Seaweed Aquaculture and Wild Harvesting in Jersey

An assessment of potential and viability with recommendations for future management of the resource

GROWTH, HOUSING AND ENVIRONMENT

MARINE RESOURCES SECTION

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CONTENTS

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1 - INTRODUCTION

For centuries seaweed has been harvested from the shores around Jersey for use as a soil conditioner and fertiliser or as an additive to the glass-making industry. Traditionally it was either burnt for pot ash or applied directly to the fields in its natural state. The value of seaweed was such that rights to different areas of foreshore existed and were closely guarded. Cart tracks were hewn into the rocks to allow quick and efficient access to the lower shore. Laws were passed to control harvesting and ensure areas were not completely denuded of seaweed. However, with the advent of modern fertiliser the use of seaweed on the fields all but died out. While there are still a few farmers who continue to use seaweed as a fertiliser the demand for seaweed from farming is now much diminished.

In recent years new commercial applications for seaweed use have been developed and more are likely to come into play as research continues. In 2014 Jersey enacted new legislation that will allow seaweed, and other non-commercialised marine flora and fauna, to be managed in a way that is practical, sustainable and appropriate to the island's available marine resources. As part of this there is the need to examine possible uses and apply appropriate extraction criteria and limits for the exploitation of the resource.

The harvesting of seaweed in the Bailiwick of Jersey is currently controlled by two areas of legislation.

1 - The *loi (1970) (Amendment No. 3) sur la coupe et la pêche des vraics* which allows legal harvesting of seaweed annually from 1 February to 30 April between sunrise and sunset from Monday to Saturday each week.

During this period there is no limit to the quantity of seaweed that may be harvested. During the remainder of the year the law prevents the harvesting of any live, attached seaweed directly from the seashore or seabed. Detached seaweed found in the surf zone or on the beach, often referred to as storm cast, may be gathered legally throughout the year.

2 - Modern legislation was brought in through the *Aquatic Resources (Jersey) Law 2014* which allows for the control of any marine resource not directly covered by the *Sea Fisheries (Jersey) Law 1994*. However, the law has not yet come into force as suitable supporting regulations under the law have not been developed.

Currently harvesting is practiced by a small number of cottage industry scale businesses which utilise seaweeds (both cut and gathered) for a range of locally marketed culinary, agricultural and body-care products. It has been suggested that a daily allowance should to be made to accommodate this use and allow the Aquatic Resources (Jersey) Law 2014 to come into force.

This report explores the potential for seaweed harvesting in Jersey waters and makes recommendations regarding potential uses, focusing on their viability and sustainability on an island scale.

2 – Seaweed Harvesting

2.1 - COMMERCIALISED USES

Seaweeds (i.e. marine macro-algae) have been used for thousands of years as food, fuel, medicine and as animal feed. Today the range of applications has expanded to include everything from potential agents against sexually transmitted infections (*U. pinnatifida*) to clearing agents for the brewing industry (*C. crispus*). Use of seaweed and the products extracted from it is an ongoing focus for industrial research and development. For example, companies in the UK are looking at seaweed as a potential third generation biofuel as it does not compete with agriculture for land or fresh water resources.

Listed below in table 1 are the main categories of commercial European seaweeds use with the relevant species or families of seaweed in brackets.

Species / **Use**	*A. armata*	*A. esculenta*	*A. nodosum*	*C. crispus*	*D. contorta*	*Cermaium spp.*	*D. sanguinea*	*F. serratus*	*F. spiralis*	*Fucus spp.*	*Gracilaria spp.*	*H. elongata*	*M. stellatus*	*Porphyra spp.*	*P. Palmata*	*Laminaria spp.*	*Laurencia spp.*	*Ulva spp.*	*U. pinnatifida*
Bioenergy										X						X		X	
Fertilizers/agro chemicals			X					X	X							X			
Animal feeds		X	X												X			X	
Seaweed baths								X											
Body-care				X	X					X			X		X	X			
Cosmetics	X		X	X									X						
Pharmaceutical	X			X									X			X			X
Biotechnology					X	X	X			X	X					X	X		
Fresh & processed foods, supplements / Nutraceutical		X		X								X	X	X	X	X		X	X

Table 1. Known uses for seaweed by species/genus. [Source: Netalgae (2012) report].

