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UK macroalgae aquaculture: What are the key environmental and licensing considerations?

Daniel Wood[a,*], Elisa Capuzzo[a], Damien Kirby[a], Karen Mooney-McAuley[b], Philip Kerrison[c]

[a] Centre for Environment, Fisheries and Aquaculture Science (Cefas), Pakefield Road, Lowestoft NR33 0HT, UK
[b] Queen's University Belfast, Queen's University Marine Laboratory, 12-13 The Strand, Portaferry, Co. Down BT22 1PF, UK
[c] SAMS, Scottish Marine Institute, Oban, Argyll PA37 1QA, UK

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ABSTRACT

Macroalgae has numerous commercial uses and the potential to create large carbon sinks. The study reviewed the legal context, including environmental and social aspects, for the setting up of a seaweed farm in the UK. A lease is required to use the seabed and a Marine Licence is required from the national regulator. There is no need for new legislation, however, the existing guidance should be updated. There is a major need to clarify what level of assessment is required as part of the marine licensing process. The environmental and social considerations to licensing were also reviewed. Changes to the hydrodynamics and sediment transport are expected in and around the farm. These may lead to changes in seabed siltation and light levels. The addition of hard substrate (from the anchors) and a macroalgae canopy lead to attraction of benthic animals, fish, marine mammals and birds. These, in addition to potential changes in organic matter and nutrients reaching the seabed from exudate and detritus, could create changes in existing benthic communities on the seafloor. No reason for major population-level impacts were seen. However, numerous knowledge gaps where identified. Scale appears to be an important consideration. A small farm on its own is unlikely to have a large effect on the marine environment. However, a very large farm, or multiple small farms next to each other could have a more notable effect. Knowledge gaps were identified and recommendations were provided that can assist the development of the UK macroalgae farming industry.

1. Introduction

Macroalgae aquaculture – the farming of seaweeds and kelps, shows potential to provide a valuable source of algal biomass for a wide variety of products. These range from food products [59] cosmetics, medicines and pharmaceuticals [116], new materials such as biopolymers for use in solar panels [8] and particularly biofuels [43]. A large market for macroalgae already exists in several parts of the world, with production in 2013 reaching almost 26.9 million tonnes wet weight farmed, with an estimated value of $6.6 billion [42]. Asian countries are the biggest seaweed producers, with China being the largest producer, harvesting 13.4 million tonnes wet weight (50.1%) and Indonesia the second largest with 9.3 million tonnes (34.6%) [42]. In the UK, macroalgae have traditionally been wild-harvested in coastal communities for hundreds of years, and used for food, feed and as fertiliser. However, harvesting of wild populations is not a feasible long-term option and is nearing its sustainable limit [113]. It is estimated that 2000 – 3000 dry tonnes (equivalent to 25,000–40,000 t wet weight) of macroalgae are harvested per year in the UK to produce food and feed products as well as speciality chemicals and fertilisers [113]. To date there have been no economic studies published on macroalgae aquaculture for the UK. However, studies from Ireland [14] and the wider North Sea [126] suggest that there is still a notable gap to be overcome before offshore farming becomes viable. Despite the economic challenges interest in commercial macroalgae farming continues to grow.

Along with the economic uses of macroalgae, farming would have social benefits such as creating jobs in coastal areas and improved economic sustainability for coastal/island communities; it would also have environmental benefits regarding sequestration of carbon dioxide and the amelioration of pollutant loads of nutrients, in particular nitrogen. Marine primary producers act as carbon sinks ("Blue Carbon") and are responsible for 55% of the world carbon fixation [87]. In particular, marine macroalgae could represent a significant sink for anthropogenic CO_2. The cultivation and harvesting of seaweeds could play an important role in carbon sequestration and reduction of greenhouse gas emissions [27].

There are however, many challenges and hurdles to be overcome if

* Corresponding author.
E-mail address: daniel.wood@cefas.co.uk (D. Wood).

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Table 1
Overview of Marine Licence regulators by country within the UK. (Inshore waters are defined as 0–12 NM, offshore waters defined as 12 NM – edge of UK Economic Exclusive Zone or the UK continental shelf [85].

