



## GENetic diversity exploitation for Innovative macro-ALGal biorefinery

### *Deliverable 6.8*

Manuscript (for submission to peer-reviewed journal)  
describing results of social licence study at test farm sites

(M42, June 2020)

**Planned delivery date:** June 2020 (M42)

**Actual submission date:** 15/07/2020

**Work Package:** WP6

**Work Package Leader:** Ciimar

**Deliverable Leader:** Scottish Association for Marine Science

**Version:** 1.0

**Start date of the project:** January 1<sup>st</sup>, 2017

<b>Project co-funded by the European Commission within the Horizon 2020 Programme (2014-2020)</b>	
<b>Dissemination Level</b>	
<b>PU</b> Public	
<b>CI</b> Classified, as referred to Commission Decision 2001/844/EC	
<b>CO</b> Confidential, only for members of the consortium (including the Commission Services)	



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 727892 (GENIALG). This output reflects only the author's view and the European Union cannot be held responsible for any use that may be made of the information contained therein.

## Contents

<b>Summary</b> .....	5
<b>Paper 1: Is social license relevant for seaweed cultivation in Europe?</b> .....	6
<b>Abstract</b> .....	6
<b>Acknowledgements</b> .....	6
1. Introduction.....	7
2. Context.....	9
2.1. Scotland.....	11
2.2. France.....	12
3. Methods.....	12
4. Results.....	13
4.1. Scotland.....	14
Mechanical kelp dredging debate improved awareness of the necessity for community engagement .....	14
Ownership, entrepreneurial confidence, and scale.....	14
Communication, accountability, and regulation .....	15
4.2. France.....	16
Scale of farm and fear for the environment .....	16
Information, misinformation, and differing perceptions of ‘evidence’ .....	16
Communication, and the regulatory framework .....	17
4.3. Producer opinions .....	18
Interactions with other stakeholders and marine users .....	18
Communication, collaboration and engagement.....	18
5. Discussion: Social license is relevant for seaweed cultivation .....	19
5.1. Legitimacy .....	19
5.2. Trust .....	20
5.3. Consent .....	21
6. Conclusions.....	21
Appendix 1.....	22
References.....	23
<b>Paper 2: Commercial seaweed cultivation in Scotland and the social pillar of sustainability: A Q-method approach to characterising key stakeholder perspectives</b> .....	28
<b>Abstract</b> .....	28
<b>Acknowledgements</b> .....	28



1. Introduction.....	29
1.1 Current seaweed cultivation consenting regime .....	30
1.2 Seaweed harvesting and cultivation context .....	31
2. Theoretical Framework .....	32
2.1 Legitimacy .....	32
2.2 Sustainability and social license .....	33
3. Q Methodology .....	34
3.1 Administering the Q sort.....	35
4. Findings.....	36
4.1 Factor 1 – Environmental and social sustainability focus.....	37
4.2 Factor 2 –Economic and environmental sustainability with a global market focus.....	37
4.3 Factor 3 –Social and institutional sustainability with local jobs as a priority.....	38
4.4 Cross-factor consensus.....	38
5. What could a successful seaweed cultivation sector look like?.....	38
5.1 The social importance of environmental sustainability .....	39
5.2 Institutional sustainability and the issue of scale .....	40
5.3 Economic sustainability and which market to target .....	40
6. Predicting legitimacy for seaweed cultivation .....	41
6.1 Implications for theory and practice for sustainable seaweed cultivation.....	42
References.....	42



## Summary

The purpose of this report is to fulfil Deliverable 6.8: *‘Manuscript (for submission to peer-reviewed journal) describing results of social licence study at test farm sites’*. This deliverable was created in Task 6.4.1 where the aim was to *‘Work with local communities at test sites to identify means for achieving social licence for the development of seaweed aquaculture.’* It presents two papers describing the results of two studies using different methodologies for exploring social license for seaweed cultivation. These papers are based research activities over the duration of the GENIALG project that included 40 formal surveys and interviews, four large stakeholder workshops, observed stakeholder site-visits, document analysis and policy overviews. Participants in the surveys, interviews, workshops and site visits represented seaweed cultivation, science and research, local community associations, environmental NGOs, wild seaweed harvesters, marine industry supply-chain, policy-makers, and regulators. These papers are presented in this document in the same format as they were submitted to the journals and include the title, abstract, authors, keywords, references and appendices. These papers and their findings will be open access publications (once accepted), and also form the basis of a chapter for Deliverable 6.9, the best practice manual for seaweed cultivation.

Paper 1, titled, *‘Is social license relevant for seaweed cultivation in Europe?’* has been submitted to the journal *Aquaculture* (11/06/2020). This manuscript investigates the societal challenges and demands that seaweed cultivation, as a nascent industry, raises across different European countries. It uses a qualitative approach with two in-depth case studies (Scotland and France) and a survey of seaweed cultivation organisations based in five different countries in the European Economic area, to explore the potential for seaweed cultivation to garner social license to operate. It shows that there are linkages between site-scale histories/ context and social acceptability, and more specifically, that risk perceptions of other industries and naturally occurring phenomena can influence perceptions of seaweed cultivation. The results describe a clear relationship between scale and ownership models of cultivation operations and potential for garnering social license, where smaller locally owned farms are more acceptable than large-scale multi-national owned farms.

Paper 2, titled, *‘Commercial seaweed cultivation in Scotland and the social pillar of sustainability: A Q-method approach to characterising key stakeholder perspectives.’* has been submitted to the journal *Global Environmental Change* (18/05/2020). This paper was previously reviewed and accepted with major revisions to the *Journal of Cleaner Production* (14/04/2020)<sup>1</sup>. This manuscript investigates the societal challenges and demands that seaweed cultivation, as a new activity, raises in the Scottish coastal zone. It uses a Q-method approach and an analytical framework based on in-put legitimacy, social license to operate and the four pillars of sustainability. The Q-methodology analysis elicits three key narratives with both diverging and shared views on the parameters for a legitimate and socially acceptable seaweed cultivation industry. The first suggests that social and environmental sustainability are paramount to social acceptability, the second reveals a juxtaposition between environmental sustainability and economic viability, and the third reflects the findings of Paper 1, where a smaller scale, locally owned seaweed cultivation industry is more likely to garner social license to operate. Finally, the results show that seaweed aquaculture is an example of an activity that is subject to specific contexts and place resulting in multiple spatial, temporal and socio-political interactions.

---

<sup>1</sup> The changes requested by one of the three reviewers required the removal of Q-method. As Q-method formed the very basis of the paper, the authors chose to submit the manuscript to another journal.

## Paper 1: Is social license relevant for seaweed cultivation in Europe?

Suzannah-Lynn Billing, Julie Rostan, Paul Tett, Adrian Macleod

Scottish Association for Marine Science, Oban, PA37 1QA, Scotland

### Abstract

The need for more sustainable sources of food, chemicals, and energy, combined with the European Union's Blue Growth Agenda and national policies of European Economic Area member states, has facilitated increasing interest in the cultivation of seaweed in European waters. There have been several research projects looking at the economic and environmental feasibility of seaweed cultivation as a low carbon commercial endeavour, however there is very little in the way of contextual social research. Given mounting evidence of a decline in social acceptability of aquaculture activities (both shellfish and finfish) at a site level, it is imperative to improve understanding of where seaweed cultivation might fit within this picture. The aim of this study is to explore site-scale social interactions of seaweed cultivation using social license to operate as the analysis framework. Two in-depth case studies were chosen to cover a developing commercial seaweed cultivation industry (France) and an embryonic one (Scotland) in addition to a survey of seaweed cultivation organisations across five European countries. The findings show that interpersonal relationships, perceptions of environmental risk, scale of decision-making and of operations, and communication were key to local perceptions of seaweed cultivation operations in both case studies. The views of seaweed cultivation organisations on social interactions and the usefulness of the social license to operate concept for this emergent industry is discussed.

**Key words:** social license, seaweed cultivation, trust, legitimacy, consent

### Acknowledgements

The authors would like to acknowledge the funding provided to the GENIALG project through the European Union's Horizon 2020 Framework Programme under grant agreement No 727892. Likewise, the authors acknowledge the funding provided to the MacroFuels project through the European Union's Horizon 2020 research and innovation programme under grant agreement No 654010. We would also like to thank the participants in this study, who provided their expertise and opinions voluntarily and the SAMS Seaweed Team for sharing their expertise.

## 1. Introduction

The bulk of seaweed (macro-algae) production is in China, Indonesia and the Philippines [1]. However, the need for more sustainable sources of food, chemicals, and energy, combined with the European Union's Blue Growth Agenda and national policies of European Economic Area member states, interest in the cultivation of seaweed in European waters is increasing [2]. Over the last decade there have been several European research projects that have focussed on different aspects of macro-algae cultivation. These include, among others; cultivation techniques and materials (see for example AT-SEA <http://www.atsea-project.eu/>); bio-refinery, genetics and diseases (see for example GENIALG <https://genialgproject.eu/>) and; development of products (see for example Macro Cascade <https://www.bbi-europe.eu/projects/macrocascade> and MacroFuels <https://www.macrofuels.eu/>). Pilot cultivation projects have helped to validate some approaches at smaller scales as well as develop a basic understanding of the environmental changes associated with this activity. However, seaweed cultivation in Europe is not yet widely commercially feasible [3], and the development of 'large-scale' cultivation projects will require a more complete understanding of the environmental interactions to fully assess and manage risk [4], [5]. To achieve this, a systematic approach to quantifying the ecological carrying capacity of water bodies with respect to seaweed cultivation will be needed.

In addition there is a need to assess social carrying capacity. Given mounting evidence that one of the most complex barriers to aquaculture growth in developed nations is related to social acceptability and site level social interactions [6]–[10], it is imperative to improve understanding of where seaweed cultivation might fit within this picture. However, there is a severe deficiency of peer-reviewed studies in Europe exploring the potential social interactions of this emergent sector [11]. This study aims to contribute to filling this gap by providing empirical evidence of site scale social interactions of seaweed cultivation, using the social licence to operate theory as a framework.

Social licence to operate (SLO) was a term coined by the extractive resources industry in the 1990's in an effort to try describe and better understand community-industry relationships [12]. The motivation for acknowledging these relationships was market-driven, where the profitability of the industry was being eroded by campaigns and litigation, started by local communities [13]. Boutilier and Thomson [14] define SLO as a term used to describe the informal processes by which communities approve of, accept or reject industrial developments. SLO specifically focusses on the measures that make an activity legitimate in the eyes of communities of place [15], [16] and in some cases, communities of interest [17]. The concept has been identified as one which could be developed into a useful framework for understanding and improving the way that industries [18] and scientific researchers [19] interact with local communities.

Since its origin, the idea of social licence has been extended from extractive industries to forestry [20], renewable energy ([21], conservation [19], [22], and aquaculture [9], [10], [23], [24]. Although SLO is a growing area of research [9], [16], the concept is however, not without criticism. One of the key arguments for using the term with caution is that there is no single definition which has been agreed on by those using or researching it [17]. However, the flexible nature of the term [25] and its adoption and understanding by industry and governmental agencies can also be considered its strength [26]. Literature reveals that there are several characteristics that are associated with having or not having SLO. [12], [15] and [10] advise that understanding of the local context and the consent of local communities is crucial to gaining and maintaining SLO, whereas [16], [20], [9], [27] focus on relationships and trust between communities, the activity operator, NGOs and regulators. Legitimacy features across much of this work [6], although it is often used interchangeably with SLO [17].

The study reported here was conducted between 2017 and 2019 as part of the H2020 GENIALG research project, the aim of which is to understand how to sustainably cultivate and use two species of European seaweeds: *Saccharina latissima* (sugar kelp) and the green alga *Ulva rigida* (sea lettuce). The purpose of the study was to explore the relationships between seaweed cultivation organisations and communities across Europe at a site-scale. In addition, we assessed how cultivating organisations view the concept of social license to operate, and whether they perceive it as useful for their activities. During the course of this research it became clear that there is confusion between the two different activities of wild harvesting of seaweed and seaweed cultivation. Table 1 provides the definitions of these terms.

**Table 1.** Definition of terms used in this paper.

<b>Term</b>	<b>Definition</b>
<i>Seaweed</i>	Aquatic multi-cellular photosynthesising organisms without roots.
<i>Seaweed cultivation</i>	The deliberate introduction of seaweed to the environment on/in human-made infrastructure either by seeding or transplanting young seaweed onto/ into human-made infrastructure or installing man-made infrastructure to allow seaweed spores to naturally establish and grow. Once the seaweed biomass has reached the desired size or is in need of removal it is harvested through manual or mechanical processes (built on the definition in [28]).
<i>Wild harvesting</i>	The removal of part or all of a wild living seaweed from its natural position of growth. Wild harvesting can include hand picking, hand cutting (with hand-held scissors or rake), and mechanical removal (built on the definition in [28]).
<i>Gathering</i>	The collection of any wild or cultivated seaweed no longer in the position of growth. This typically refers to beach/shore-cast seaweed (built on the definition in [28]).
<i>Social license</i>	<i>'The ongoing acceptance or approval of an operation by those local communities stakeholders that are affected by it and who can affect its profitability'</i> [29], seen here as consent based on trust and perceived legitimacy.
<i>Community of place/ local community</i>	A group of intercommunicating people who live in a particular geographical area. Used in this paper for communities that live within close proximity to a proposed seaweed cultivation site or the infrastructure required to run such an operation such as slipways, ports and harbours.
<i>Community of interest</i>	A group of people who share an interest in a specific subject area or activity, but who may be geographically dispersed.
<i>Stakeholder</i>	A person or organisation with a recognised interest in an operation or activity. E.g. regulators, businesses, environmental Non-Governmental Organisations, citizens.
<i>Legitimacy</i>	<i>"A generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs and</i>

	<i>definitions</i> " [30]. In the case of this paper we are describing it as the sense/ belief that an activity and its operator are deemed desirable, proper or appropriate by local communities and communities of interest [6], [26].
<i>Consent</i>	Permission for, or agreement to, action. Ideal consent is a free choice by a well-informed actor; community consent can be the simple aggregate of members' consents or the result of intercommunication. The grounds for consent depend on an examination, using the actor's or community's normative framework, of the potential outcomes of the action. For example, if the framework is utilitarian, the grounds might concern the balance of costs and benefits, perhaps calculated individually, perhaps with an eye to fair distribution over a community.
<i>Trust</i>	Broadly defined as belief in the truth, reliability or ability of someone or something. For example a shared state of mind that considers the operator and the regulatory regime to be trustworthy enough to carry out the activity in a way that is fair and consistent [9], [6].

## 2. Context

Scotland and France were chosen to facilitate a comparison between two development levels of seaweed cultivation. France is already cultivating for commercial markets and is the second largest producer in the EU [31]; Scotland has small and mostly research-related seaweed cultivation activities, but aspires to develop the industry further [32]. Table 2 compares the regulatory frameworks in the two countries.

**Table 2:** Operational governance/regulation of seaweed farming in France and Scotland. Few laws explicitly mention seaweed cultivation, and it is therefore regulated in the same way as shellfish farming. However there is a brief Scottish policy reference in the Seaweed Cultivation Policy Statement [33]. See Table 3 for acronym definitions.

Topic	France	Scotland
Use of seabed for moorings	Included in marine concession	Lease required from CES
Consent to development	Included in marine concession	Not required for marine operations; LA must consent terrestrial operations
Public consultation and consent	Application for concession considered by CCM; may be public enquiry	Not required for marine operations
Zoning for activity	Not currently? But may become explicit within DSF	Not explicit within NMP or RMP, but commercial farms can only operate in SWPA and SHA; no designated DMA
Permission to occupy sea space	Marine concession (for use of public waters) required from departmental Prefect	Marine Licence required from MS - LOT
Regulation of environmental impact	EIA and discharge consents not required; AFB, Agence de l'Eau, IFREMER, consulted	EIA and discharge consents not currently required; HRA may be needed if SNH so determines
Water (ecological/ environmental) quality	Managed by Agence de l'Eau in WFD coastal water bodies, AFB offshore	Managed by SEPA in WFD coastal water bodies, including special monitoring of SWPA
Biosecurity and bio-sanitary arrangements	Conseil supérieur d'hygiène publique de France (CSHPF)	Local seed recommended; operation in SHA & SHPA only
Permission to operate as a business		Will need an APBL from MS-FHI if treated like shellfish farms
Staffing and vessels	Farm vessels need navigation permit and muster roll; staff need professional qualifications	Adherence with all relevant Marine and Coastguard Agency regulations and certification requirements (several).