Seaweed products range in value from less than £1/kg (fuel, raw animal feed, soil conditioner) up to close to £5,000/kg (nutraceuticals, cosmeceuticals, special medical/technological applications). The potential for many higher value products remains speculative and is reliant on predicted technological developments expected to come into play between 2020 and 2030 (as reported by Cefas in 2016). At the other end of the scale the lower value products (£1 - £5/kg) will probably be uneconomic to bring to market in Jersey, either due to the price of readily available alternatives or because of competition with producers in Asia and South America.

The mid-range of products where prices range between £5 and £1000/kg looks to be more viable for Jersey. A majority of these products are focused around luxury/specialist food, cosmetic and beauty products that command a good price but have modest volume sales. Demand for these products exists locally but is limited relative to the potential supply and export will be required to create an industry of significant value to the local economy.

Processing will likely need to take place on island so the costs of this will need to be considered in the viability of the industry along with market security and ease of distribution routes. The cost and complexity of processing ranges widely depending on the product/quality required.

Organic Status (EC regulation n°710/2009) can be gained for seaweeds harvested from, or grown in, waters that are consistently rated as good or very good under the EU Water Framework Directive. Additionally, organic standards requires the following:

- Sustainable updated management plan
- Renewable energy sources and recycled material being preferred
- Harvesting carried out with minimal harm to the aquatic environment
- Cultivation must utilize naturally occurring nutrients in the environment or from organic animal production
- Cultivation must be part of polycultural system
- Organic and non-organic macroalgae kept separately
- Conversion period from traditional to organic farming is 6 months or a life cycle
- Drying must not be done in direct contact with flames

Species Profile: *Sargassum muticum*

S. muticum is a prolific non-native seaweed that was first reported in Jersey in 1980. It quickly dominated Jersey's seashore and is considered a pest in many ports and estuaries and can easily become tangled in a boat's propellers once detached and free floating. Its growth is seasonal, dying back in the winter, but reaching eight meters in the summer.

Multiple management strategies have been considered across Europe but the only realistic control method is manual harvesting. This brings up the question of what to do with it once harvested. *S. muticum* has a naturally high content of antioxidants, carotenoids and phenols, including the well-known anti-cancer compound fucoxanthin meaning it may have pharmacological applications. Work is ongoing in determining how best to extract and utilise these but the benefits of consuming the plant fresh are recorded as matching it in a processed form. The species is also exceptionally good at absorbing heavy metals, cadmium and arsenic and as arsenic has been flagged as on the rise in Jersey waters this may present an issue to its use. *S. muticum* is not viable for anaerobic digestion due to the high levels of O_2 it stores in its floats and the phenols which inhibit the methanogenic bacteria.

2.2 - MANUAL HARVESTING

At present hand cutting and gathering of storm cast seaweed is carried out by several individuals both for personal use and small scale commercial enterprises. Various species of seaweed are either supplied fresh to the restaurant trade or go through drying/processing for use in cosmetics, as speciality foods, and as soil conditioners for the Jersey royal potato industry.

Gathering for food and cosmetics is small in scale and generally limited by what a person can carry up the beach. Harvests of more than 20kg per day are unusual. Seasonal gathering of vraic on the strandline by farmers is greater with trailer loads being collected in a single session.

2.3 - MECHANICAL HARVESTING

The harvesting of live and storm cast vraic was historically a major business in Jersey with seaweed being used by the agriculture and potash industries. Harvesting of seaweed on an industrial scale has not been widely practiced in Jersey since the 1950s when effective inorganic fertilizers were introduced to agriculture.

The mechanised harvesting of seaweed takes place along several European coastlines including those of France and Britain. The commonest technique involves using boats to gather live kelp (*Laminaria* spp.) using a *scoubidou*, a mechanical device which twists kelp from the seabed. Mechanised harvesting can cause significant damage to the seabed and interferes with the ecosystem services provided by kelp forests which are principally nursey functions, erosion control and primary production. It can take up to five years for kelp areas to recover from harvesting which makes the industry difficult to manage sustainably in areas of low supply.

Harvesting using a scoubidou is prohibited in Jersey's no mobile gear zones which cover 150km^2 of the island's shallow marine area. Looking at UK and European operations, the commercial harvesting scale required for low value products is likely to outstrip the available supply in Jersey waters. Removal of a significant proportion of the island's kelp and wrack beds through harvesting might have a serious knock on impact on the lobster and crab populations that utilise this habitat.