Country	*Regulator*	*Remit*	*Consultees*
England	Marine Management Organisation	Licensing of marine activities under the Marine and Coastal Access Act (2009). Responsibility for screening activities to determine if a licence is required.	Advice and consultation comes from scientific advisors, local/relevant bodies including heritage trusts, lighthouse authority, Maritime and Coastguard Agency and relevant statutory nature conservation bodies. Advice may be taken from organisations across the UK.
Northern Ireland	Department of Environment (inshore waters) Marine Management Organisation (offshore waters)	Provision of Marine licensing in adherence with the Marine and Coastal Access Act (2009) and the Marine Licensing (Civil Sanctions) Order (Northern Ireland) 2011.	
Scotland	Marine Scotland	The Marine Scotland Licensing Operations Team (MS-LOT) provide marine licensing services and enforcement under the Marine (Scotland) Act 2010 (within Scottish inshore waters and under the MCAA 2009 in offshore regional waters (12–200 NM). Macroalgae farms located in Shetland and certain parts of Orkney require an additional works licence from the relevant Harbour of Port Authority. Works Licences ensure that all relevant consultations have been carried out and that there are no adverse effects on the safety of navigation within the Harbour or Port area.	
Wales	National Resource Wales (NRW) (inshore waters) Marine Management Organisation (offshore waters)	NRW Marine Licensing Team (MLT) is responsible for the determination of marine licence applications, ensuring compliance with all relevant legislation in Welsh inshore waters.	

a sustainable macroalgae farming industry is to develop in the UK. Much of this relates to the process of licensing for macroalgae farming. The process of setting up a macroalgae farm in the UK is not clear. While legislation covering aquaculture exists, it has yet to be interpreted for macroalgae culture. This creates considerable uncertainty for potential developers and farmers. There are also a great number of unknowns of the environmental effects (both positive and negative) of macroalgae farming. In turn this further increases the uncertainty (and therefore the risk) for both farmers and regulators.

The purpose of this paper is threefold:

(1) Firstly, the legal and regulatory context of setting up a macroalgae farm was reviewed. Specifically, the following question was addressed: Does relevant legislation exist and is it clear to prospective farmers (and regulators)?
(2) Secondly, the existing evidence base was examined. The critical questions here are:

- Is the evidence base sufficient to allow regulators and their advisors to make informed decisions on applications?
- What are the environmental and social considerations when deploying a macroalgae farm off the UK coast that need to be considered when applying for a marine licence?

(3) Finally, the findings from (1) and (2) are drawn together to provide recommendations that will both assist the macroalgae farming industry in developing, while at the same time allowing regulators to assess applications in an effective manner.

2. Legal and regulatory requirements

The aquaculture consenting processes for England, Scotland and Wales, including algae, have recently been reviewed to varying degrees [2,24,92]. The process for Northern Ireland is essentially the same as in these other parts of the UK. There are two permissions that must be obtained before any development can be introduced to the marine environment in the UK. These are: a lease from The Crown Estate and; a marine licence from the relevant regulator.

2.1. Crown Estates lease

Prospective macroalgae farmers should initially contact the land owner to obtain permission to use proposed area of seabed. In nearly all areas of inshore waters around the UK this is The Crown Estate (custodians of the UK seabed out to the 12-nautical mile (NM) territorial sea limit). A lease must be obtained from The Crown Estate, incurring an annual fee for the lease duration [122]. When applying for a Crown Estate lease, applicants must specify the coordinates of the area proposed for development, along with a description of the cultivation equipment to be deployed and details of how the site would eventually be decommissioned. The Crown Estate also requires an outline of the business / production plan to verify that the prospective development is financially viable. If a marine licence has not yet been granted at the point of application, a lease-option can be obtained, which would remain in place until statutory consent is granted, but would lapse if the consent is not granted within the period specified in the option agreement. A lease-option does not permit development but provides the security of a time-limited exclusive interest in an area of seabed whilst regulatory licence applications and associated information are prepared and submitted.

While the process for applying for a lease appears straight forward, it is notable that all guidance currently refers to fin and shellfish aquaculture, with little or no mention of macroalgae culture. The Crown Estate rental rates are based on the value of the business undertaken and the nature of the development. Finfish farm lease rents are levied as a production-related tariff, while those for shellfish farm leases and macroalgae farm leases are levied on the type and amount of infrastructure installed (i.e. moorings, buoys, lines, platforms etc.). Applicants looking to develop macroalgae farms submit the generic ‘fish farm application form’. Upon receipt of an application, The Crown Estate advises whether the area is available for lease and also provides information on any neighbouring activities that might impact upon the proposed macroalgae farm. For example, the location of any nearby sewage outfalls would affect site suitability if the farmed product (or any waste/by-product) were destined for human consumption.