**Table 3.** List of acronyms from Table 2.

Acronym	Acronym phrase, France	Acronym	Acronym phrase, Scotland
Agence de l'Eau	(Regional) Water Boards, 6 in total	APBL	Aquaculture Production Business Licence
AFB	Agence française pour la Biodiversité	CES	Crown Estate Scotland, or subsidiary local non-profit organisation
CCM	(Departmental?) Commission des cultures marines, including representation from DDTM, AFB, IFREMER, CDPMEM, environmental groups	DMA	Disease management area, designated for prevention or treatment of disease
CDPMEM	Comité départemental des pêches maritimes et des élevages marins: deparatmental committee for marine fisheries and aquaculture, including local fishers and farmers	EIA	Environmental Impact Assessment
		FSS	Food Standards Scotland
DDTM	Direction Départementale des Territoires et de la Mer	LA	Local Authority (for Town & Country Planning), tpically a 'county' such as Argyll & Bute
DIRM	Direction interrégionale de la Mer, 4 in total, responsible for marine planning	HRA	Habitats Regulations Appraisal
DSF	Document stratégique de façade, Sea Basin strategy from DIRM	MS MS-LOT MSS MS-FHI	Marine Scotland, including MS Licensing Operations team Marine Scotland Science MS Fish Health Inspectorate
EIE	Etude d'impact environnemental	NMP	National Marine Plan
IFREMER	Institut français de recherche pour l'exploitation de la mer	SHA	(Officially designated) Shellfish Harvesting Area, FSS monitored for harmful algae and bacteria
		SWPA	(officially designated) Shellfish Water Protected Area, monitored by SEPA
		RMP RMPP	Regional Marine Plan, made by Regional Marine Planning Partnership: 11 in total, only 2 currently operational
		SEPA	Scottish Environment Protection Agency
		SNH	Scottish Natural Heritage

## 2.1. Scotland

As with many coastal and island communities in Europe, Scotland has a long history of seaweed use, dating back to at least the Iron Age, where it was used for fertiliser and fodder. From 1720 – 1840's industrial use of *Laminaria* (kelp) in bleaching, soap, and glass-manufacture processes was a significant source of income for Orkney and the Uists [34]. In the 1900's there were several revivals of use of seaweed in industry along the West Coast of Scotland, including for iodine and alginate production[28]. A detailed history can be found in [28]. This legacy of seaweed use continues today with several companies still conducting wild harvesting operations of a variety of seaweeds for several uses. All of these operations are relatively small-scale and high value. However, the Scottish Government and Local Authorities are looking to increase the use of Scotland's seaweed resources for economic and social development, particularly in Argyll and the Islands [35], [33]. In 2017 the Scottish

Government released a Seaweed Cultivation Policy Statement, in support of ‘small to medium scale’ seaweed farms [33]. At the same time, the Scottish Seaweed Industry Association welcomed an increase in membership numbers from 2016 – 2018, reflecting a return to interest in using seaweed as an economic resource and the potential for its use to sustain populations in remote and rural coastlines [36]. Seaweed cultivation in Scotland is still in its infancy with only a few small commercial operations and small experimental farms.

In 2018, a company based in the south of Scotland submitted a scoping report for harvesting up to 33,000 tonnes of kelp (*Laminaria hyperborea*) per year from the West and North Coast including the islands of Scotland for the purpose of alginate and nanocellulose production [37]. However, opposition to the plans were far reaching, resulting in a Change.org petition started by a local advocate in the West Highlands and signed by 14,000 people (October 2018) [38]. Voices of objection included natural historian and broadcaster Sir David Attenborough [39], the Scottish Green Party [40], and a spokesperson for the Natural History Museum [41]. In November 2018, the Scottish Parliament voted unanimously to include an amendment (14ZA) to the Scottish Crown Estate Bill (2018) prohibiting mechanical harvesting of five species of kelp, for the purposes of ‘commercial use’ [42].

## 2.2. France

Historically, seaweeds were used in France as a source of animal food, fertilizers or were burned for heating. From the 17<sup>th</sup> century, seaweed was extensively used in the glass industry to produce sodium bicarbonate extracted from ashes. Iodine production from seaweed started during the 19<sup>th</sup> century as well as the alginate industry and continues on today [43]. Most seaweed cultivation in France is located along the west coast in Brittany and Normandy. However, some developers are currently looking into the possibility of farming seaweed in the Mediterranean Sea. In 2012, French seaweed production was estimated around 70 000 tons/year from mechanical harvesting and hand harvesting. The production of seaweed from farming has increased from 50 tons in 2012 to 350 tons in 2015 [44] and significant sites of up to 150ha have since been authorised in Brittany [45]. Seven companies are currently registered as seaweed farmers by the CEVA algae technology & innovation center, and some of these companies have several farms [46].

In Brittany, where much of the seaweed cultivation industry is located, there are historical and current issues around a proliferation of green algae due to excessive nutrient run-off from intensive farming of maize, pigs, and chicken, and bay typography [49]. The decomposition of this algae results in hydrogen sulphide, which can be deadly to human and animals and is responsible for the deaths of two people and several wild boar [50]. Within the media, both local and international, and by some of the interviewees this green algae is described as macro-algae or seaweed (see for example <http://en.rfi.fr/environnement/20190718-france-sued-not-doing-enough-fight-killer-seaweed-brittany> and <https://www.theguardian.com/environment/2019/sep/08/it-can-kill-you-in-seconds-the-deadly-algae-on-brittanys-beaches> and, <https://www.anses.fr/en/content/green-algae-risks-surrounding-populations-walkers-and-workers> ).

## 3. Methods

Case studies of community opinion were carried out in Scotland and France, and were complemented by surveys of producer opinion in five seaweed cultivation organisations operating in five different countries in the European Economic Area. These countries are not listed to protect the anonymity of the producers. The survey focused on the local scale variables, comprising those that relate to site-scale seaweed cultivation operations and regulation, the local community, and community-operator

relationships, rather than larger scale interactions such as the global economic or regulatory environment [15].

This case study approach, drawing on methods in [51], was qualitative, and included primary sources from interviews triangulated with secondary sources from documents (i.e. planning applications, policies, and news articles) [52]. A range of stakeholders and community representatives (local and of place) were interviewed in both of these cases, detailed in Table 3. During the interviews, the terms ‘social license’ and/ or ‘social license to operate’ were not used by the interviewer. Rather the interviewer asked the participants to explain or describe the nature of the relationships that they had with the local community or the seaweed cultivation company. Interviews with French participants were conducted in French and then translated into English for analysis by the second author. All other interviews were conducted in English. The survey (appendix 1) included information on social license, so that participants could self-gauge their understanding of the concept and determine its relevance to their activities.

All of the data that were collected, from both the survey and the interviews, were thematically coded by the first author using the theoretical approach detailed by Braun and Clarke 2006 [53], and QSRNvivo 11 software. This led to the subheadings in the Results section. Final analysis, explored in the Discussion was based on the key attributes for social license found in the literature [24]; *trust*, *consent*, and *legitimacy*, the definitions of which can be found in Table 1.

This study was granted approval by the University of the Highlands and Islands Research Ethics Committee (approval number: OLETHSHE214).

## 4. Results

This section presents the findings for each in-depth case study according to the emergent themes, before describing the results from the producer survey. The results of this study refer to the period 2017-2019. We acknowledge that SLO may change over time [15], and have attempted to record perceptions of this through the narrative of development of seaweed cultivation by interviewees, particularly in France. Quotes from interviews are aggregated by case study rather than representation category, to ensure anonymity.

**Table 2.** Number of interviewees and stakeholder representation in the in-depth case studies.

Case study	Number of interviewees	Representation
Scotland (SC)	17	Certification organisation x1, Community organisation representative x2, Cultivation organisation x2, Harvester x2, Other interested parties x2, Politician x1, Regulator x1, Science and research x3, Supply-chain x3
France (FR)	14	Cultivation organisation x4, Potential cultivation organisation x2, Environmental NGO x1, Industry associations x1, Marine industries (not aquaculture) and local community associations x4, Regulator x1, Science and research x1

#### 4.1. Scotland

##### Mechanical kelp dredging debate improved awareness of the necessity for community engagement

The mechanical kelp harvesting debate was highly influential throughout the Scottish interviews. Comments ranged from support of the anti-kelp harvesting campaign to concern about the lack of scientific discussion before mechanical harvesting was banned. However, there was consensus that the absence of communication and engagement by the company with the local communities, fishers, and other small-scale seaweed harvesters already in operation, increased negativity towards the company and the idea of mechanical kelp harvesting as a whole. Fears from those in island locations included the threat of increased coastal erosion due to the removal or alteration of wave attenuating kelp beds and reduction in habitat for fish nurseries, on which the local inshore fishing industry relies. These concerns also appeared in the Scottish Government's Strategic Environmental Assessment for Wild Seaweed Harvesting [54]. The last paragraph of the campaign against mechanical harvesting [38] suggested an alternative to harvesting:

*“Kelp CAN BE FARMED. It is farmed in Norway, the Faeros and at Rathin Island between Ireland and Scotland. If alginate companies want kelp they must invest time in researching how they can make farming viable for them. Dredging the wild beds must never be an option.”*

For the interviewees, regardless of their category, the process of banning mechanical kelp harvesting heightened awareness of public perception and the importance of gaining local social license for any proposed seaweed farming activities. However, the reality of the difficulty of balancing social acceptance with economic and ecological pressures was highlighted. One provided a succinct summary of the issue; *“Social acceptance doesn't necessarily equate to commercial viability and environmental and commercial viability doesn't necessarily mean social acceptance”* (SC03). Despite clear recognition of the complexity of working towards sustainability, interviewees identified measures through which social license can be gained such as; *“getting communities on board”* (SC03) from the start and then *“carrying communities with you”* (SC15) as the industry develops. These two points were seen as the key to maintaining good community-industry relationships, and gaining the social approval most interviewees deemed necessary for seaweed cultivation activities to develop on a commercial scale.

##### Ownership, entrepreneurial confidence, and scale

The idea of 'commercial' or 'large-scale' scale seaweed cultivation resulted in varying opinions on the social challenges that these 'commercial' models would present. For example, when discussing ownership of large-scale farms by international companies, most interviewees wanted local jobs and benefits to be generated. This was of particular importance for interviewees talking about the context of the West Coast of Scotland, where depopulation and an ageing population [55] pose serious concerns for the economy, social services, and social cohesion [56]. However, most felt that the standard commercial model was not the “right” model for Scotland and that job provision by itself was not a strong enough argument for large-scale internationally owned seaweed farms. For example, one interviewee from the islands noted that *“Island thinking is that the sea doesn't belong to anyone”* (SC10) and privatisation of it through large-scale seaweed cultivation by international companies is considered undesirable. Others noted that international ownership would almost certainly result in less benefits to local communities.



Many interviewees spoke about a need for social innovation, where the goal is no longer profit for a few people, but decent pay for all those employed, and benefits for the rest of the community. The majority of interviewees envisaged that the industry would start small and locally owned, before being sold on to larger companies or being developed into cooperatives. Interviewees associated the concept of cooperatives with terms such as “*social entrepreneurship*” and “*sustainability*”. Most felt that a locally-based development of the industry should be accelerated. One participant argued strongly that Scotland should make a move in this sector as soon as possible and that confidence is required to take that step. They warned that “... *if we don’t [start seaweed cultivation] someone else will come in and do it. Do we really want that?*” (SC14). Comparisons were drawn with the salmon farming industry, where over the past 30 years individual farms operators were bought out, eventually leading to mostly international ownership [57], perceived by many of the interviewees as reducing community benefits and jobs. “*There are already companies, not naming names that are going for the approach where they don’t involve anyone local. I’m afraid that this will become the norm.*” (SC08). Loss of, or difficulty in gaining, social license for the activity was seen by all interviewees as a barrier to seaweed cultivation, should ownership be international and the scale large. “*It’s hard to change people’s views and it might be difficult to get them on board, but if it’s incomers, it will be even more difficult to gain acceptance.*” (SC15)

### Communication, accountability, and regulation

Communication was inextricably linked with accountability and regulation by all interviewees, with communication between local communities, regulators, and cultivators seen as key to the development of seaweed cultivation in a socially equitable manner. One interviewee surmised, “*The industry... needs to have as much community engagement as possible.*” (SC16) Many interviewees advised that if the farms were small scale and locally owned this communication would be “*organic*” in nature. Where the informal structures of the local community through social gatherings, school, clubs, personal friendships etc. would act as a sufficient conduit for information exchange about the seaweed farming activities. However, they also noted that if the farms were larger scale and owned outside of the local community, then a more formal communication strategy would be required. Some interviewees preferred the former mechanism to the latter as they felt that “*engagement strategies*” developed by professionals in communication rather than those working on the farm, would be less trustworthy. Conversely, others felt that engagement and communication is best left to those who have the skills to reach the best outcomes for everyone.

The current regulatory regime of the finfish aquaculture sector was seen by most interviewees as inefficient and unacceptable which, reduced their confidence in how the seaweed cultivation industry would be held accountable for their activities, should ownership become international and the industry large scale. However, when considering the current scale of the industry, most of the interviewees were calling for clarity of what the regulations are, and how they can feed into their development. There was recognition that statutory consultees such as Scottish Natural Heritage are engaging with the researchers and those in the sector to try and understand what is required. Nevertheless, there was also general discontent with the current licensing process required by Marine Scotland. Interviewees who were actual or potential cultivators reported the procedures as difficult to navigate, because definitions of scale, size, and operational techniques are based on shellfish aquaculture, rather than seaweed cultivation. “*Seaweed cultivation as a term is not specific enough. What does it actually mean? It’s as diverse as saying ‘I want to grow plants’*” (SC08). Most interviewees who were involved in seaweed cultivation would like to have the option to integrate it with other aquaculture, such as mussel or oyster farming, but felt the current licensing process did not accommodate such combinations.

One interviewee advised that for seaweed cultivation in Scotland to reach its full potential as well as develop in a socially sustainable manner, an adaptive management regime [58] based on reviewable

management plans could improve transparency and accountability of cultivation activities. This type of procedure might allow the industry to innovate with systems that are not limited monoculture, such as those that are multi-trophic, whilst also gaining social legitimacy for the activity(ies) [59]. *“Seaweed cultivators should learn what not to do from the salmon farming industry. It won’t be helped by the regulatory regime so it has to secure its own sustainability rather than just function under compliance.”* (SC04)

## 4.2. France

### Scale of farm and fear for the environment

Across both industry and community groups/ NGOs interviewed in France, social acceptability was inversely related to the scale of the industry and the area occupied by the farms, and also depended on the balance of local benefits and costs of seaweed cultivation operations. This was particularly true of interviewees representing community groups and environmental associations; *“It is important to stay at the local level, i.e. micro-economic. We do not take into account the national or European issues that today wish to develop what is called ‘blue gold’.”* (F03). These interviewees advised the strategies at a high level do not account for the impacts on normal social function at a local level. Examples included site abandonment (leaving semi-permanent structures such as moorings in the sea), introduction of invasive species, and seaweed washed ashore during storm events to decay on beaches.