2.4 – AQUACULTURE

Seaweed aquaculture is a practice well established in many parts of the world. As the range of industrial, medical, cosmetic and culinary uses for different species of seaweed grows it may become a viable industry for our waters. Cultivating seaweed might be preferable to wild harvesting as it does not remove algal biomass from the system and is simpler to monitor and regulate.

The most viable system for farming seaweeds in our waters is probably the use of tightly twisted lengths of net, rigged onto a floating or static metal frame. Some farms use a corner anchored grid pattern, others a hexagonal spider's web on a central anchor. Several other designs exist for European waters but the suitability of each would need to be assessed for Jersey's waters, tidal range and weather.

The net ropes are 'seeded' in a shore-based laboratory using a selected, high yielding variety of the desired species before being transferred to the sea for active growth. Biosecurity issues would need to be considered before this practice could be approved if the operator planned to use non-native seed.

In considering seaweed aquaculture and identifying potential sites, consideration will need to be given to other established uses that could be impeded be they commercial or recreational. A cost/benefit analysis would need to be completed. Currently, in Europe, there is a research focus on growing seaweed within existing oyster concessions with the aim of reducing shellfish aquaculture impacts and maximizing useful production from the zone.

Looking at aquaculture from a different angle: Irish growers have found success in selective breeding of some seaweed species to produce a better cropping plant. It would be worth investigating how native strains of commercially targeted seaweeds compare in terms of size, growth rate, and concentration of desired chemicals to those from other parts of Europe. Key questions could include: do any Jersey strains look likely to be commercially advantageous? Would Jersey allow farmers to import seed from other areas?

As the aim of aquaculture is to bring on growth of a target species efficiently for harvest it is worth looking at the following statistics:

- Culturing of brown seaweeds in Scotland has been shown to generate growth of roughly 2 to 4 kg/m$^{2\text{-yr}}$.
- Various red seaweeds achieve cultivation rates between up to 10 to 17 kg/m$^{2\text{-yr}}$.

- In Japan rates of up to 60 kg/m^{2-yr}. have been achieved with *L. japonica*.

2.5 - COMMERCIAL SCALE, NON-MECHANISED HARVESTING

Of the commercially desirable seaweed species listed in Table 1, many are best targeted by hand harvesting. The management approach for each species will need to be different dependent on its seasonality, growth and spawning patterns. Depending on the scale of the harvesting operation, its impacts on the species as a habitat will also need to be considered in the management strategy. To put this in context:

Significant research has focused on harvesting kelps and especially *Laminaria hyperborea*. Scottish experiments show that if the canopy is cleared a new canopy will establish within 12 to 18 months but the biodiversity associated with the mature stalk and holdfasts will take up to ten years to fully regenerate. [Wild Seaweed Harvesting, Scottish Government, 2016]

Isle of Man and Norwegian studies show that areas completely cleared of kelp will take three years to recover total biomass (as a shorter, denser colony) and will experience transitional seaweed communities before dominance by *L. hyperborea*. Full regeneration of the original canopy structure takes around seven years and is reliant on seed populations in the vicinity. [Wilkinson, 1995]

A 1995 study of *A. nodosum* and *C. crispus* showed recovery times of six years and 18 months respectively after harvesting. However *A. nodosum* was shown to have a three year recovery if only cropped down to 20 cm. The impacts of this level of harvesting on associated local fauna would also need to be considered. [McLaughlin et al., 2006]

In many parts of Europe significant quantities of specific species are harvested using sickles or shears and transported by boat or van for processing on land. This system is viable where the price for the crop is high enough to justify the time input of the harvested bearing in mind that the work is often irregular and weather dependent. The result is that only species that command a relatively high price can be gathered in this way.

A. nodosum, a mid-shore, perennial seaweed has been noted as being useful in hindering the potato cyst nematode (PCN), a blight to agriculture in Jersey. Trials have taken place in the past and subsidies offered to get farmers to use seaweed on the land but perhaps a further round of species specific trials would be of value in light of the dwindling availability of nematicides. The use of *A. nodosum* would need to be part of a multi-pronged attack on PCN but may be a useful tool in the armoury. Sustainable harvesting rates for the species would require careful calculation.

