or misguided observations, with emphasis on scientific recommendations as the acceptable 'evidence'. Further, issues of scale were problematic in relating scientific findings and local knowledge. Scientific modelling

exercises on kelp biomass are aggregated to the national or sometimes the regional level, while observations of negative impacts of kelp harvesting described in terms of declines of fish stocks are observed at a very local scale and were effectively excluded from the process. This points to a general difficulty in including non-scientific knowledge in environmental decision-making (Asdal, 2008), and the integration of local and scientific knowledge advocated by adaptive governance.

The regulatory process in Scotland focussed on the availability of scientific evidence regarding ecological effects and aims at reducing uncertainty through a managerial approach. Given the significant uncertainty regarding ecological effects, a precautionary approach of advising a small-scale project was advocated. However, attributing changes to ecosystem functioning to the impacts of kelp harvesting is rife with uncertainties, and accommodating uncertainty for the purpose of learning is incompatible with legislative requirements (see 6.3). In any case, the 'overruling' amendment adopted through the parliamentary process prevents such an approach. This process was influenced by a range of knowledge and opinions, including the public campaign which was well-informed and emotive and based on knowledge promoted by ENGOs, using media and social media. There was an acknowledged lack of evidence regarding the impacts or potential benefits of kelp harvesting and opportunity to evaluate the issue. Mechanisms that could consider knowledge in a balanced way and to debate and negotiate the risks and benefits were unavailable and sharing of knowledge and analytical deliberation to enable adaptive governance was thus limited.

Different views on how to apply a precautionary approach in the light of uncertainty also emerged. In Norway, several actors, including regional authorities and fisheries associations, argued that uncertainty regarding potential ecosystem impacts justified reducing the frequency of harvesting cycles until more conclusive evidence is available. In contrast, the industry argued that negative impacts on the kelp ecosystems must be proven to justify any changes to harvesting practices. Iterative learning, emphasized by adaptive governance, in this case is thus contingent on who has the prerogative to interpret science and to decide on what practices that may be considered sustainable or not.

While the revised regulation from DoF maintains five-year harvesting cycles, thereby not aligned with the initial recommendation from IMR to increase by one year, arguments used by DoF to justify this draw on a new way of thinking about kelp harvesting in terms of pristine vs. harvested fields. One the one hand, the suggested model can be seen as based on new arguments for maintaining the status-quo, without following new knowledge made available through IMR's recommendations. On the other hand, this may signal a learning-based approach to kelp management. However, learning in this case is based on harvesting data which was only available to DoF and the industry, rather than broader learning across different stakeholders. The confidentiality of the data that the new management strategy rests on may therefore limit the legitimacy of the governance regime in the future. The extent to which this represents adaptive management depends on how new knowledge and data are made available, incorporated and taken into account in management decisions in the next revision rounds.

Other challenges to adaptive management were evident in the debate in Scotland, including resourcing and accountability of such management. Arguments were made that industry should fund any adaptive management of common pool resources where they were ultimately the primary beneficiary. Government-controlled, non-commercial adaptive management was proposed to enable a 'step-wise' approach necessary for learning, but without the presumption of scaling up to the scale required by industry to be economically feasible. However, community-led trials and pilot studies could provide ability to secure local benefits, as well as incorporate local opinion and knowledge alongside scientific analysis of ecological effects.

6.3. Legal adaptive capacity

Here, we explore the policy and legislative conditions and their role

in supporting or constraining adaptive governance. The Norwegian governance arrangements for kelp harvesting is an adaptive process since it requires the regulations to be renewed every five years, based on updated scientific understanding and with participation of the local and regional interests. In principle, the legal provision for repeated and cyclic review of regional regulations provides an opportunity for change, through a learning-based approach, and indicates higher legal adaptive capacity than in Scotland. However, as described above, this process is shown to be problematic in practice, given the lack of agreement on the use of knowledge and unclear mandate of local actors, particularly since authority is maintained centrally and these agencies dominated outcomes.

The Norwegian case also illustrates a lack of coordination between the Marine Resource Act, administered by DoF, and the Nature Diversity Act, administered by NEA. Although interdepartmental coordination between the two directorates is legally required, the form and content of this coordination is not clearly defined. Furthermore, the two directorates have different legal objectives in kelp management which are difficult to integrate. A regulatory process that adheres to the Marine Resources Act renders broader ecosystems concerns, for example the role of kelp in supporting seabirds, to be outside its' scope. In Norway, a sectoral logic still underlines politics and management of natural resources (Sandersen and Kvalvik, 2015) and difficulties are indicated in implementing an ecosystem-based management approach, as required by the Nature Diversity Act, through existing and sector-specific governance (Knol, 2013). This may explain why NEA continues to raise objections to kelp harvesting based on wider ecosystem concerns, and why the DoF do not view NEA's input as relevant to their regulation. The adaptive capacity of the Marine Resource Act must thus be contrasted with the rigidity of the sectoral principles and indicates difficulties of implementing ecosystem-based and adaptive governance within an established governance system, where existing mandates remain unchanged.