Linked to this, the expansion of the seaweed cultivation industry reduced its acceptability to community groups and other local associations interviewed. This was also recognised by industry. *“Until recently there were not too many problems with social acceptability because we cultivated on smaller spaces... 3-4 hectares is fine but 100-150 is impossible.”* (F02). One interviewee noted that although they organised demonstrations against large-scale seaweed cultivation, they were supportive of smaller scale endeavours. *“We had three demonstrations and 500 people were gathered at each one... we offered 5 hectares for 5 years... their answer was no because it doesn’t correspond with their economic model... so you can see that we don’t always tell them ‘no’.”* (F09)

There were six interviewees who used the term ‘peur’ to describe perceptions of large-scale seaweed cultivation. The term ‘fear’ engenders unpleasant feelings related to harm, danger to livelihood or life. Within the context of loss of human life due to seaweed decomposition, it does not seem unreasonable that ‘fear’ is used, rather than a less emotive term such as ‘concern’ or ‘worry’. However, as exemplified by the next quote, the main focus for the interviewees was not for human life, but for the environment. *“The fears are essentially environmental. Aquaculture has a bad reputation, particularly for force-feeding livestock and environmental pollution. The seaweed farming is not an exception, the fear comes from the high density of monoculture and invasive species, which close to the odds, will necessarily colonize and impoverish the local marine flora.”* (F03).

### Information, misinformation, and differing perceptions of ‘evidence’

From the interviews it was evident that the technocratic and centralist approach to governance in France [60] is set against an emergence of grassroots arguments and local evidence gathering. The context of the localities where seaweed is cultivated in France has a strong influence on how the industry is perceived. Where there are already agricultural and aquaculture issues, these were projected onto the seaweed cultivation industry. For example, interviewees expressed concerns around monoculture, use of nutrients, and invasive species, associated with the proliferation of green algae around the coast of Brittany.

From the perspective of community associations and eNGOs, there was a lack of trust in the evidence that was produced by government commissioned scientists about seaweed cultivation. *“Generally we*

*find scientific reports are written in support of those who request them rather than to help with the decisions. It's like that in the applied sciences.” (F09). Equally, those who were in the cultivation business did not trust the process of engagement, either with communities or with regulatory agencies. One of the interviewees summed it up as; “I think there are 3 types of people: Those who do not want to hear anything, so there it is not worth it [talking to them], those who want to listen well but scientific arguments do not work because there is a lack of scientific culture, and the third category is open and ready to listen to our arguments.” (F10)*

This interviewee noted that where problems arise is with the second category of people, who make ad hominem decisions. Another interviewee felt similarly, where they advised that in order to expand a seaweed farm, one has to be in the right situation from a political perspective. In a study exploring the effects of ad hominem attacks on scientific claims, Barnes et al, found that assertions of conflict of interest were as influential as accusations of fraud on [61]. Nevertheless, both of these interviewees and another 11 stated that participation and communication with stakeholders and local communities was essential to the process of gaining a concession for seaweed cultivation. This suggests that the process is as much about relationships as it is about science. More specifically, it implies that it is about the relationships between select groups and individuals (e.g. members of environmental associations and project officers/ managers from companies), rather than members of the general public and operators. Following this narrative was the finding that dialogue is essential to trust in the evidence that is being presented to communities, associations and to NGOs. “I don't say that we are “all good” and that they are “all wrong”. We must link and gather points of view that are far apart. We are in a logic of co-construction, sharing of decisions and uses, but for this to work, it is necessary that people admit that we can share and therefore [have] discussions.” (F01)

However, this is evidently difficult to achieve when there are fundamental differences in understanding about how various aquaculture systems work and their associated environmental interactions. “... I see what happens on shellfish farming when there are meetings in the presence of the public when the locals condemn the activity in advance because of pollution when actually we have no inputs and we just make a product in its environment. We do not add food, we do not add antibiotics or anything.” (F05)

### Communication, and the regulatory framework

Communication was presented as a problematic topic for all interviewees. A conundrum was evident between producers and local NGO's/ associations. Some producers stated that they were less willing to communicate with local communities and other interest groups about their activities because they are concerned that they will “destroy” their proposals. On the other hand, local NGO's/ associations that object to some cultivation activities object on the very basis of lack of information. Intertwined with communication issues, is the regulatory framework, where many of the cultivators found it difficult to navigate and therefore difficult to know when the appropriate time for communication with stakeholders was.

When delving deeper into this issue, most of the interviewees advised that this is an area that requires improvement and compromise, mostly by industry, regulators, and the competent science authority. Transparency was seen as key to establishing better relationships. However, it was recognised by industry and acknowledged by NGOs/ associations that transparency will not always result in social acceptance for a seaweed cultivation activity. Further, interviewees within industry found it difficult to engage individuals who are not direct stakeholders. “But finally, if we do not do voluntary communication that is more targeted, there is little engagement from the public who are not directly concerned.” (F10)

However, interviewees also related communication issues to economic status, culture change, immigration and opinions on what are acceptable activities for the area. *“In coastal populations there are fewer and fewer people initially from the coast. Today, it's more urban people who come with money, they have paid a lot for the view they have from their garden.”* (F01)

### 4.3. Producer opinions

All of the producer organisations surveyed operate in close proximity to the coastline of their respective countries. In two cases, there are population centres of more than 40,000 people within sight of the operations. Four out five of the organisations surveyed cultivate for both experimental and commercial purposes, one cultivates solely for experimental purposes and only one cultivates on-shore. All of the organisations reported interactions with other stakeholders and marine users, and they all provide information about their activities in varying formats. Only one of the organisations had social license concepts built into their business plan, but all expressed that it is a useful concept for their activities.

#### Interactions with other stakeholders and marine users

All of the organisations perceived that the majority of stakeholders that they have had interactions with have a positive view of seaweed cultivation. Three organisations, two in the North East Atlantic and one in the North Sea, experienced negative interactions with other users of the marine environment, namely other aquaculture operators and the fishing industry. In two of the cases, the issue was the designation of the space for an activity other than fishing. This is not a new phenomenon, as one of the organisations experienced this problem in the 1980's. The same company also reported a reduction in conflict as the years went by and a move towards acceptance as people became used to their operations – a well-documented process within social acceptability literature (see for example [62], [63]).

Survey respondents expressed that communicating with, negotiating and understanding the position of the fishing industry during the licensing process does not necessarily end once the space has been allocated to seaweed cultivation by the governing authority. Two organisations experienced cases where fishers were fishing within the boundaries of the space allocated to seaweed cultivation, and in one case they had several instances where fishing was going on underneath the farm itself. Both companies are in communication with the people that were conducting these activities and are working together with them to mitigate the danger that this type of fishing poses. Equally, they recognised that the space granted to seaweed cultivation through formal licensing processes, is not culturally accepted by the fishing community; *‘Although we legally have the space, the fishers have historical and cultural ownership of the area – which is why we have to work them, rather than just rely on regulation’* (O3).

#### Communication, collaboration and engagement

All organisations surveyed were going beyond compliance with regulation in terms of communication and collaboration with local communities and other interested parties and stakeholders. This included having partnerships with local schools, NGOs, chefs, and community groups. Interestingly, all of the organisations differentiated between audiences, communication tools and content required for SLO as opposed to marketing. Figure 1 shows the links between SLO and the communication and engagement activities that the organisations identified during the survey. Four out of five of the organisations do not have any official communication or engagement strategy for their seaweed cultivation activities. However, all of them communicate with stakeholders through activities including: open days, seafood expos, websites, leaflets, and generally answering inquiries about the seaweed cultivation operations. When asked how they felt about the concept of SLO for seaweed cultivation, responses were varied. Some organisations agreed with SLO aspects relating to opportunities for expansion and cost of

producing the commodity, and others suggested that SLO provides the space to reflect on possible conflicts and come up with strategies for mitigation before they occur.

All organisations felt that they have SLO. However, only one recognised this as part of their business plan. Interestingly, this is the same organisation and the only organisation to suggest that social license is only relevant where engagement, transparency, and communication are not written into the business plan for the organisation. *‘The concept of SLO should not be necessary, for it must be dealt with in your business plan already!’* (O2). Another organisation suggested that because they are part of a larger institution that conducts environmental research, their farming activities by association, are granted SLO. *‘I think locals trust the brand of [O5] and so tolerate our farming activities, knowing that we believe in sustainability and will not carry out environmentally detrimental activities... If the farm was owned by an independent company, I think the situation could be more difficult since [the site] would need to be larger and more actively visited.’* (O5)

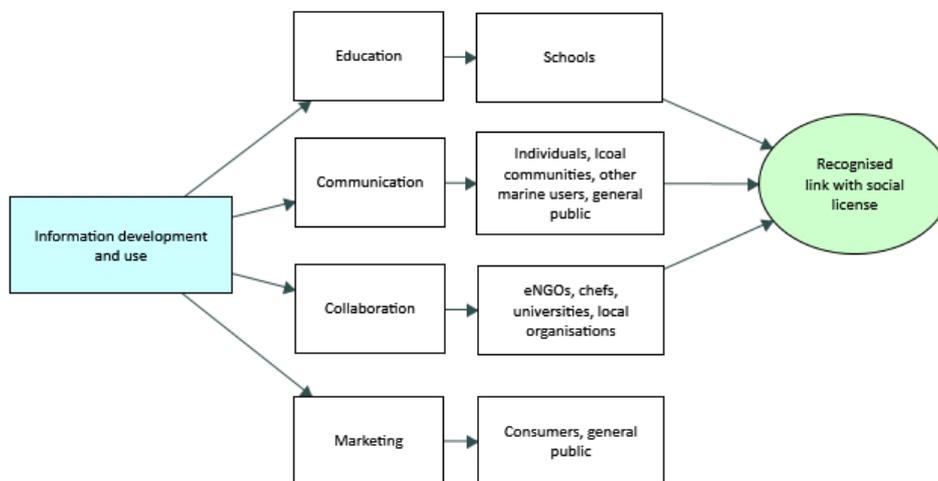


Figure 1. From left to right: the purpose of information that seaweed cultivation organisations have developed, the target audience, and recognition of links with social license as evidenced through the survey.

## 5. Discussion: Social license is relevant for seaweed cultivation

Below we consider the results of this study within our framework of three major social license attributes; trust, consent, and legitimacy. We describe how our results contribute to furthering detailed understanding of social license for the emergent European seaweed cultivation industry within different contexts, cultures, and marine and coastal resource use histories.

### 5.1. Legitimacy

The legitimacy of seaweed cultivation in the case studies was related to economic viability and potential local social and environmental opportunities and challenges. The economic viability of the industry in both the French and the Scottish case studies was set against perceptions of what constitutes a socially acceptable industry. In France, a socially acceptable industry was perceived as one that is small scale, with clear and transparent environmental regulation and information provision. In Scotland, the emphasis was on local jobs and social entrepreneurship. Neither of these ideas of what constitutes a socially acceptable seaweed cultivation industry were considered as economically viable in the short-term and under the current aquaculture industrial and policy paradigm (large scale, single ownership) by interviewees who were regulators. However, options for how to marry social legitimacy with economic efficiency were suggested and included small-scale farms, possibly owned by the same

company or by separate small businesses as part of a cooperative, diffused along a coastline. To develop this type of a cultivation model, a joined-up planning and management structure would be required, to reduce biosecurity risks [5] and associated economic shocks. The current lack of European and global governance structures for biosecurity for seaweed cultivation has been identified as a serious risk to the industry [2], [64]. Given the prominence of sustainability and perceptions of environmental issues in forming local scale opinions on a resource use activity, evident within our case studies and broader aquaculture literature (see for example [9], [15]), this is a matter in need of address.

## 5.2. Trust

Issues of environmental risk are associated with information and dissemination [65], and are of particular relevance to social license, trust and consent. Information and more importantly, who provides it, played a key role in interviewee's opinions on whether they trusted assessments of environmental risk. In France, the debate over evidence production and interpretation by different stakeholders was at the forefront of arguments against opposing views (both for seaweed cultivation and against). For example, local scale environmental and community organisations perceived evidence and advice presented in reports produced by state level scientific agencies as supportive of the industry, to the detriment of the local environment and local people. Likewise, the arguments presented by those opposed to large-scale seaweed cultivation were perceived by those in regulation and industry as illegitimate, and to the detriment of 'facticity' as experienced by scientists. When thinking about the complex issue of 'evidence' and 'facts' within the current era of misinformation [66], relationships, trust, and deliberative knowledge production is at the forefront of tackling these 'balance as bias' situations [66]. This is important to note, as recent evidence suggests that people's individual opinions, whether they are directly interested in a topic or not, are susceptible to partisan media, and to perceived public support [61]. This can result in affective polarisation of opinion, which increases animosity between citizens and reduces the likelihood for deliberation [62].

In their paper on the Fukushima Dai'ishi nuclear power plant disaster, Mabon and Kawabe [65] found that perceptions of trust in governing agencies and industry is linked with the proximity and personal risk associated with their decisions. Hence, the further away the decision is being made, the less likely it is to be trusted by those who are living in the area where that decision is applied. However, where there are government and industry representatives embedded within the local community and co-producing knowledge, relationships are formed and with that comes trust [65]. The importance of dissonance of scale and decision-making and opportunities for two-way communication and relationship-building was emphasised in both of our in-depth case studies. However, it was more prominent in France, where perceptions of risk from seaweed cultivation was set within the context of ongoing controversy around green macro-algae blooms, which have been associated with human and animal mortalities [60].

Smaller scale cultivation was seen as risk management strategy for most Scottish interviewees and for local level environmental and community organisations in France. At a small scale, access to those conducting the activities was seen as simple, described as "organic" in nature and based on relationships, contextual knowledge and trust, as opposed to strategies, messaging and technocracy. In this way, social license for seaweed cultivation is more associated with community embeddedness and the relationships that local people and organisations could or do have with the company and/ or individuals conducting the activity, rather than the information and communication methods employed. This is echoed by other social license research, where quality communication [16] and relationship-building are seen as key to socially legitimate operations [24]. Further, Orozco and Veiga [67] found that assumptions around objections to large scale gold mining, and acceptance of small scale gold mining was less related to economic and environmental factors and more related to maintaining social

order. This is described by the authors as; “*the practices, values, networks and human interrelationships at the local level that build and enforce certain types of behaviour.*”

### 5.3. Consent

In our case studies, accountability and scale were linked with consent for the industry. The formal and monetary requirements of holding international corporations to account for errors or accidents, was seen as near impossible by interviewees in Scotland. Large-scale food production systems (finfish in Scotland and agriculture in France) were provided as examples of the difficulty of enforcing mitigation measures for environmental and social impacts. Smaller scale operations in France had consent on the basis of ease of interactions and therefore ability to hold the individuals conducting the activity to account if anything goes amiss. In both Scotland and France, the immediacy of this access to operators by “*being neighbours and friends*” and having shared knowledge of a particular area, seemed to form a significant part of whether an operator (or potential operator) is trusted, and further, whether they are likely to receive consent for their activities. Examples from our case studies included stories associated with specific marine and coastal features that non-locals would not know.

When referring to non-locals, interviewees were not talking about ethnic origin or demographics, but rather a typology of behaviours. In relation to seaweed cultivation this included what we are calling ‘hasty actions’, where an organisation, group or individual failed to understand and connect with the local context and people before acting or making a decision that would impact the local area. Within this scenario there is limited space for consent to take place, as there is by default, no understanding of what comprises consent from a local community. In words of one interviewee, these ‘hasty actions’ resulted in “*no chance to come to a consensus*”. Reduction in the acceptability of the aquaculture activities has been linked with economic status and perceptions of the marine environment as leisure opportunity versus use [9], [23]. In our case studies there was concern that those with power and money (often described as migrants from urban regions) were prioritised in social license negotiations. This issue of ownership of operations and power relations between actors involved in deliberation for social license requires further research. However, these findings are analogous to some social acceptability literature on the role of historical context and deliberation in acceptance of renewable energy technologies in the marine environment (see for example [69] and [70]). Perhaps useful to further enquiries are the established bodies of literature on the role of elite power in transformations (e.g. as described by Sovacool et al [70]) and the role of power in marine planning (as described by Flannery et al [71]).