3 – ENERGY

Energy may be extracted from seaweed by drying and burning it. However, this is a space hungry process and only useful when heat is desired either directly to warm an area or to drive a turbine via steam production. A more flexible and useful fuel can be produced by either bio-digestion or anaerobic digestion (AD) to produce methane (biogas), or fermentation to produce bioethanol or butanol. The advantage being that these fuels can be stored in for prolonged periods at much lower volume cost than the raw seaweed.

This form of fuel production is still in its research phase. Significant investments are being made into the development of this technology in the UK, Ireland and Norway as well as in Japan, China and the USA. This is driven by international climate and emissions targets as well as by a desire to avoid putting agricultural land into fuel production and therefore reducing food output.

For biofuels there is a challenge in creating and maintaining the right conditions for the biological process drivers, especially maintaining temperatures and feed levels, while holding down toxins such as salinity, ammonia, sulphur and heavy metals. This is a challenge that is particularly problematic when scaling up from laboratory to commercial.

Seaweed contains no lignin and little cellulose and has good conversion efficiencies and stability. The residues are usable for agriculture and the production doesn't compete with land or freshwater for agriculture. This means that as well as being a potentially useful resource in itself seaweed harvested for energy could actually improve land quality – something unlikely to be found in many terrestrial energy crops.

There are several seaweed species that have potential to be grown as feedstock for biofuel production in the UK. If selecting species using the criteria of fast growth rates in cultivation, the productivity rates quoted above indicate that the kelps (especially *L. saccharina)*, *S. polyschides* and *Alaria* spp. would be prime candidates. *Fucus* spp., *S. muticum* and *A. nodosum* are not appropriate for AD.

Space and infrastructure are as ever an issue, there is the chance to utilise nutrients form the waste water treatment works and also perhaps heat from the EFW in some way but a suitable site would be needed to hold an AD or bioethanol plant and to store seaweed before loading into the plant.

3.1 - BIOETHANOL PRODUCTION

Bioethanol, produced by fermenting the sugars in seaweed, has the advantage of producing a combustible fuel that is liquid at room temperature and can be used directly as a component of transport fuel with all vehicles being able to accept fuel made up of 10% ethanol and many manufacturers now working towards accepting much higher proportions. This makes for a ready market for the end product.

The challenge still to be solved is the perfection of the series of enzymes and microbe communities that are needed for the multi-step process from kelp to ethanol. Research into this area is ongoing but recent points of interest from the literature include the development of a genetically modified bacteria that may be able to complete many of the steps in one go.

Ulva has been identified as a potential target species for bioethanol due to its relatively good sugar levels and low structural integrity. It has been found that 90% of the sugars in *Ulva* can be accessed by a combination of hot water treatment and hydrolysis.

3.2 - BIOGAS/BIO-METHANE PRODUCTION

This process was first perfected by accident hundreds of years ago by the Scottish sheep that are walled off from green pastures for much of the year and left to consume seaweed on the foreshore. Their ability to digest seaweed has been studied and microbe communities from their faecal matter are being tested to see if their digestive processes can be recreated and improved on by industry.

Methane from terrestrial sources such as manure and landfill sites is also common and has been used for decades often as part of a Combined Heat and Power Plant where the heat is either used to keep the process running or is supplied, along with the power, into a grid.

Many seaweeds require pre-treatment before digestion, for brown seaweeds this involves a chemical or physical process to break them down into small pieces. Interestingly though, percolation or the natural hydrolysis of the algae has been used successfully with the green algae *Ulva* spp. (Sea Lettuce); simple storage at 4^{o}C for a month increased the methane yield by 45%.

Nutrients required for AD are, in decreasing order of importance, nitrogen, sulphur, phosphorus, iron, cobalt, nickel, molybdenum and selenium. A 2015 lit review summarises that Optimum levels of a substrate's C:N ratio for anaerobic digestion are in the range 20:1 to 30:1. Lower than this and ammonia can be an issues. *Ulva* is often lower in value, down to 8:1 at times. The ratios improve with daylight / sunshine hours and *Ulva* has also been recorded with levels as high as 24:1 at peak growing season.