In Scotland, legal provisions are available to support adaptive management as a general approach, including national policy in the NMP⁴⁰, and the precautionary principle, and through the regulatory process applicable to any licensed activities at sea (where monitoring requirements can be appended as conditions of licenses to assess actual effects). New legal provisions also define opportunities for devolved, community-based management of certain marine assets including kelp through the SCE Act. However, the adoption of the amendment to the SCE Act specifically restricting kelp removal prevents these activities from occurring and these mechanisms being used. Although in line with nature conservation advice, the amendment can be considered *mal-adaptive* to the extent it presents a legal barrier to future adaptive governance of kelp harvesting and cannot be revisited in light of new circumstances or knowledge⁴¹ (Soinnen and Platjouw 2018), including at small scale. While responding to broad public concern and protecting an ecologically important habitat, future decisions based on the relative merits and disadvantages in particular settings are precluded. This is pertinent since the distribution of kelp is increasing in response to climate change-related ocean warming in both Norway and Scotland (Burrows et al., 2017) which may lead to a larger resource and potential socio-economic opportunities.

Legal adaptive capacity of the regulatory process indicates challenges in implementing adaptive approaches in Scotland. In granting a license, strict conservation requirements must be met including

⁴⁰ GEN20: Adaptive management: Adaptive management practices should take account of new data and information in decision making, informing future decisions and future iterations of policy (Scottish Government, 2018: 33).

⁴¹ In the UK, the concept of parliamentary sovereignty means that legislation can only be amended or revoked by Parliament, not the courts (as would be the case in case law) and primary legislation (the SCE Act and amendment) is therefore of low adaptability.

demonstrating ‘beyond reasonable scientific doubt’ that the proposed activity will not adversely affect protected habitats and species. Accommodating uncertainty for the purpose of learning is incompatible with conservation legislative requirements, which limits the potential for adaptive management (Craig and Ruhl, 2014). While adaptive management is supported in government policy, the standard approach to licensing of any activity based on the regulations does not allow risk to be taken for the purposes of learning. This illustrates the challenges of enabling adaptive governance in highly regulated systems (Cosens et al., 2018). Tension is noted between policy supporting adaptive approaches and policy addressing goals of preservation and conservation, tending to be of limited legal adaptive capacity and less able to adapt to changing conditions (Camacho and Glicksman, 2016).

7. Conclusion

In this paper, we analysed the governance regimes for kelp harvesting in Scotland and Norway. While the ecological and historical contexts are similar, approaches to management of kelp harvesting are markedly different. A large-scale industry is well-established in Norway based on a regional management regime which assigns harvesting areas, and which is periodically reviewed. Further regions are likely to be opened for harvesting, particularly in Northern Norway. In Scotland, where no large-scale industry exists as yet, the governance regime developed rapidly in response to a commercial proposal for an individual license, based on the Norwegian model, to which stakeholder reaction was strongly negative, and a legal amendment was adopted which effectively bans the activity from occurring in Scottish waters.

Across the cases, aspects of adaptive governance are observed but with several constraints. The Norwegian governance arrangements for kelp harvesting present the basis of an adaptive governance approach, with an established review process based on nationally coordinated monitoring of harvested areas and involvement of multiple interests across scales. However, attempts to promote a more locally relevant and inclusive process were undermined by the prevailing authority of national bodies, as well as a lack of local mandate and coordination between relevant legislative instruments. In Scotland, co-operation between organisations and informal networks were highly influential in the development of primary legislation. While widely considered a success and ensuring strict protection of an important habitat, our analysis show that the process lacked balanced consideration of evidence and knowledge, and the rigid outcome prevents further consideration and adaptation to new knowledge and circumstances.

Our paper reveals several obstacles to knowledge-based adaptive governance applied in practice. Firstly, the cases show that it is insufficient to create the processes of engagement and participation - these must be associated with greater level of empowerment in the process to be influential in governance and remain legitimate (cf. Chapin et al., 2014). Secondly, poor integration between administrative levels compromises governance outcomes and insufficient co-ordination leads to undermining and inefficiencies rather than beneficial redundancy, shown in Scotland between the arena of legislative development and the regulatory process, and between legal instruments in Norway. The lack of co-ordination and integration, including between new and old legislative instruments, compromises the adaptive capacity of a governance regime.

Third, eliciting and processing of views and opinions based on different knowledge forms was compromised. In each case, consensus was elusive and diverging perspectives on kelp harvesting were sustained even though final outcomes were reached. This indicates a need for processes to deliberate and consider multiple viewpoints and types of knowledge, across different scales, to enable social learning and consensus-building. Central authority (government) was shown to be a poor mediator in both cases, whether legally constrained or facing pressure from elsewhere, and an independent, non-state actor appears necessary to fulfil this mediating function and ensure legitimacy.

Finally, the adaptive capacity of the various legal instruments defining the governance regime are of crucial importance. Its capacity to both enable on-going revision (as in Norway) and limit future change (in Scotland) is starkly different and the design of legal instruments must consider the relationship with other policy and the potential need to adapt over time.

It is critical that kelp forests are protected and managed appropriately, given the diverse ecosystems they support as well as their role in sequestration of carbon (“blue carbon”⁴²) and coastal protection (Burrows et al., 2017). This paper does not argue in support of or against harvesting, but significant uncertainty around impacts on kelp forests and associated ecosystem recovery necessitates an adaptive and learning-based approach. The ‘kelp issue’ is just one example of the increasing complex governance challenges as natural resources are more contested and threatened, while their value to society is increasingly understood. Balancing competing demands and managing trade-offs places focus on the need for legitimate and effective governance which incorporates balanced views of available evidence and perspectives. This requires more defined and inclusive adaptive management practice, addressing the barriers and opportunities identified through this study.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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