## 6. Conclusions

From the evidence presented in our cases we can see that for large-scale multi-national owned seaweed cultivation operations the default position for engaged stakeholders is limited trust, lack of consent, and legitimacy based on formal legal and planning processes, resulting in the requirement for undertaking formal activities that will garner social license (e.g. communication strategies, community grants). Conversely, local small-scale operators already have consent, trust, and informal legitimacy based on inter-personal relationships, placing them in a much better position to gain social license, or perhaps already having social license by default. All of the cultivation organisations surveyed were already engaged in activities that build relationships with local communities, and some provided evidence of where issues were solved quickly and in a deliberative manner because of their embeddedness within the local area and their positive relationships with other local users of the marine environment. They were all small-scale and locally-owned.

There is a prevailing assumption, in the wording of many research projects and national and supranational policies, that because seaweed cultivation is environmentally relatively low-risk [11] it is therefore more socially acceptable than other marine aquaculture industries. However, this is clearly not the case [5]. There is potential for unforeseen social and ecological consequences of this emerging industry [64]. Our study shows that inter-personal relationships, context-related perceptions of environmental risk, and levels of trust in regulators and operators, feed into social license for cultivation operations as much as observed environmental impacts. We found that where formal governance systems bring together actors who have different worldviews and understandings of science in an effort to democratise decision-making, ad hominem arguments are more likely. This emphasises the role and qualities of actors and agency in social license negotiation, rather than of structure, organisations and law.

We see the concept of social license to operate as a useful starting point for industry and regulators to improve on or start building relationships with the communities that might host commercial scale seaweed cultivation activities and the agents that influence their opinions. Equally, it could provide local communities and interest groups and other marine users with a means to negotiating better terms for hosting commercial seaweed cultivation operations.

### Acknowledgements

The authors would like to acknowledge the funding provided to the GENIALG project through the European Union’s Horizon 2020 Framework Programme under grant agreement No 727892. Likewise, the authors acknowledge the funding provided to the MacroFuels project through the European Union’s Horizon 2020 research and innovation programme under grant agreement No 654010. We would also like to thank the participants in this study, who provided their expertise and opinions voluntarily and the SAMS Seaweed Team for sharing their expertise.

**Suzannah-Lynn Billing:** Conceptualisation, methodology, investigation, formal analysis, writing – original draft and review and editing **Julie Rostan:** Investigation, writing – review and editing **Adrian Macleod:** writing – review and editing **Paul Tett:** Conceptualisation, writing – review and editing, funding acquisition.

### Appendix 1

List of species cultivated (please choose <b>C</b> for species you grow commercially and <b>E</b> for those you grow experimentally):			
1. Saccharina latissima	C/E	2. Osmundea pinnatifida	C/E
3. Alaria esculenta	C/E	4. Ulva spp.	C/E
5. Palmaria palmata	C/E	6. Laminaria digitata	C/E
Type of farm (please tick all of the cultivation methods that apply to your farm):			
Onshore tank		<input type="checkbox"/>	
Onshore pond		<input type="checkbox"/>	
Sea-based net		<input type="checkbox"/>	
Sea-based line		<input type="checkbox"/>	
Other (please describe)		<input type="checkbox"/>	



1. Spatial context of your farm or affiliate farm including; size and proximity to the coast and other marine users [ <i>this can be a map or a short description</i> ]:
2. Have you had any interactions with local communities, individuals and/ or NGOs up until now? Yes/No
3. If so, please provide a few sentences summarising what the interactions were about and whether they resulted in any outcomes (positive, negative, or otherwise):
4. Do you have a formal communication/ engagement plan within your company about your seaweed cultivation activities outside of any legal or planning obligations? Yes/ No
5. Outside of legal/ planning obligations, how did you communicate with;
a. local communities (including schools)?
b. other users of the area (fishers, fish farmers, tourists etc.)?
c. individuals?
d. others (please specify)?
•
6. What type of information did you provide;
a. local communities (including schools)?
b. other users of the area (fishers, fish farmers, tourists etc.)?
c. individuals?
d. others (e.g. NGOs)?
7. Have you read the Social Licence to Operate (SLO) handbook? Yes/ No
8. Do you think that the concept of SLO, presented in the handbook, is useful? Yes/No
9. In what ways do you agree/ disagree with the concept of SLO?
10. Do you think your seaweed farming activities have SLO (as defined in the handbook)? Yes/ No
11. In what ways do you think SLO could be made relevant for your farming activities?
12. If you have any other comments which you think might be useful or relevant for this study, please write them here:

## References

- [1] FAO, "The State of Fisheries and Aquaculture in the world 2018," Rome, 2018.
- [2] M. Barbier, B. Charrier, R. Araujo, S. L. Holdt, B. Jacquemin, and C. Rebours, "Phycomorph



- European Guidelines for a Sustainable Aquaculture of Seaweeds,” 2019.
- [3] S. W. K. van den Burg, A. P. van Duijn, H. Bartelings, M. M. van Krimpen, and M. Poelman, “The economic feasibility of seaweed production in the North Sea,” *Aquac. Econ. Manag.*, vol. 20, no. 3, pp. 235–252, 2016.
- [4] D. Wood, E. Capuzzo, D. Kirby, K. Mooney-McAuley, and P. Kerrison, “UK macroalgae aquaculture: What are the key environmental and licensing considerations?,” *Mar. Policy*, vol. 83, pp. 29–39, Sep. 2017.
- [5] I. Campbell *et al.*, “The Environmental Risks Associated With the Development of Seaweed Farming in Europe - Prioritizing Key Knowledge Gaps,” *Front. Mar. Sci.*, vol. 6, no. March, 2019.
- [6] I. E. van Putten, C. Cvitanovic, E. Fulton, J. Lacey, and R. Kelly, “The emergence of social licence necessitates reforms in environmental regulation,” *Ecol. Soc.*, vol. 23, no. 3, 2018.
- [7] O. Strand *et al.*, “Ecosystem Approach to making space for aquaculture. Case Study final reports.” 2017.
- [8] G. Krause *et al.*, “A revolution without people? Closing the people–policy gap in aquaculture development,” *Aquaculture*, vol. 447, pp. 44–55, Oct. 2015.
- [9] S. Billing, “Using public comments to gauge social licence to operate for finfish aquaculture : Lessons from Scotland,” *Ocean Coast. Manag.*, vol. 165, no. September, pp. 401–415, 2018.
- [10] C. Mather and L. Fanning, “Social licence and aquaculture: Towards a research agenda,” *Mar. Policy*, vol. 99, pp. 275–282, Jan. 2019.
- [11] S. W. K. van den Burg, H. Dagevos, and R. J. K. Helmes, “Towards sustainable European seaweed value chains: a triple P perspective,” *ICES J. Mar. Sci.*, 2019.
- [12] J. Prno and D. Scott Slocombe, “Exploring the origins of ‘social license to operate’ in the mining sector: Perspectives from governance and sustainability theories,” *Resour. Policy*, vol. 37, no. 3, pp. 346–357, 2012.
- [13] K. Jenkins, ““Can I see your social license please?”” *Policy Q.*, vol. 14, no. 4, pp. 27–35, 2018.
- [14] R. Boutilier and I. Thomson, “Modelling and Measuring the Social License to Operate: Fruits of a Dialogue Between Theory and Practice,” 2011.
- [15] J. Prno, “An analysis of factors leading to the establishment of a social licence to operate in the mining industry,” *Resour. Policy*, vol. 38, no. 4, pp. 577–590, Dec. 2013.
- [16] K. Moffat and A. Zhang, “The paths to social licence to operate: An integrative model explaining community acceptance of mining,” *Resour. Policy*, vol. 39, pp. 61–70, 2014.
- [17] J. Gehman, L. M. Lefsrud, and S. Fast, “Social license to operate: Legitimacy by another name?,” *Can. Public Adm.*, vol. 60, no. 2, pp. 293–317, 2017.
- [18] N. Gunningham, R. A. Kagan, and D. Thornton, “Social licence and environmental protection: why businesses go beyond compliance,” *Law Soc. Inq.*, vol. 29, no. 2, pp. 307–341, 2004.
- [19] R. Kelly, G. T. Pecl, and A. Fleming, “Social licence in the marine sector: A review of understanding and application,” *Mar. Policy*, vol. 81, pp. 21–28, Jul. 2017.
- [20] K. Moffat, J. Lacey, A. Zhang, and S. Leipold, “The social licence to operate: A critical review,” *Forestry*, vol. 89, no. 5, pp. 477–488, 2016.
- [21] N. Hall, J. Lacey, S. Carr-Cornish, and A.-M. Dowd, “Social licence to operate: understanding how a concept has been translated into practice in energy industries,” *J. Clean. Prod.*, vol. 86, pp. 301–310, Jan. 2015.
- [22] R. Kelly, A. Fleming, and G. T. Pecl, “Social Licence for Marine Conservation Science,” *Front.*



- Mar. Sci.*, vol. 5, no. November, pp. 1–6, 2018.
- [23] P. Leith, E. Ogier, and M. Haward, “Science and Social License: Defining Environmental Sustainability of Atlantic Salmon Aquaculture in South-Eastern Tasmania, Australia,” *Soc. Epistemol.*, vol. 28, no. 3–4, pp. 277–296, 2014.
- [24] J. Baines and P. Edwards, “The role of relationships in achieving and maintaining a social licence in the New Zealand aquaculture sector,” *Aquaculture*, vol. 485, pp. 140–146, Feb. 2018.
- [25] J. Cooney, “Reflections on the 20th anniversary of the term ‘social licence,’” *J. Energy Nat. Resour. Law*, vol. 35, no. 2, pp. 197–200, 2017.
- [26] J. Morrisson, *The Social License: How to Keep Your Organisation Legitimate*. London, UK: Palgrave Macmillan, 2014.
- [27] J. Baines and P. Edwards, “The role of relationships in achieving and maintaining a social licence in the New Zealand aquaculture sector,” *Aquaculture*, vol. 485, pp. 140–146, Feb. 2018.
- [28] S. Angus, “Modern Seaweed Harvesting and Gathering in Scotland: The Legal and Ecological Context\*,” *Scottish Geogr. J.*, vol. 133, no. 2, pp. 101–114, 2017.
- [29] C. Gallois, P. Ashworth, J. Leach, and K. Moffat, “The Language of Science and Social Licence to Operate,” *J. Lang. Soc. Psychol.*, vol. 36, no. 1, pp. 45–60, 2017.
- [30] M. C. Suchman, “and Strategic Managing Legitimacy : Approaches,” *Acad. Manag. Rev.*, vol. 20, no. 3, pp. 571–610, 1995.
- [31] C. Rebours *et al.*, “Seaweeds : an opportunity for wealth and sustainable livelihood for coastal communities,” *J. Appl. Phycol.*, vol. 26, pp. 1939–1951, 2014.
- [32] The Scottish Government, “Seaweed Review,” 2019. [Online]. Available: <https://www2.gov.scot/Topics/marine/seamanagement/seaweedrev>. [Accessed: 05-Nov-2019].
- [33] The Scottish Government, “Seaweed Cultivation Policy Statement,” 2017.
- [34] J. M. Bumstead, “The rise and fall of the kelping industry in the Western Isles,” in *From Clan to clearance*, Oxford: Oxbow Books, 2005, pp. 123–138.
- [35] Argyll and Bute Council, “News from Argyll and Bute Economic Development and Strategic Transportation Service,” *Transformation*, p. 3, 2017.
- [36] Marine Scotland, *Scotland’s National Marine Plan: A Single Framework for Managing Our Seas*. 2015.
- [37] ABPmer, “Wild Seaweed Harvesting Scoping Report: A Report produced by ABPmer for Marine Biopolymers Ltd.,” 2018.
- [38] Change.org, “Do not allow mechanical kelp dredging in Scottish Waters.,” 2018. [Online]. Available: <https://www.change.org/p/scottish-parliament-ensure-that-mechanical-kelp-dredging-does-not-happen-in-scotland>. [Accessed: 19-Sep-2019].
- [39] ITV News, “Sir David Attenborough demands MSPs protect ‘globally important’ kelp beds,” 2018.
- [40] BBC News Scotland, “Scottish kelp harvesting plan ‘entirely sustainable,’” Nov-2018.
- [41] K. Pavid, “Kelp dredging in Scotland would be a ‘disaster’ for British coasts,” *Natural History Museum*, Oct-2018.
- [42] Scottish Parliament, *Scottish Crown Estate Bill*. Scotland: Scottish Parliament, 2019.
- [43] Netalgae, “La filière des macro-algues en France,” 2012.



- [44] P. GAILLARD, “Economie de la mer. Les algues, une filière nouvelle sortie de la mer,” *Ouest-France*, 2016. .
- [45] actu.fr, “Finistère. Algolesko cultive désormais 150 hectares d’algues à Lesconil,” 2019. [Online]. Available: [https://actu.fr/bretagne/loctudy\\_29135/finistere-algolesko-cultive-desormais-150-hectares-dalgues-lesconil\\_21173146.html](https://actu.fr/bretagne/loctudy_29135/finistere-algolesko-cultive-desormais-150-hectares-dalgues-lesconil_21173146.html). [Accessed: 16-Dec-2019].
- [46] CEVA, “Directory of French seaweed producers and processors (food applications),” 2019. .
- [47] legifrance.gouv, “Décret n° 2009-1349 du 29 octobre 2009 modifiant le décret n° 83-228 du 22 mars 1983 fixant le régime de l’autorisation des exploitations de cultures marines | Legifrance,” 2009. .
- [48] L. Balay and A. Dargnies, “Expertise du projet de filière d’ algoculture alimentaire en Bretagne,” 2012.
- [49] ANSES, “Green algae, risks to surrounding populations, walkers and workers,” 2016. [Online]. Available: <https://www.anses.fr/en/content/green-algae-risks-surrounding-populations-walkers-and-workers>. [Accessed: 14-Nov-2019].
- [50] A. Chrisafis, “‘It can kill you in seconds’: the deadly algae on Brittany’s beaches,” *The Guardian*, Sep-2019.
- [51] R. K. Yin, *Case Study Research Design and Methods*, 5th Editio. Thousand Oaks, CA: SAGE Publications Inc, 2014.
- [52] A. Bryman, *Social Research Methods*, Fourth. United States: Oxford University Press, 2012.
- [53] V. Braun and V. Clarke, “Qualitative Research in Psychology Using thematic analysis in psychology Using thematic analysis in psychology,” *Qual. Res. Psychol.*, vol. 3, no. 2, pp. 77–101, 2006.
- [54] The Scottish Government, “Wild seaweed harvesting: strategic environmental assessment - environmental report,” 2016.
- [55] National Records of Scotland, “Argyll and Bute Area Profile,” 2019. [Online]. Available: <https://www.nrscotland.gov.uk/files/statistics/council-area-data-sheets/argyll-and-bute-council-profile.html>. [Accessed: 18-Sep-2019].
- [56] Argyll and Bute Council, “Argyll and Bute Council Leader’s Report,” 2019.
- [57] I. Gatward, A. Parker, S.-L. Billing, and K. Black, “Scottish aquaculture: a view towards 2030,” 2017.
- [58] E. Bigagli, “The EU legal framework for the management of marine complex social-ecological systems,” *Mar. Policy*, vol. 54, pp. 44–51, 2015.
- [59] R. K. Craig, “Fostering adaptive marine aquaculture through procedural innovation in marine spatial planning,” *Mar. Policy*, no. May, p. 103555, 2019.
- [60] M. Bourblanc, “Expert assessment as a framing exercise: The controversy over green macroalgal blooms’ proliferation in France,” *Sci. Public Policy*, vol. 46, no. 2, pp. 264–274, 2019.
- [61] R. M. Barnes, H. M. Johnston, N. Mackenzie, S. J. Tobin, and C. M. Taglang, “The effect of ad hominem attacks on the evaluation of claims promoted by scientists,” *PLoS One*, vol. 13, no. 1, pp. 1–15, 2018.
- [62] J. West, I. Bailey, and M. Winter, “The divergent public perceptions of renewable energy in the southwest of england: A cultural theory approach,” *Energy Policy*, vol. 38, no. 10, pp. 5739–5748, 2010.
- [63] J. Firestone and H. Kirk, “A strong relative preference for wind turbines in the United States



- among those who live near them,” *Nat. Energy* 2019, vol. X, pp. 1–13, 2019.
- [64] E. J. Cottier-Cook *et al.*, “Policy Brief : Safeguarding the future of the global seaweed aquaculture industry,” 2016.
- [65] L. Mabon and M. Kawabe, “Engagement on risk and uncertainty—lessons from coastal regions of Fukushima Prefecture, Japan after the 2011 nuclear disaster?,” *J. Risk Res.*, vol. 21, no. 11, pp. 1297–1312, 2018.
- [66] J. Cook, U. Ecker, and S. Lewandowsky, “Misinformation and how to correct it,” *Emerg. Trends Soc. Behav. Sci.*, pp. 1–17, 2015.
- [67] Z. Toledo Orozco and M. Veiga, “Locals’ attitudes toward artisanal and large-scale mining—A case study of Tambogrande, Peru,” *Extr. Ind. Soc.*, vol. 5, no. 2, pp. 327–334, Apr. 2018.
- [68] S. Kerr *et al.*, “Establishing an agenda for social studies research in marine renewable energy,” *Energy Policy*, vol. 67, pp. 694–702, Apr. 2014.
- [69] D. Rudolph, C. Haggett, and M. Aitken, “Community benefits from offshore renewables : The relationship between different understandings of impact , community , and benefit,” *Environ. Plan. C Polit. Sp.*, vol. 36, no. 1, pp. 92–117, 2018.
- [70] B. K. Sovacool and M.-C. Brisbois, “Elite power in low-carbon transitions: A critical and interdisciplinary review,” *Energy Res. Soc. Sci.*, vol. 57, p. 101242, Nov. 2019.
- [71] W. Flannery, J. Clarke, and B. McAteer, “Politics and Power in Marine Spatial Planning,” in *Maritime Spatial Planning*, J. Zauha and K. Gee, Eds. Palgrave Macmillan, 2019, pp. 219–243.