Bio-digesting 25% *Ulva* (dry or fresh) with 75% cattle slurry has been shown to produce an optimum mix giving 170m^3 of methane/t volatile solids. Ratios up to 50:50 would work but at reduced output. To keep the biological community in balance dried *Ulva* would need to be used when not available from the foreshore.

In Japan commercial bio-digestion of *Laminaria* has been demonstrated to yield 22m^3 of methane /t of weed and *Ulva* to produce 17m^3 of methane/tonne of weed both on commercial scales. UK species are expected to produce methane in the same range.

In using methane to drive a turbine it was found that having the ability to add natural gas to maintain a constant flow / pressure was useful as the output of methane (and its ratio to CO_2) can vary over the decomposition process or as environmental factors change.

3.3 - BIOENERGY CONCLUSIONS

Commercial bioenergy production is not yet close to deployment at a scale and price suitable for Jersey. Research is ongoing and while, under laboratory conditions, good yields have been achieved the challenge of replicating these on a continuing bases in an industrial setting is significant. Considering also the costs of farming, collection, drying and mixing with terrestrial waste as a purely financial proposal there are significant challenges to overcome. The factors that will help bring either Biogas or bioethanol to market are:

- Developments of more efficient bacterial / yeast strains
- Facility / equipment cost reduction with scaling up of industry
- Development of seaweed strains better suited to aquaculture.

However, if the clearing of *Ulva* from St Aubin's Bay is seen as a requirement for Jersey in the future then the feed costs of an AD or bioethanol plant are reduced to some degree. Further if Biogas or ethanol was produced for use as a substitute for power generation at times of peak load to reduce costs it could have an enhanced value. Taking this thought one step further; off peak or power from future local renewable energy (PV, Wind or Tidal power) could be used to drive biofuel output by adding, heat, light or agitation to the enhance the process. This could address, to some degree, both the issues of power to the digester/fermenter and storage of energy from renewables.

4 - SEAWEED BIOMASS AND POTENTIAL ON JERSEY

Historical estimates of the potential weight and area of harvestable seaweed in Jersey has usually been based on topographic assumptions about substrate species' distribution rather than biological data. As a result there is no reliable estimate of seaweed biomass or production potential available.

This report has brought together highly accurate data for the area of intertidal seaweed coverage with offshore data for subtidal kelp distribution. When combined with existing studies on regional seaweed biomass and potential production, this permits an accurate estimate of the distribution and potential harvest for key species.

4.1 - METHODOLOGY

The area occupied by individual seaweed species was obtained for the following locations.

- *Les Minquiers*
  The area of seaweed was taken directly from biotope (habitat) mapping data held by the Société Jersiaise (see Chambers, Binney and Jeffreys (2016).

- *Les Écréhous*
  The area of seaweed was taken directly from unpublished biotope mapping data held by Paul Chambers.

- *Paternosters (Les Pierres de Lecq)*
  The area of seaweed was taken from Chambers and Morel (2012) and unpublished biotope survey work by Paul Chambers.

Jersey Subtidal Kelp (Laminaria hyperborea)

Data from Jersey Seasearch and the Société Jersiaise suggests that subtidal kelp forms a fringe along the north coast of Jersey and on most subtidal rocky reefs between about 0 and 20m depth. The area of kelp was calculated using the area of bare subtidal rock between 0 and 20m below Chart datum as mapped in Le Hir *et al.* (1986).

Jersey Intertidal Seaweed

Two different beach profiles were determined to account for differentiated seaweed zonation and distribution, as noted in habitat survey work by the Société Jersiaise (Figure 1).

Profile 1 is for shallow gradient rocky shores with wide wave-cut platforms, as found along the south, east and west coasts. This profile is favourable for brown seaweeds which may occur in some profusion.

Profile 2 is for steep gradient rocky shores, often associated with cliffs, as found on the north, north-west and south coasts. This profile tends to be more exposed to wave action and is less favourable for all seaweeds but is more favourable for encrusting animals such as barnacles.

A ratio of seaweed species for shallow and steep rocky shores was calculated using a biotope map created (but incomplete) by the Société Jersiaise. The area of shallow and steep intertidal rock was calculated using the mapped rocks on the States of Jersey digital basemap. The ratio of seaweeds was then applied to the two profiles to provide an estimate of the area of rocky shore occupied by the main species.