## Paper 2: Commercial seaweed cultivation in Scotland and the social pillar of sustainability: A Q-method approach to characterising key stakeholder perspectives.

Maiken Bjørkan<sup>1</sup> and Suzannah-Lynn Billing<sup>2</sup>

<sup>1</sup>Nordlandsforskning, Bodø, Nordland Norway

<sup>2</sup>Scottish Association for Marine Science, Oban, Scotland

### Abstract

Finding the right way to move forward with seaweed cultivation requires the relevant stakeholders to reach agreement on what goals/ limits to set and subsequently what measures should be taken to achieve them. Using a Q-method approach and an analytical framework based on in-put legitimacy, social license to operate and the four pillars of sustainability, we discuss the answers of a diverse set of stakeholders to the question: how should commercial seaweed cultivation in Scotland develop? Our results reveal three main discourses. The first focused on environmental and social sustainability, the second on accessing global markets, economic and environmental sustainability and the third prioritized jobs and social and institutional sustainability. The areas of consensus across the factors included the perception that large-scale and multi-national owned farms is not an ideal model for development of the industry in Scotland. All participants advised that the current regulatory regime for seaweed cultivation requires improvement. These results are discussed within the analytical framework and a prediction of the factors required to establish a legitimate seaweed cultivation industry in Scotland is presented.

**Key words:** Seaweed-cultivation; aquaculture; stakeholders perception; Q-methodology; legitimacy; Social License to Operate.

### Acknowledgements

The authors would like to acknowledge the funding provided to the GENIALG project through the European Union's Horizon 2020 Framework Programme under grant agreement No 727892. Likewise, the authors acknowledge the funding provided to the MacroFuels project through the European Union's Horizon 2020 research and innovation programme under grant agreement No 654010; and the Norwegian Research Council HAVBRUK2 under grant agreement No 267946. The second author would like to thank Dr Philip Kerrison, Dr Arlene Ditchfield, Dr Adrian Macleod, and Dr Kati Michalek for their assistance in creating the Q concourse (stakeholder workshops) and providing their expert advice on all things related to seaweed cultivation.

## 1. Introduction

The need to source materials for food and fuel, and chemical and pharmaceutical industries from sustainable supplies is growing. The marine environment has long provided these resources, with seaweeds supplying everything from alginates and carrageenans for toothpaste through to salad for dinner. The Food and Agricultural Organisation of the United Nations analysis shows that there has been a global increase in seaweed production of 7.6% between 2004 and 2014, much of which is based in China (FAO, 2018). However, the opportunities that seaweed presents as a potentially sustainable resource, have been recognised across Europe, which has led to several research projects and companies exploring commercialisation (van den Burg et al., 2019). While many seaweeds can be harvested from the wild there is a growing opposition to kelp harvesting specifically, led by fishers, environmentalists, and local communities. Hence, countries in the North Atlantic, both east and west to look to seaweed cultivation as a solution.

While seaweed cultivation holds potential for the “blue growth”, it also generates new challenges as it is set within the context of escalating competition for the use of ocean and coastal areas and resources. As such, there is the possibility that this newly emerging activity could add to conflicts in the coastal zone that are likely to relate to all aspects of sustainability; natural, economic, social and institutional. For example, large-scale cultivation can have a different impact on the biophysical marine environment than small-scale cultivation. However, as this is a new industry in Europe the effects on the environment at any scale are still uncertain (Campbell, 2019). Local ownership has the potential to generate different benefits for local communities than multinational ownership, both creating varied but strong links between social and economic sustainability. Finally, how the sector should be organized in terms of regulations will impact issues such as who is included in governance processes, and where accountability lies if something goes wrong – be it environmental, social, or economic. Finding the right way to move forward with seaweed cultivation requires that the relevant stakeholders reach agreement on what goals to aim for and subsequently what measures should be taken to achieve them (Raadgever et al., 2008). In order to realize this, it is pivotal to elicit stakeholders’ perspectives to understand what a “successful” seaweed cultivation sector would look like.

Taking a constructivist approach to these issues and using Q methodology, we explore stakeholders’ perception of seaweed cultivation within the context of the concept of legitimacy, described in more detail later on in this paper. Legitimacy is argued as key to ensuring sustainable management of resources in line with good governance ideals, and to safeguard the stability of social, political and economic systems (Suchman, 1995). We use Scotland as a case study, as the Scottish government has identified seaweed cultivation as an industry that can contribute to the blue economy with particular potential for rural, island and coastal communities (Scottish Government, 2017). In addition, the West Coast is already host to several test sites and small-scale commercial operations. In this study, we explore how stakeholders, that is, seaweed cultivators, scientists, regulators, supply-chain services and interested community representatives, view the current processes around seaweed cultivation and its development. We investigate if the process of establishing seaweed cultivation as a new industry in the coastal zone is perceived as legitimate or not, and what it will take to achieve legitimacy. In order to answer this, we ask: ***how should commercial seaweed cultivation in Scotland develop?***

In the following sections, we will present the current context of seaweed cultivation in Scotland, including the consenting regime and relevant social and legal processes it interacts with, before describing the theoretical framework we used to conduct the study and analyse the results.

## 1.1 Current seaweed cultivation consenting regime

The aquaculture consenting procedure in Scotland is currently characterized by the marine planning regime, comprised of national and supranational frameworks (see Figure 1) and several different national (Scottish) and regional (county level) authorities, government agencies and licenses (see Table 1).

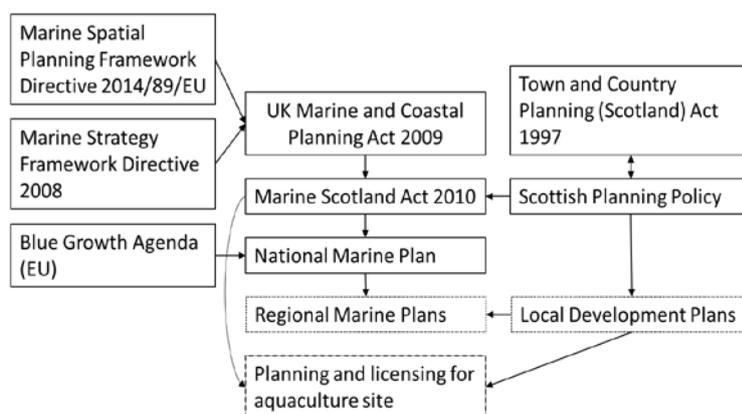


Figure 1. Rough guide to the marine planning regime in Scotland as described by Brooker et al., (2019) in addition to Billing, (2018). Dotted lines show processes that include local level stakeholder and community engagement.

Prior to 2016 there were no commercially operating seaweed farms in Scotland, and no regulations to suit. However, in 2012 the Scottish Government conducted a Strategic Environmental Assessment for seaweed cultivation (Marine Scotland, 2012) and in 2017 concluded a consultation process started in 2013, through the publication of the Scottish Seaweed Cultivation Policy Statement (Scottish Government 2017). The Statement sets out seven policies (P), of which the first and fifth are of particular relevance to this study. Policy one asserts that “*In principal, the Scottish Government is supportive of small-medium farm seaweed cultivation...<sup>2</sup>*” subject to planning and environmental regulation. Policy five states that “*Other marine users and activities should be considered in the siting of farms*”. The other five policies relate to biosecurity (P2), location of farms in relation to water quality (P3), survivability and suitability of equipment (P4), site suitability including visual impacts (P6), and general support for integrated multi-trophic aquaculture (P7).

Although seaweed cultivation is viewed by government and some regional level organisations as an industry that has the potential to expand in a sustainable manner (Scottish Government, 2017; Argyll and Bute Council 2017), it will be competing for space in an already busy inshore marine environment. In addition, there are currently industries operating in this area which are not identified as competitors by the Scottish National Marine Plan but are by local communities and businesses. For example, perceived negative impacts on the tourism industry are often a cited as a reason for objecting to planning applications for finfish aquaculture (Billing, 2018). Although there are efforts currently underway to improve understanding around the potential impacts that seaweed cultivation might have in Scottish waters (see for example the H2020 projects Genialg and MacroFuels), it is currently not known what scale of seaweed cultivation is required for economic feasibility (van den Burg et al., 2016), what environmental impacts different scales might imply (Campbell et al., 2019), or the potential conflicts

<sup>2</sup> “Small to medium” scale farms are classified by the Scottish Government as 0-50x200 meter lines (Scottish Government, 2017)

or synergies that might arise in relation to other users of the sea and local communities that will host the industry.

Table 1. The current consenting regime for cultivating seaweed in Scotland.

Application	Authorising regulator/ monitoring agency	Legislation	Additional information
Marine Licence	Marine Scotland Licensing Operations Team (MS-LOT)	Marine Scotland Act 2010	The application requires an assessment of areas of concern such as Special Areas of Conservation, Special Protected Areas, Special Sites of Scientific Interest, Marine Protected Areas, Ramsar sites, shellfish harvesting areas, and marine archaeology. It might also require a pre-application public consultation. If so, a report of the consultation should be submitted with the application. This should include those who were consulted, when, where, and how. MS-LOT will consult with statutory consultees including the Northern Lighthouse Board, statutory Harbour Authority, Scottish Natural Heritage, Scottish Environmental Protection Agency, Historic Scotland, Royal Society for the Protection of Birds, and the relevant District Salmon and Fishery Board. A Marine Licence is normally granted for 6 years. Determination of an application is 14 weeks, although it can take longer.
Seabed Lease	The Crown Estate Scotland	Crown Estate Act 1961 and The Scotland Act 2016	The Crown Estate Scotland encourages any applicants to contact them before applying for a lease to check whether the site is available.
Habitats Regulations Appraisal (if necessary)	MS-LOT, Crown Estate Scotland, relevant Local Authority, Scottish Environmental Protection Agency	The Conservation (Natural Habitats, & c.) Regulations 1994	Scottish Natural Heritage are the advisory agency and if a Habitats Regulations Appraisal is required, SNH must be consulted by the competent authority.
None	Scottish Natural Heritage Scottish Police Force	Wildlife and Natural Environment (Scotland) Act 2011, Wildlife and Countryside Act 1981	It is an offence to grow any plant species outside of its native range, including seaweed. SNH provides guidance to the competent authority on whether the activities applied for under a Marine License are compliant with these laws.
Works Licence Policy 2017	Shetland Islands Council	Zetland County Council Act 1974	A Work Licence is required from the Shetland Islands Council for the cultivation of seaweed within the Shetland County Council Area.
Planning permission	Local Planning Authority/ Local Council	Town and Country Planning (Scotland) Act 1997	Planning permission is required for any land side infrastructure such as new slipways and drying facilities.

## 1.2 Seaweed harvesting and cultivation context

Kelp forests around the UK are biodiverse and provide several ecosystem services including; habitat for species of inherent and commercial value (e.g. European lobster, Atlantic cod, Pollock, seals, and otters); coastal defence through wave attenuation and dampening and; health and wellbeing benefits for humans through interaction, cultural significance and economic reliance (Smale et al., 2013). In 2017, a Scottish company submitted a proposal to harvest up to 33,000 ton of kelp (*Laminaria hyperborea*) per year from coastal waters in western Scotland. The kelp was to be used as a raw material for the production of biomaterials including alginate and nanocellulose. The proposal was opposed by fishers, fish-farmers, hand-harvesters of seaweed, coastal and island communities, the general public, public figures (including Sir David Attenborough) and some environmental NGOs. Opposition included a social media campaign, media coverage, and a petition signed by 14,000 people.

Following this public controversy, several amendments were made to the Crown Estate Bill under consideration at that time, by the Scottish Parliament. The final amendment (14ZA) was accepted by

Parliament on 21 November 2018 and prohibits any mechanical removal (for commercial purposes) of 5 species of “wild kelp from the seabed” that “would inhibit the regrowth of the individual plant”. Listed species were *Laminaria hyperborea*, *L. digitata*, *Saccharina latissimi*, *Saccorhiza polyschides* and *Alaria esculenta* (Scottish Parliament, 2018). Given that the main meristem of *L. hyperborea* is at the top of the stipe (i.e. the base of the frond) (Burrows et al., 2018), this effectively outlaws mechanical harvesting of this species for its alginate-rich stipe.

*Laminaria hyperborea* can be farmed, but existing strains have a low yield of alginate under farm conditions. *Saccorhina latissima* is currently farmed and has a good content of alginate. However, providing the biomass needed for commercial purposes would require farms covering at least 30 km<sup>2</sup> (at harvestable densities of 10 tonnes per hectare) (Bak et al., 2018). However, the Scottish Seaweed Cultivation Policy Statement determines support for seaweed cultivation in farms of up to 1 hectare. The Statement does not consider large sites on the grounds that they are not at present technically, environmentally or economically feasible (Scottish Government, 2017). In this context, a review of the “regulatory regime of all kelp harvesting activity up to and including farming”, was announced on 20 November 2018 by the Scottish Environmental Secretary, Roseanna Cunningham and is currently underway (The Scottish Government, 2019).

## 2. Theoretical Framework

### 2.1 Legitimacy

Legitimacy theory is concerned with understanding what makes something – a process, an institution, a governance structure, in our case an industrial activity and its regulation – acceptable within a socially constructed system (Suchman, 1995). It plays a key role in policy development and democracy as is found in a large body of literature within anthropology, philosophy, organizational studies and more (e.g., Bjørkan, 2011, Jentoft, 2000, Weber, 1946, Wilson, 2009). In general, legitimacy is assumed to induce compliance, encourage participation and lower costs to those seeking it. Suchman (1995) defines legitimacy as;

“...a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs and definitions.” (1995; 574 in Suchman)

Given the aim of this article is to try and understand the characteristics that might make a seaweed cultivation industry in Scotland acceptable to stakeholders and local communities, within, at the time of writing, a limited regulatory framework, this definition of legitimacy fits well. However, we choose to take the approach of Scharpfs (1999) in trying to understand the requirements of legitimacy (*in-put and out-put*), rather than the four typologies described by Suchman (1995). Our choice on the basis that the industry we are studying is not yet commercialised and we therefore cannot assess or observe the actions of the organisations running the operations, nor the audience (interested parties, stakeholder, or local communities).

Scharpfs (1999) distinguishes between in-put and out-put legitimacy, where in-put legitimacy refers to procedure and participation and out-put legitimacy relates to consequences, problem-solving capacity and effectiveness (see also Bäckstrand et al., 2010). Some authors claim that if in-put legitimacy is high, this can increase the out-put legitimacy (see for instance Risse, 2004). Others argue that high out-put legitimacy can compensate for low in-put legitimacy (Sharpfs, 1999). Dingwerth (2007) proposes four dimensions of out-put legitimacy: 1) policy effectiveness; 2) institutional effectiveness; 3) compliance effectiveness and; 4) environmental effectiveness. Although touching on out-put-legitimacy, our main focus as reasoned in the previous paragraph, is on the three dimensions of in-put legitimacy; 1) participation and inclusion; 2) democratic control and accountability and; 3) argumentative practice and deliberative quality (Bäckstrand et al., 2010).

Legitimacy assessments rest on a complex interplay between the decision-making processes and the out-put of these processes. In practice, the dialectic relationship between in-put and out-put legitimacy makes it difficult to clearly distinguish between procedural and substantive sources of legitimacy (Connelly et al., 2006). Through concepts such as overall legitimacy (Bäckstrand et al., 2010; Birnbaum, 2015) and throughput legitimacy (Schmidt, 2013) scholars have tried to overcome the dichotomy between in-put and out-put legitimacy: *“There is widespread agreement in scholarly literature that in-put and out-put legitimacy are closely connected and that legitimacy can neither be attained by inclusion nor by effectiveness alone”* (Hogl et al., 2012; 14).

Our aim in this paper is not to discuss or emphasize the dichotomous aspects of legitimacy. Rather, the data has pointed us towards dimensions related to in-put legitimacy. Relating in-put legitimacy to our Scottish context, we ask if the policies and norms for seaweed cultivation are being developed in a transparent, fair, inclusive and accountable manner, and form effective institutions for problem-solving and performance. We focus mainly on how stakeholders would like the seaweed cultivation sector to develop, or in line with the legitimacy definition above; *what actions are desirable, proper, or appropriate in the seaweed cultivation sector as perceived by stakeholders*. Given that in-put legitimacy is geared to democratic principles, this article can be understood as a contribution in terms of giving voice to stakeholders and be a part of *“the good argument”* (Hogl et al., 2012). We do not argue that there is a direct link between a legitimate seaweed cultivation sector, little conflict and effective decision making. However, we do argue that it is key to understand stakeholders’ perception to try to navigate these issues as best as possible, to realise the benefits of industry development and avoid the pitfalls.

Legitimacy is not observable as such, which makes it a challenge to directly measure. However, as a starting point we assume a link between the four pillars of sustainability, legitimacy and the potential for social license for the seaweed cultivation sector (see figure 3). Based on this assumption, we have chosen statements for our Q method that represent the social, economic, environmental and institutional sustainability of the seaweed sector (Table 2). In the next section, we describe the four pillars of sustainability in relation to legitimacy and social license, before describing our Q method approach in detail.

## 2.2 Sustainability and social license

The Scottish Government is supportive of Blue Growth, within the parameters of sustainability of environment, economy and society (Scottish Government, 2019). The concept of “sustainability” was launched in the “our Common Future” report (1987), defined as development that meets the needs of the present without compromising the ability of future generations to meet their needs. Over time, the concept has become holistic, including economic, social and institutional dimensions in addition to the environment. These dimensions are co-dependent, and Figure 2<sup>3</sup> is often used to illustrate this.

Importantly, social sustainability is closely related to the social acceptability and social license for an industry (Provasnek et al., 2017), in our case, seaweed cultivation. Further, social license (or lack

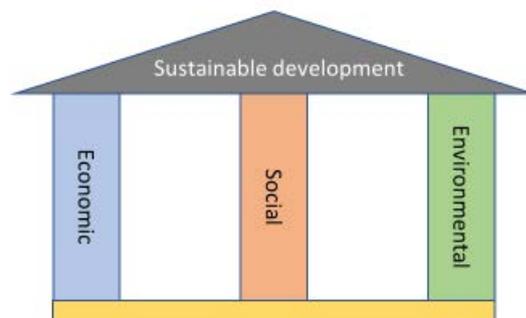


Figure 2: The environmental, economic and social sustainability are the pillars, and the foundation is made of institutional sustainability, which consists of management and governance. After Nofima AS, inspired by University of York & Chemical Industries Association, 2005

<sup>3</sup> Original figure is found here: <https://nofimaas.sharepoint.com/sites/public/Cristin/Rapport%2035-2018.pdf?&originalPath=aHR0cHM6Ly9ub2ZpbWFhcy5zaGFyZXBvaW50LmNvbS86Yjovcy9wdWJsaWMvRVJvU1pvYTZyeEZCdTZ3NXgySkE0WmdCYWdVS29nNzIwOWJpcjByckh5WGE0UT9ydGltZT0xT2h6Zm9wODEwZw>

thereof) can impact access to space in the coastal zone (Kelly et al., 2017; Cullen-Knox et al., 2019) and is often related to issues such as day-to-day effects on society, jobs, value creation (Baines and Edwards, 2018) and environmental pollution (Billing, 2018) – that is, the economic and environmental pillars. The terms and conditions placed on the industry to gain social license must also be economically sustainable in order for the industry to survive in the long run.

Social license has been identified as a term which could be developed into a useful framework for understanding and improving the way that marine industries, scientific researchers and management measures interact with local communities (Kelly et al., 2017). It is, however, not without criticism. One of the key reasons for using the term with caution, is that there is no single definition which has been agreed on by those using or researching it (Gehman et al., 2017). However, due to its increasing prevalence in literature around marine industries, we see it as a useful, broad (Cooney, 2017), and complementary concept to legitimacy. For the purpose of this paper we define it as; general acceptance of the activities associated with an industry by

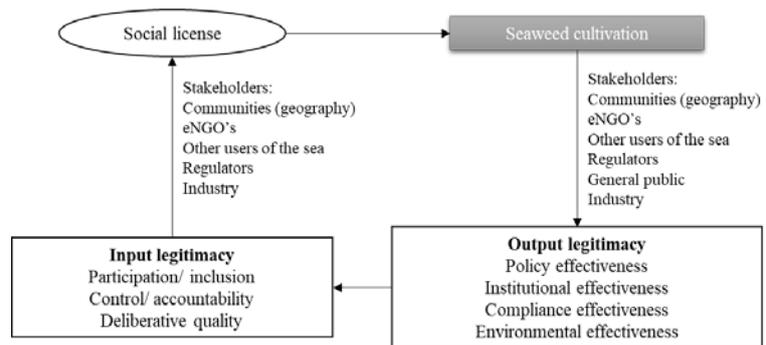


Figure 3. Application of legitimacy and social license to the seaweed cultivation industry. Legitimacy context after Bäckstrand et al., (2010) and Schmidt (2013). Social license context after Billing (2018) and Prno (2013).

local communities (Moffat and Zhang, 2014). For brevity, we do not discuss to what degree legitimacy and social license concepts overlap or diverge. We are primarily concerned with exploring the factors that stakeholders perceive as linked to legitimacy and social license for seaweed cultivation. We argue that there is a relationship between legitimacy and social license for the industry, and these can be successfully integrated with the four pillars of sustainability.

### 3. Q Methodology

Q-methodology is a technique developed in the 1930's (Stephenson, 1953) to explore individual phenomena such as opinions, perspectives and attitudes (Watts and Stenner, 2012). It is a way to investigate various views of a specific topic within a group, and it combines the strength of quantitative and qualitative research methods (Watts and Stenner, 2012). There are typically six phases to Q-method: 1) development of the concourse, 2) development of the Q-sample (statements), 3) development of the P set (informants), 4) the Q sort, 5) data analysis and, 6) interpretation.

The informants are asked to arranged the set of statement – the “Q-set” – across a normal distribution (bell curve) that indicates agreement/disagreement (see Figures 4-6 for example). We chose a relatively flat bell curve since the informants are knowledgeable about the issue at hand (Watts and Stenner). The selected group of informants rank the statements in relation to one another, in this case from 4 to -4. The result of each informants ranking is called the Q sort. Each Q sort was then analysed using a software called PQmethod. We factor-analyzed the Q sorts to find a small number of ideal factors that capture an acceptable amount of the studys overall vector variance (Watts and Stenner, 2012). Hence, the narratives presented are derived using a statistical process (Principal Component Analysis) and are the products of any subset of the participants who revealed similar views through the distribution of the sorted statements (Eden et al., 2005). Each factor or narrative are hence “idealized sorts” and not necessarily the exact Q sort of any participant (Webler and Danielson 2009). For this article, we chose a solution with three factors that represent groups of shared societal perspectives, and used automatic flagging. Finally, we analysed each of the three factors in detail in order to write a descriptive narrative.

### 3.1 Administering the Q sort

The aim of the concourse survey is to provide a comprehensive understanding of the range of opinions that exist on the topic at hand. This study forms part of the H2020 GENIALG project, where the Scottish Association for Marine Science is investigating the social acceptability of seaweed farming in several case studies across Europe, of which Scotland is one. Semi-structured interviews, workshops, and document analysis formed some of the activities in the Scottish case study (data was collected in 2017-2019). Based on the findings of these activities, a large number of statements was collected for the Q-sample. In order to reduce these to a manageable number that we could situate in through rich contextual data, we used the four pillars of sustainability to sift them: environmental, social, economic and institutional sustainability. This resulted in 20 statements shown in Table 2.

Table 2. Statements/ opinions (concourse) on seaweed cultivation in Scotland chosen by the authors from the Q-sample.

Environmental Sustainability	Social Sustainability	Economic Sustainability	Institutional sustainability
7 Seaweed cultivation should take place offshore	14 Seaweed cultivators should engage with local communities	4 Seaweed cultivation in Scotland should be developed for local markets	9 Seaweed cultivators should communicate with other users of the sea
10 Environmental sustainability of seaweed cultivation should be a priority	19 Seaweed cultivators should provide transparent information about farming techniques to the public	3 Local economic benefits should be put above nation-wide economic benefits	12 Co-operatives are a viable development option for seaweed cultivation companies
18 Seaweed cultivation is more environmentally acceptable than finfish cultivation	16 Seaweed cultivators should be aware of the social contexts that they work in	11 Seaweed cultivation should look to the circular economy as a model for development	1 Large-scale seaweed farms run by multi-national companies is the way forward
15 The current regulatory processes for seaweed cultivation are fit for purpose	8 Seaweed cultivation should enrich communities through traditional uses and knowledge re-enforcement	5 Seaweed cultivation in Scotland should be developed to be globally competitive	2 Locally run small to medium scale seaweed farms are the way forward
17 Seaweed cultivation should be prioritised over other uses of the marine environment	13 Seaweed cultivation should provide community benefits and local jobs	6 Seaweed cultivation in Scotland should be developed for regional and national markets	20 Seaweed cultivators should rely on regulators to establish best-practice guidelines

Participants undertaking the Q sort were asked to talk through their opinions on individual statements, why they chose to rank them as they did, and open comments on the subject area. This approach arguably provides both theoretical and empirical observations. Setting the results within context and offering a narrative to underpin the factor (Webler and Danielson, 2009). It is necessary to define perspectives before conducting a survey to measure the frequency of occurrence of perspectives in a population (Webler and Danielson, 2009).

Since the respondents, or “P-Sample”, are not selected in order to produce generalizable “patterns within and across individuals” (Barry and Proops, 1999, pp 339), a limited number of participants is acceptable and appropriate (Watts and Stenner, 2012). The number of participants (N=16) fits within the standard of the literature (Webler and Danielson, 2009). The 16 participants chosen were relevant to the question as they were; 1) already involved in the seaweed cultivation or harvesting industry, are currently undertaking science on seaweed cultivation, or 2) are interested in starting up a seaweed cultivation business or service, or 3) are regulators, or are seaweed industry association representatives (see Table 3).

Table 3. Overview of participants per sector. In the idealized q sort, 4 community representatives, 2 scientists, 1 regulator, 2 from harvesting sector, 2 seaweed cultivation companies and 4 from the supply chain/service sector were flagged by the automatic flagging in PQ method.

Community representatives	Science	Regulation	Harvesting	Seaweed cultivation company	Supply chain/service sector
5	2	1	2	2	4

## 4. Findings

As mentioned above, three distinct perspectives, or patterns, emerged from the factor analysis of the Q sort. Cumulatively, these explained 72% of the variance between the 16 Q sorts, shown in Table 4 (P1=25%, P2=25%, P3=22%). We understand the three factors as discourses, and we analyzed these based on the “crib-sheet method” (Watts and Stenner 2012). This means that while we focus on the distinguishing statements, which are those statements differing the most between the three discourses, we also address what the discourses agreed on, known as the consensus statements, as well as the statements in between. We give the three discourses titles based on their idealized sorts: 1) Environmental and social sustainability focus; 2) Economic and environmental sustainability with a global market focus and; 3) Social and institutional sustainability with local jobs as a priority.

Table 4. Factor matrix (Q Sort results) where ‘X’ indicates a defining sort using automatic flagging in PQ method.

Q sort	Stakeholder	Factors		
		1	2	3
1	Science	0.7504X	0.3158	0.0461
2	Harvester	0.8054X	0.1711	0.3792
3	Science	0.5045	0.5724X	0.0928
4	Regulation	0.5786X	0.3915	0.3518
5	Community representative	0.2558	0.6704X	0.2270
6	Supply-chain	0.1939	0.0809	0.8520X
7	Supply-chain	0.0587	0.4332	0.5022X
8	Seaweed cultivation company	0.7188X	0.2291	0.5153
9	Supply-chain	0.2110	0.5033	0.7317X
10	Community representative	0.2921	0.8009X	0.0540
11	Community representative	0.1752	0.8259X	0.1859
12	Harvester	0.6815X	0.3513	0.2898
13	Seaweed cultivation company	0.2395	0.8112X	0.3051
14	Community representative	0.4582	0.5203	0.5155
15	Supply-chain	0.3618	0.1584	0.8196X
16	Community representative	0.6938X	0.1373	0.5795
	<b>% expl. Variance</b>	<b>25</b>	<b>25</b>	<b>22</b>

Table 5. Factor Q sort values for each statement.

#	Statement	Factor Arrays		
		1	2	3
1	Large-scale seaweed farms run by multi-national companies is the way forward	-3	-3	-3
2	Locally run small to medium scale seaweed farms are the way forward	1	2	-1
3	Local economic benefits should be put above nation-wide economic benefits	0	1	-1
4	Seaweed cultivation in Scotland should be developed for local markets	0	-3	0
5	Seaweed cultivation in Scotland should be developed to be globally competitive	-1	4	0
6	Seaweed cultivation in Scotland should be developed for regional and national markets	-1	-1	-1
7	Seaweed cultivation should take place offshore	-4	-1	-2

8	Seaweed cultivation should enrich communities through traditional uses and knowledge re-enforcement	-1	-2	1
9	Seaweed cultivators should communicate with other users of the sea	2	0	1
10	Environmental sustainability of seaweed cultivation should be a priority	4	3	3
11	Seaweed cultivation should look to the circular economy as a model for development	1	0	0
12	Co-operatives are a viable development option for seaweed cultivation companies	1	3	1
13	Seaweed cultivation should provide community benefits and local jobs	3	1	4
14	Seaweed cultivators should engage with local communities	3	0	2
15	The current regulatory processes for seaweed cultivation are fit for purpose	-3	-4	-4
16	Seaweed cultivators should be aware of the social contexts that they work in	2	2	0
17	Seaweed cultivation should be prioritised over other uses of the marine environment	-2	-2	-2
18	Seaweed cultivation is more environmentally acceptable than finfish cultivation	0	0	-3
19	Seaweed cultivators should provide transparent information about farming techniques to the public	0	1	2
20	Seaweed cultivators should rely on regulators to establish best-practice guidelines	2	-1	3

#### 4.1 Factor 1 – Environmental and social sustainability focus

Five participants significantly associated with this factor; one from science, one from regulation, one seaweed cultivator, and two from wild seaweed harvesting (Q Sort 1, 2, 4, 8, 12). The main focus of this factor is environmental sustainability and social responsibility with a strong emphasis on local jobs and communication with local communities and other marine users by seaweed cultivation companies. This factor disagrees most strongly with the statement that seaweed cultivation should take place offshore. It also feels that the current regulatory regime is not fit for purpose, however participants were aware of ongoing efforts to improve regulation and regulatory agencies knowledge of the industry. This factor is neutral about issues related to economics and comparisons between seaweed and finfish cultivation.