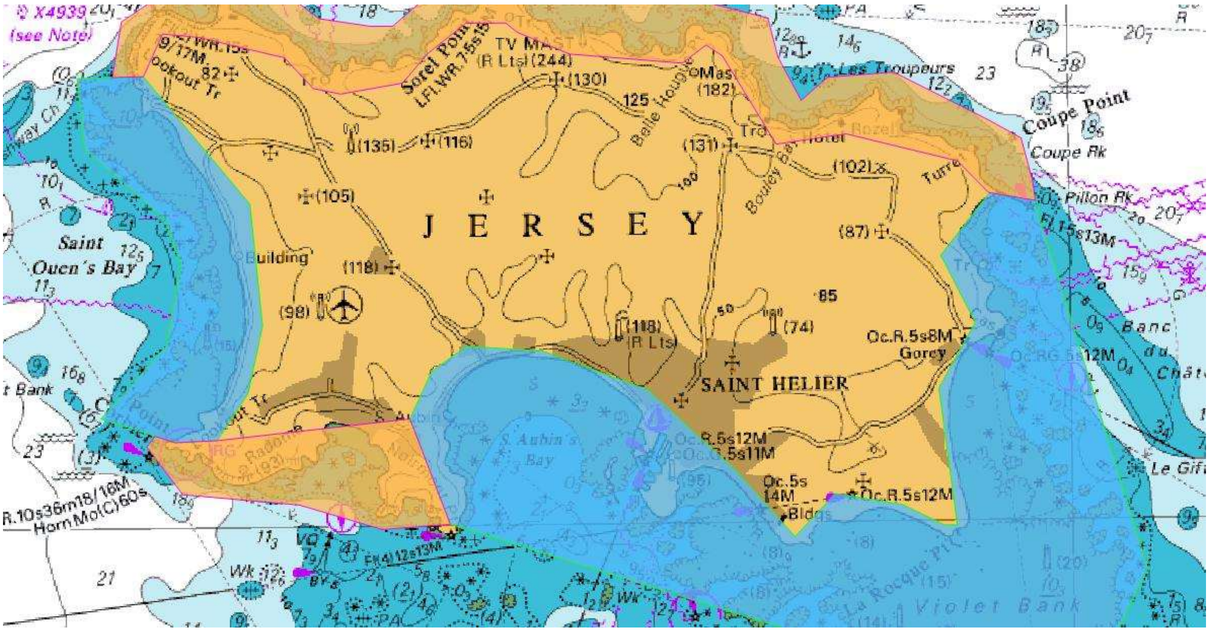

Figure 1 – The two seashore profiles on Jersey used to calculate biomass and production figures. Orange = steep gradient rocky shores; Blue = shallow gradient rocky shores.

Biomass (wet and dry) and the potential production (in tonnes/km2) for individual species was taken from existing scientific literature. Particularly important is the work of Kerambrun (1984) which concerns the commercial seaweed potential of the north Brittany coast and whose statistics are highly applicable to the Channel Islands.

The principal source of information for each species is as follows:

Ascophyllum, *Fucus* spp., *Pelvetia* and *Laminaria* spp.: Kerambrun (1984)

Chondrus, *Mastocarpus*: Sharp *et al.* (2008)

Sargassum: Arenas and Fernandez (2000)

4.2 – AVAILABLE SPECIES AND POTENTIAL PRODUCTION

Pelvetia canaliculata – Channelled Wrack

Total Potential Production: 14.1 tonnes

Stocks: An upper shore plant that favours steep surfaces in moderate to sheltered conditions. Rarely found on the offshore reefs with the stock being concentrated in discrete areas of Jersey's coast.

Recovery time: Five to eight years but variable between locations. (Marine Scotland, 2016)

Ascophyllum nodosum – Egg Wrack

Total Potential Production: 4476 tonnes

Stocks: Principally the south-east coast and some areas between St Catherine's Breakwater and Rozel. Occurs on middle shore wave-cut rocks, sometimes in profusion. Harvesting might be problematic as the majority of the biomass is in difficult to access locations along the south-east coast.