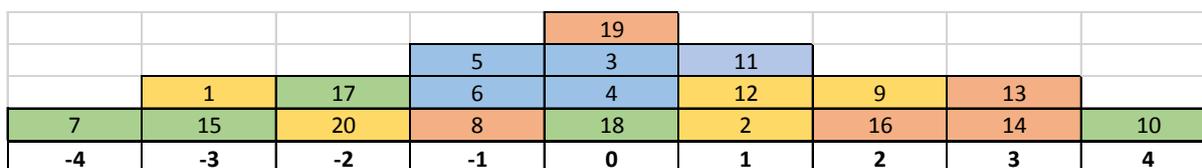


Figure 4: Ideal sort for factor 1. Factor name was chosen based on statements 7 and 14. Colour coding is based on the four pillars of sustainability (green = biological sustainability, blue = economic sustainability, Red = social sustainability and yellow = institutional sustainability).

#### 4.2 Factor 2 –Economic and environmental sustainability with a global market focus

The interviewees that represent factor two are three community representatives, one from science, and one seaweed company (Q Sort 3, 5, 10, 11 and 13). Factor two is very critical of the regulatory regime as it is perceived as slow and embryonic, with the regulators taking too much time to make decisions. This is the only factor that feels strongly that seaweed cultivation should focus on global markets, supplied by small to medium scale, locally run farms. Communication, collaboration and education featured heavily in discussion about why the participants disagreed with seaweed cultivation run on a large scale by multi-national companies or offshore and being prioritised over other uses of the sea. This factor is the one that is spread the most across the four pillars of sustainability and is also the only factor that feels strongly about economic aspects.

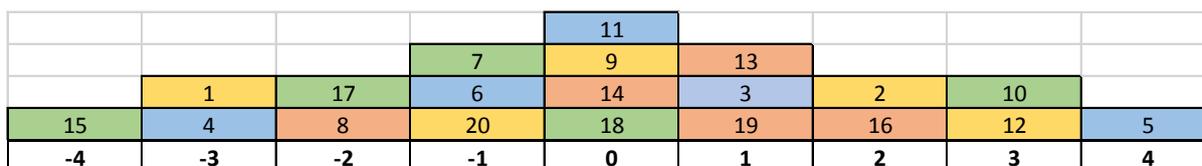


Figure 5: Ideal sort for factor 2. Factor name was chosen based on statements 15 and 5. Colour coding is based on the four pillars of sustainability (green = biological sustainability, blue = economic sustainability, Red = social sustainability and yellow = institutional sustainability).

### 4.3 Factor 3 –Social and institutional sustainability with local jobs as a priority

This factor is made up of participants from supply-chain/ service sectors (Q Sort 6, 7, 9, and 15). That participants feel very strongly that seaweed cultivation should focus on community benefits and local jobs, through an industry which is socially and environmentally sustainable. Linked to this, factor three strongly disagrees that large-scale seaweed farms run by multi-national companies is the way forward. Equally, this factor does not agree that markets should be constrained, but rather they should develop where there is demand, whether that be local, regional, national, or international so long as it provides local jobs. Despite not scoring communication and transparency as highly as possible it was a running theme throughout the comments about the statements. This factor, like all of the others, thinks that environmental sustainability is central and does not think that the current regulatory regime is fit for purpose.

				11				
			2	16	9			
	1	17	6	4	12	19	10	
15	18	7	3	5	8	14	20	13
-4	-3	-2	-1	0	1	2	3	4

Figure 6: Ideal sort for factor 3. Factor name was chosen based on statements 15 and 13. Colour coding is based on the four pillars of sustainability (green = biological sustainability, blue = economic sustainability, Red = social sustainability and yellow = institutional sustainability).

### 4.4 Cross-factor consensus

Statements that were not ranked significantly differently between perspectives are termed, areas of consensus. Four statements were non-significant for all perspectives at  $p > 0.05$ , as seen in Table 5. This means that the three factors felt similarly about the statement, both in terms of agreeing or disagreeing. It is clear that large-scale seaweed farms run by multi-national companies and limiting industry development to regional and national markets are not the optimal way forward according to all factors. Likewise, all factors agreed strongly that the environmental sustainability of seaweed cultivation should be a priority. Participants described the responsibility of this priority as being shared between cultivators and regulators, with an emphasis on collaboration between the two. This was to ensure there is enough knowledge to develop an efficient system for both regulation and good practice. There was variation across the participants as to whether good practice should be enforced by regulators, led by industry, or a mix of both. Some of the participants suggested that good practice is linked with social acceptability and in one case, the term “social license” was used.

Table 6. Agreement across factors: Those statements that do not distinguish between any pair of factors. Those listed here at the statements that are non-significant at  $P > .05$ .

#	Statement	Factor Arrays		
		1	2	3
1	Large-scale seaweed farms run by multi-national companies is the way forward	-3	-3	-3
6	Seaweed cultivation in Scotland should be developed for regional and national markets	-1	-1	-1
10	Environmental sustainability of seaweed cultivation should be a priority	4	3	3
17	Seaweed cultivation should be prioritised over other uses of the marine environment	-2	-2	-2

## 5. What could a successful seaweed cultivation sector look like?

In the interests of brevity, the following section explores the most prominent and contextually relevant of our results in relation to the four pillars of sustainability and our legitimacy framework. It should be noted that there is not a specific section focusing on social sustainability, as was found to be inextricable linked with environmental, economic, and institutional sustainability and is therefore interwoven throughout the sections in our discussion. The difficulty of defining social sustainability characteristics as distinct from the other pillars within the context of seaweed cultivation in Scotland, is evident.

### 5.1 The social importance of environmental sustainability

Across all factors, participants disagreed strongly with the statement that “*The current regulatory processes for seaweed cultivation are fit for purpose*”. When we categorised the statements in Table 2, this one was placed under the “environmental pillar” of sustainability, as we assumed that the regulations would lead to environmental sustainability. However, the Q sorting revealed differences in the interpretation of the issue.

Factor 1 disagrees with the statement as participants perceive that there is currently no effective regulatory process. Prominent reasons for this perspective included; marine licencing being viewed as too broad to be an efficient mechanism for regulation and that there is currently no testing of cultivated or harvested seaweeds (for heavy metals, contaminants etc.) bound for human consumption markets (Wood et al., 2017). Most participants noted that the regulations are based on other industries rather than specific knowledge of seaweed cultivation, advising that this is a recipe for social and environmental issues. Factor 2 bases their disagreement with the statement on the complexity of the situation, arguing that where there is work underway between the regulators and cultivators, it is viewed as “not there yet”. Put differently, the participants stated that regulation is embryonic, decision-making is slow, and not suitable for seaweed cultivation. Finally, Factor 3 disagrees because the participants had not heard of any regulatory processes and are therefore assumed that there are not any or they are not adapted to seaweed cultivation.

There was acknowledgement across the factors that regulators are making an effort to learn, but also that cultivators have an opportunity to develop good-practice that goes above and beyond the law. Going beyond compliance is a prominent theme in social license literature, often being recorded as a means to garner or maintain acceptance of a resource extractive or intensive industry (Gunningham et al., 2004; Howard-Grenville et al., 2008). When exploring this in terms of sustainability and legitimacy, the perception of lack of institutional effectiveness is perceived as a barrier to seaweed cultivation. However, we also see how the “in-put” end of legitimacy (that is participation, deliberation, and control) is potentially being constructed through willingness to learn and collaborate between regulators and cultivators.

All factors agree that “*Environmental sustainability of seaweed cultivation should be a priority*”. Participants in Factor 1, which rate this statement at 4, reasoned that there “*is no logical reason why it can't be [environmentally sustainable]*”, that it would be beneficial to have a form of aquaculture that has net positive environmental impact, and that both of these considerations will improve the social acceptability of the industry. Factor 2 rates this statement at 3. However, the reasoning provided by stakeholders for their choice was based on morality; “*it will keep me awake at night if it is not sustainable*”; “*it's about bringing people along with the industry and that will only happen if it is sustainable*”; “*to ignore environmental sustainability is madness*”. Moral legitimacy, as defined by (Suchman, 1995) is “sociotropic” – in other words, is based on “the right thing to do”, reflecting the values and beliefs of the individual as well as socially constructed norms. In this case, moral legitimacy could be linked with in-put legitimacy, given the former has been related to procedure and process (Weber, 1978 in Suchman, 1995). Factor 3 also rated this statement at 3. One stakeholder made an important point about the current emergent state of the seaweed cultivation industry in Scotland and the opportunities this position presents for sustainable development, best described in their own words:

*“Agriculture and aquaculture should strive for environmental sustainability. Here there is the opportunity for seaweed cultivation to have a positive impact on the environment if it's done correctly and we keep an eye on genetics and diseases. What is the point if it isn't? Seaweed cultivation in Scotland is in the privileged position not to have engrained poor environmental standards, if you start off from the perspective of environmental sustainability then it sets a good baseline to develop from.”*

All factors disagree that “*Seaweed cultivation should be prioritised over other uses of the sea*”. The reasons behind this disagreement were very similar and can be summarised as; the sea has too many uses and is important to too many people to have seaweed cultivation as a priority. We postulate that this view is related to seaweed cultivation being a new “player” in the coastal zone, hence, it does not take priority over other more traditional uses such as fishing or even farming salmon. Interestingly, both Factors 1 and 2 are neutral about the statement “*Seaweed cultivation being more environmentally acceptable than finfish*”, while Factor 3 disagrees quite strongly with this. The differences in opinion around this statement are related to the trade-offs that finfish aquaculture represents in Scotland. On the one hand, offering full time jobs and economic potential in rural coastal areas, and on the other causing environmental impacts (Tett et al., 2018).

Despite variation in reasoning and in some cases values, there is a shared desire across all factors and individual participants, that seaweed cultivation should be developed to have as little impact on the environment as possible. Further, that environmental sustainability offers pathways to legitimacy and social license for the industry as it was perceived to be a key component of decision-making (opposing or supporting developments) by local communities, other users of the sea and interested parties.

### 5.2 Institutional sustainability and the issue of scale

Across all factors, stakeholders disagree strongly with the statement “*large-scale seaweed farms run by multi-national companies is the way forward*”. This is unsurprising, given the current context of media scrutiny into multi-national owned finfish aquaculture (Billing, 2018), and the Scottish Government Seaweed Cultivation Policy Statement (focussing on small and medium scale farms) (Scottish Government, 2017). Factors 1 and 2 argued that a large-scale model would defeat the point of environmental sustainability and would lead to less community benefits and contribute less to rural coastal development. Many of the participants provided the example of salmon farming as a negative association between large corporations and sustainability goals. Nevertheless, resigned pragmatism was evident in participant perceptions as they note that these types of companies have capital, and therefore advised that the large-scale model might in fact, be the way that seaweed cultivation does develop. Interestingly, Factor 3’s disagreement with this statement was on the same basis as the other two but diverged through the perception it is difficult to hold multi-national companies accountable for any negative actions or impacts (either social or environmental). The same participants argued that the industry should develop at the scale necessary (be it small, medium or large scale), but monopolies on any level are undesirable and damaging to local communities. From these perspectives, it could be argued that large-scale seaweed cultivation is seen as economically legitimate, but not socially or environmentally legitimate.

The issue of scale is therefore perceived as institutional and relates to all pillars of sustainability. Who should be allowed to cultivate seaweed and at what scale, is seen as having an impact on 1) local benefits, 2) jobs, and 3) environment. This means that the institutional and regulatory structure of the seaweed cultivation industry should, at the least, recognise that local perceptions of a legitimate industry are not likely to stretch to large-scale, multi-national ownership. In turn, this understanding should inform the approach of those who embark on commercial-scale seaweed cultivation in Scotland, where the three attributes listed above should be at the forefront of good-practice, operational strategies, and communication with local communities, other users of the sea and interested parties.

### 5.3 Economic sustainability and which market to target

All factors disagree on the statement “*Seaweed cultivation in Scotland should be developed for regional and national markets*”. However, they do not feel strongly about it, rating it at -1. Stakeholders in Factor 1 had some reservations as they think that the industry should not exclude international markets, but should not be wholly focused on them either. Stakeholders in Factor 2 focussed on the current lack of local and regional markets, advising that tapping into already developed markets could provide the opportunity for innovative, high value products. Linked with this is the perception (and evidence seen here: Scotland Food and Drink (2018)) that seafood branded as “Scottish” is increasingly competitive in international markets. Factor 3 argues that since the national market is quite small or

under-developed, any market should be developed as long as there is enough demand. In sum, all factors think that there is a need to balance local, regional, national, and international markets (economic sustainability) with local jobs and community benefits (social sustainability) and environmental sustainability.

## 6. Predicting legitimacy for seaweed cultivation

Sustainable blue growth in coastal and marine areas in line with the stated objectives of Scotland's National Marine Plan (Marine Scotland, 2015) raises new challenges and demands. Such growth will increase the number and variety of activities and hence the spatial and temporal diversity and number of stakeholders in the coastal zone. In our study, we have investigated how the new industry of seaweed cultivation in the Scottish coastal zone should develop, as perceived by a wide variety of relevant stakeholders. We have linked the concept of legitimacy with the four pillars of sustainability, to further investigate what this perception will entail for future management and the likelihood of garnering social license to operate. Our results show a diverse range of characteristics that stakeholders emphasise as most important regarding sustainability. However, it is also evident that stakeholders share some views on what a "successful" seaweed sector would look like.

We see that the factors agree that the top priority for seaweed cultivation is to ensure it develops in an environmentally sustainable way, and that a small-scale approach with a focus on the local benefits such as job creation is more desirable than a large-scale approach. Moreover, there is a general consensus that production should be for all markets, even if the reasoning behind this view differs across factors. We found that there is a general agreement that the regulatory processes are not fit for purpose, and further discussion with participants suggests that in their current form, they are an obstacle for effective management. We also want to underline that while communication and transparency does not score very highly in the Q sort it was a running theme throughout conversations with participants about the statements.

There are also some diverging views, and here we will only point to the most relevant. To Factor 1 environmental and economic sustainability, is less important for developing the sector in a legitimate manner than local social benefits. For Factor 2, seaweed cultivation in Scotland should be developed to be globally competitive, at the same time as prioritising social sustainability through local scale cultivation and business models that support is the way forward (e.g. co-operatives). The overall priority of Factor 2 is environmental and economic legitimacy. This is also the only factor that rates the economic aspects of seaweed cultivation as important relative the other statements. Factor 3 is mostly concerned with issues relating to social and institutional legitimacy, where local jobs and robust regulation are viewed as key.

As this is a new industry, there is little empirical evidence about its legitimacy regarding both processes (in-put) for seaweed cultivation and the effectiveness (out-put) of the different dimensions. What we find in our analysis is that there are both shared and diverging viewpoints about how seaweed cultivation should develop in the future in order to be legitimate and, arguably, more effective and sustainable. In line with (Raasgever et al., 2008) we argue that this overview of stakeholders' perspectives can be useful for the development of seaweed cultivations as it can help to; a) set the research agenda; b) identify differences in values and interests that need to be discussed; c) create awareness of issues

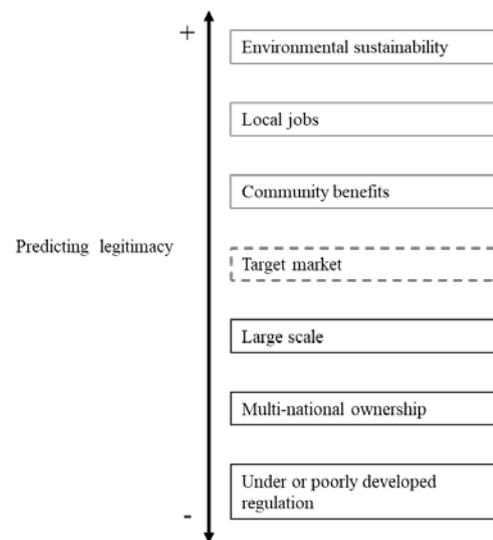


Figure 7. Characteristics predicting a legitimate seaweed cultivation sector in Scotland, based on the results of all three factors. Boxes in black are likely to be less legitimate, boxes in grey are likely to be more legitimate, and the dashed line box shows the characteristics that is neutral.

among a broad range of stakeholders, and; d) characterise potential development scenarios. This last statement is especially true in the context of seaweed cultivation in Scotland as it is an emergent industry that holds a lot of promise, but also has some potential pitfalls (Cottier-Cook et al., 2016). In this article we have pointed to some key issues that can improve the overall legitimacy of seaweed cultivation (Figure 7). This research suggests that a successful seaweed industry is perceived as one that is environmental and socially sustainable, where local benefits and local jobs are key. We found there is potential to improve the current regulatory processes in place for seaweed cultivation in Scotland, which could empower those who want to diversify into it, at the same time as improving trust in the industry for those who are sceptical.

### 6.1 Implications for theory and practice for sustainable seaweed cultivation

Reaching national blue growth goals within the framework of sustainable development, can be hampered if regional and local social contexts are not accounted for (Rybråten et al. 2018; Hersoug, 2013; Osmundsen et al. 2020; Krause et al. 2015). As such, it is important to recognize that the coastal zone is far from empty, with several sectors, uses and users vying for space at any one time. As seaweed cultivation is a nascent industry in the North Atlantic, with much touted potential for various sustainable value-chains (e.g. pharmaceuticals, nutraceuticals, biofuel, bioplastics, to name a few) (van den Burg et al. 2019), characterising the potential for it to be perceived as legitimate by a diverse range of key stakeholders, is an important issue to explore. However, studies on stakeholder perceptions are typically based on qualitative data (Barry and Proops, 1999, Bjørkan and Veland, 2019) which to some, especially the natural sciences, industry and regulators who are traditionally trained in quantitative approaches, can be vague and diffuse (see for instance Law, 2004; Sovacool et al., 2018). To address this issue of language and understanding across disciplines and sectors, we used Q method in a novel way, combining rich qualitative narrative, with quantitative data, set within the four pillars of sustainability. We hope that this can help more disciplines draw clear lines of understanding between sustainability, perceived legitimacy of coastal activities to stakeholders, and strategies for garnering and maintaining social license to operate for blue growth industries. Hence, we suggest that Q-method, styled in this way, is an approach that has the potential to increase positive impact of qualitative studies by making them more approachable to those outside the social scientific community. This is not a critique of qualitative methods, rather, an understanding that in order to contribute to the solutions to real-life problems, we must find a way to communicate across disciplines and sectors. Simply put, Q allows us to pinpoint issues that will generate areas of consensus and conflict, providing a fundamental understanding of stakeholder perceptions of how blue growth sectors should develop.

## References

- Argyll and Bute Council (2017) 'News from Argyll and Bute Economic Development and Strategic Transportation Service', Transformation, p. 3. Available at: [https://www.argyll-bute.gov.uk/sites/default/files/autumn\\_2017\\_v2.pdf](https://www.argyll-bute.gov.uk/sites/default/files/autumn_2017_v2.pdf).
- Baines J and Edwards P (2018) The role of relationships in achieving and maintaining a social licence in the New Zealand aquaculture sector. *Aquaculture*. Elsevier, 485, pp. 140–146. doi: 10.1016/J.AQUACULTURE.2017.11.047.
- Bak UG, Mols-Mortensen A and Gregersen O (2018) Production method and cost of commercial-scale offshore cultivation of kelp in the Faroe Islands using multiple partial harvesting. *Algal Research*. Elsevier, 33, pp. 36–47. doi: 10.1016/J.ALGAL.2018.05.001.
- Billing S (2018) Using public comments to gauge social licence to operate for finfish aquaculture: Lessons from Scotland. *Ocean and Coastal Management*. Elsevier, 165 (September), pp. 401–415. doi: 10.1016/j.ocecoaman.2018.09.011.



- Birnbaum S (2015) Environmental co-governance, legitimacy, and the quest for compliance: when and why is stakeholder participation desirable? *Journal of Environmental Policy and Planning*.  
<http://www.tandfonline.com/doi/full/10.1080/1523908X.2015.1077440>
- Bjørkan M (2011) Fishing for advice - the case of the Norwegian fishing fleet. PhD Thesis, University of Tromsø, Faculty of Biosciences, Fisheries and Economics, Norwegian College of Fisheries Science.
- Bjørkan, M. and S. Veland (2019) Beyond consensus: Perceptions of risk from petroleum developments in Lofoten, Vesterålen and Senja, Norway. *ICES Journal of Marine Science*. Doi:  
<https://doi.org/10.1093/icesjms/fsz056>.
- Brooker EE, Hopkins CR, Devenport E, Greenhill L and Duncan C (2019) Civil society participation in the Scottish marine planning process and the role of Environmental Non-Governmental Organisations. *Journal of Environmental Planning and Management*. Routledge, 62(12), pp. 2101–2123. doi:  
10.1080/09640568.2018.1532876.
- Burrows M, Fox C, Moore P et al. (2018) Wild Seaweed Harvesting as a Diversification Opportunity for Fishermen: A Report for Highlands and Islands Enterprise. Available at:  
[http://eprints.whiterose.ac.uk/137123/1/02376\\_WildWeed\\_Report\\_Clean\\_Issue.pdf](http://eprints.whiterose.ac.uk/137123/1/02376_WildWeed_Report_Clean_Issue.pdf)
- Bäckstrand K, Khan J, Kronsell A, et al. (2010) *Environmental Politics and Deliberative Democracy: Examining the Promise of New Modes of Governance* UK: Elvar Edgar Publishing. doi:  
10.4337/9781849806411.
- Campbell I, Macleod A, Sahlman, C et al. (2019) The Environmental Risks Associated with the Development of Seaweed Farming in Europe - Prioritizing Key Knowledge Gaps. *Frontiers in Marine Science*, 6(March). doi:  
10.3389/fmars.2019.00107.
- Connelly S, Richardson T and Miles T (2006) Situated legitimacy: Deliberative arenas and the new rural governance. *Journal of Rural Studies*. Volume 22, Issue 3, 2006. pp 267-277. <https://doi.org/10.1016/j.jrurstud.2005.11.008>.
- Cooney J (2017) Reflections on the 20th anniversary of the term “social licence. *Journal of Energy and Natural Resources Law*. Taylor & Francis, 35(2), pp. 197–200. doi: 10.1080/02646811.2016.1269472.
- Cottier-Cook EJ, Nagabhatla N, Badis Y et al. (2016) Policy Brief: Safeguarding the future of the global seaweed aquaculture industry. Available at: <https://www.sams.ac.uk/t4-media/sams/pdf/globalseaweed-policy-brief.pdf>
- Cullen-Knox C, Fleming A, Lester L, et al. (2019) Publicised scrutiny and mediatised environmental conflict: The case of Tasmanian salmon aquaculture. *Marine Policy*. Pergamon, 100, pp. 307–315. doi:  
10.1016/J.MARPOL.2018.11.040.
- Dingwerth K (2007) *The New Transnationalism: Transnational Governance and Democratic Legitimacy*, Basingstoke: Palgrave Macmillan.
- FAO (2018) The State of Fisheries and Aquaculture in the world 2018, FAO. Org. Available at:  
<http://www.fao.org/state-of-fisheries-aquaculture>.
- Gehman J, Lefsrud LM and Fast S (2017) Social license to operate: Legitimacy by another name?. *Canadian Public Administration*, 60(2), pp. 293–317. doi: 10.1111/capa.12218.
- Hersoug, B (2013) The battle for space — the position of Norwegian aquaculture in integrated coastal zone planning. In: Moksness, E., Dahl, E., Støttrup, J. (Eds.), *Global Challenges In Integrated Coastal Zone Management*. Wiley-Blackwell, Oxford, pp. 159–168.
- Hogl K, Kvarda E, Nordbeck R and Pregernig, M (2012) Legitimacy and effectiveness of environmental governance: concepts and perspectives. Available at:  
[https://www.researchgate.net/publication/261707801\\_Legitimacy\\_and\\_effectiveness\\_of\\_environmental\\_governance\\_concepts\\_and\\_perspectives](https://www.researchgate.net/publication/261707801_Legitimacy_and_effectiveness_of_environmental_governance_concepts_and_perspectives). DOI: 10.4337/9781849802703.00008.

- Jentoft S (2000) Legitimacy and disappointment in fisheries management. *Marine Policy* 24(2): 141-148. Doi: [https://doi.org/10.1016/S0308-597X\(99\)00025-1](https://doi.org/10.1016/S0308-597X(99)00025-1)
- Kelly, R, Pecl, GT, and Fleming, A. (2017) Social licence in the marine sector: A review of understanding and application. *Marine Policy*. Pergamon, 81, pp. 21–28. doi: 10.1016/J.MARPOL.2017.03.005.
- Krause G, Brugere C, Diedrichde A, et al. (2015). "A revolution without people? Closing the people–policy gap in aquaculture development." *Aquaculture* 447: 44-55. <https://doi.org/10.1016/j.aquaculture.2015.02.009>
- Marine Scotland (2012) Strategic Environmental Assessment (SEA) Scoping Report Seaweed; Policy Statement. Available at: <https://www2.gov.scot/seag/seagDocs/SEA-00715/12730.pdf>.
- Marine Scotland (2015) Scotland’s National Marine Plan: A Single Framework for Managing Our Seas. Available at: <http://www.gov.scot/Publications/2015/03/6517/0>.
- Moffat K and Zhang A (2014) The paths to social licence to operate: An integrative model explaining community acceptance of mining. *Resources Policy*. 39, pp. 61–70. doi: 10.1016/j.resourpol.2013.11.003.
- Nofima (2018) Utvikling av bærekraftportal for norsk havbruk [development of a sustainability portal for Norwegian Aquaculture]. Report 35/28. Faglig sluttrapport Kine Mari Karlsen, Ulf Winther (SINTEF Ocean), Roy Robertsen, Eirik Mikkelsen & Roger Richardsen (SINTEF Ocean).
- Osmundsen TC, Amundsen VS, Alexander, KA, Asche, F et al. (2020). "The operationalisation of sustainability: Sustainable as defined by certification schemes. *Global Environmental Change*. <https://doi.org/10.1016/j.gloenvcha.2019.102025>
- Provasnek AK, Sentic A and Schmid, E (2017) Integrating Eco-Innovations and Stakeholder Engagement for Sustainable Development and a Social License to Operate. *Corporate Social Responsibility and Environmental Management*, 24(3), pp. 173–185. doi: 10.1002/csr.1406.
- Raadgever GT, Mostert E and van de Giesen NC (2008) Identification of stakeholder perspectives on future flood management in the Rhine basin using Q methodology. *Hydrol. Earth Syst. Sci.* 12 1097-1109
- Schmidt VA (2013) Democracy and legitimacy in the European Union revisited: In-put, out-put and ‘throughput’. *Political Studies*, 61(1), 2-22. Doi.: <https://doi.org/10.1111/j.1467-9248.2012.00962.x>
- Sovacool BK, Axen J, Sorrel S (2018) *Promoting novelty, rigor, and style 628 in energy social science: Towards codes of practice for appropriate methods and research design*. *Energy Research & Social Science* 45: 12-42. <https://doi.org/10.1016/j.erss.2018.07.007>.
- Risse T (2004) Global governance and communicative action. *Government and Opposition*, 39(2), 288–313.
- Rybråten S, Bjørkan M, Kaltenborn B and Hovelsrud G (2018) Sustainable coasts? Perceptions of change and livelihood vulnerability in Nordland, Norway. *Local Environment* 23(12) <https://doi.org/10.1080/13549839.2018.1533931>
- Scharpf FW (1999) *Governing in Europe: Effective and democratic?* New York: Oxford University, New York: Oxford University.
- Scotland Food and Drink (2018) Industry performance review 2018. Available at: <http://clients1.ibisworld.com/reports/us/industry/currentperformance.aspx?entid=5715#KED>.
- Smale, DA, Burrows MT, More P, et al. (2013) Threats and knowledge gaps for ecosystem services provided by kelp forests: A northeast Atlantic perspective. *Ecology and Evolution*, 3(11), pp. 4016–4038. doi: 10.1002/ece3.774.
- Stephenson W (1953) *Q-technique and its methodology*. Chicago IL, The University of Chicago Press.
- Suchman MC (1995) Managing Legitimacy: Strategic and Institutional Approaches. *Academy of Management Review*, 20(3), pp. 571–610. Available at: [https://www.jstor.org/stable/258788?seq=1#metadata\\_info\\_tab\\_contents](https://www.jstor.org/stable/258788?seq=1#metadata_info_tab_contents)

Tett P, Verspoor E, Hunter D, et al. (2018) Review of the environmental impacts of salmon farming in Scotland. Available at: [http://www.parliament.scot/S5\\_Environment/General Documents/20180125\\_SAMS\\_Review\\_of\\_Environmental\\_Impact\\_of\\_Salmon\\_Farming\\_-\\_Report.pdf](http://www.parliament.scot/S5_Environment/General Documents/20180125_SAMS_Review_of_Environmental_Impact_of_Salmon_Farming_-_Report.pdf).

The Scottish Government (2017) Seaweed Cultivation Policy Statement. Available at: <http://www.gov.scot/Resource/0051/00515518.pdf>.

The Scottish Government (2019a) Marine and Coastal Economy and Communities. Available at: <https://economicactionplan.mygov.scot/place/marine-and-coastal/> (Accessed: 7 November 2019).

The Scottish Government (2019b) Seaweed Review. Available at: <https://www2.gov.scot/Topics/marine/seamanagement/seaweedrev> (Accessed: 5 November 2019).

Van den Burg SWK, Van Dejuin AP, Bartelings H et al. (2016) The economic feasibility of seaweed production in the North Sea. *Aquaculture Economics & Management*. Taylor & Francis, 20(3), pp. 235–252. doi: 10.1080/13657305.2016.1177859.

Van den Burg, SWK, Dagevos, H and Helmes, RJK (2019) Towards sustainable European seaweed value chains: a triple P perspective. *ICES Journal of Marine Science*. doi: 10.1093/icesjms/fsz183.

Watts S and Stenner P (2012) *Doing Q Methodological Research: Theory, methodology and interpretation*. London: Sage Publications Ltd.

Weber M (1971) *Makt og byråkrati: essays om politikk og klasse, samfunnsforskning og verdier*. Oslo, Gyldendahl.

Weber M (1946) From Max Weber, tr. and ed. by H. H. Gerth, and C. Wright Mills. New York: Free press

Webler T and Danielson S (2009) Using Q Method to Reveal Social Perspectives in Environmental Research, pp. 1–53. Available at: [https://www.researchgate.net/publication/273697977\\_Using\\_Q\\_Method\\_to\\_Reveal\\_Social\\_Perspectives\\_in\\_Environmental\\_Research](https://www.researchgate.net/publication/273697977_Using_Q_Method_to_Reveal_Social_Perspectives_in_Environmental_Research)

Wilson DC (2009) *Paradoxes of transparency -science and the ecosystem approach to fisheries management in Europe*. Amsterdam, Amsterdam University Press.

Wood D, Caluzzo E, Kirby D et al. (2017) UK macroalgae aquaculture: What are the key environmental and licensing considerations? *Marine Policy*. Pergamon, 83, pp. 29–39. doi: 10.1016/J.MARPOL.2017.05.021.