Recovery time: Very slow. 46% after 12 years. If totally removed then recovery is unlikely as *Fucus* species will crowd in. (Marine Scotland, 2016)

***Fucus* spp. – Spiral Wrack; Bladder Wrack; Serrated Wrack;**

Total Potential Production: *F. spiralis* = 1.9 tonnes; *F. vesiculosus* = 1,782 tonnes; *F. serratus* = 6,485 tonnes.

Stocks: These are intertidal species that prefer sheltered or moderately exposed coasts. The bulk of the biomass is on the south and east coast of Jersey with smaller concentrations on Les Écréhous. The fragmented nature of rocks distributed along the south and east coasts means that stands of *Fucus* tend to be isolated from one another and sometimes in inaccessible places, such as gullies.

Recovery time: One to three years. Will regenerate from the remaining stem provided that it is not removed entirely. (Marine Scotland, 2016)

***Sargassum muticum* - Wireweed**

Total Potential Production: 380 tonnes.

Stocks: Found almost everywhere where there is water between the upper shore and Chart Datum. The biggest concentration of plants is on the fringe of intertidal areas where there is a mixture of sediment and rock. This is particularly true on Les Ecrehous and Minquiers, where it is concentrated It is probably impracticable to harvest from small rock pools. Issues could be that *Sargassum* is almost exclusively found within protected areas, is associated with high biodiversity habitats (such as seagrass) and that the cutting of it may encourage its spread further afield.

Recovery time: Will recover annually if the stem is left in place.

***Laminaria digitata/L. ochroleuca* - Oarweed**

Total Potential Production: 1,305 tonnes

Stocks: *Laminaria digitata/ochroleuca* occupies a narrow fringe along most rocky coasts from about 1.0m to -2.0 metres Chart Datum. Below this it grades into kelp forests occupied by *Laminaria hyperborea*. In terms of access, it could be harvested with *L. hyperborea* although most of the stock is within protected areas. Kelp is generally considered to be a nursery area for many species including lobster, crab and ormer. If harvested great care is needed so as not to disrupt local ecosystem services.

Recovery time: Three to five years for biomass, five to eight years for full size plants

***Laminaria hyperborea* - Kelp**

Total Potential Production: 33,584 tonnes

Stocks: A subtidal species found between about -2 and -20 metres Chart Datum. Can occur in thick forests, especially on subtidal wave-cut platforms. The distribution around Jersey is controlled by the availability of suitable subtidal rock and much of the biomass is concentrated along the north coast and in Les Minquiers. There is not the scale of biomass that is seen on the Brittany coast as Jersey has a subtidal regime that is dominated by sediment. Kelp is generally considered to be a nursery area for many species including lobster, crab and ormer. If harvested great care is needed so as not to disrupt local ecosystem services.

Recovery time: Three to five years for biomass, five to eight years for full size plants

Chondrus crispus/Mastocarpus stellatus

Total Potential Production: 286 tonnes

Stocks: These are lower shore species that share the same habitat preference although *Mastocarpus* will dominate more in exposed areas. They tend to occur in a narrow intertidal band between about 1.4 and 0.8 metres, often occupying low rock. This can be found on all shore types but is best developed on the south-east and south coasts. Mechanical harvesting is probably not practicable as the habitats are often spread out and located within protected areas. Limited hand harvesting is a possibility.

Recovery time: unknown

4.3 - RESTRICTIONS ON MECHANICAL HARVESTING

There are restrictions on the use of mobile gear (which includes scoubidou) along Jersey's coast anticlockwise between St Helier and Gronez. Additional inshore no mobile gear zones exist in St Aubin's and St Brélade's bays. These cover an area of 113 km^2 around Jersey and are complimented by further no mobile gear zones at Les Minquiers (47.5 km^2) and Les Écréhous (15 km^2).

Almost the entire seaweed resource in Jersey's waters is contained within these no mobile gear zones, the exceptions being the coastal area between Gronez and Noirmont (excluding St Brélade's bay) and subtidal areas around the Paternosters, Dirouilles, Anquettes and the extreme western edge of the Plateau des Minquiers. Additionally, all the offshore reefs and Jersey's south-east coast (St Helier to Gorey) are designated Ramsar sites where the environment is to be managed under the broad principles of 'wise use' and sustainability. See Figure 2 for a depiction of this.

This could place a severe limitation on the area where mechanical harvesting could be used; if so, then the mechanical harvesting of seaweed may not be viable within Jersey waters.

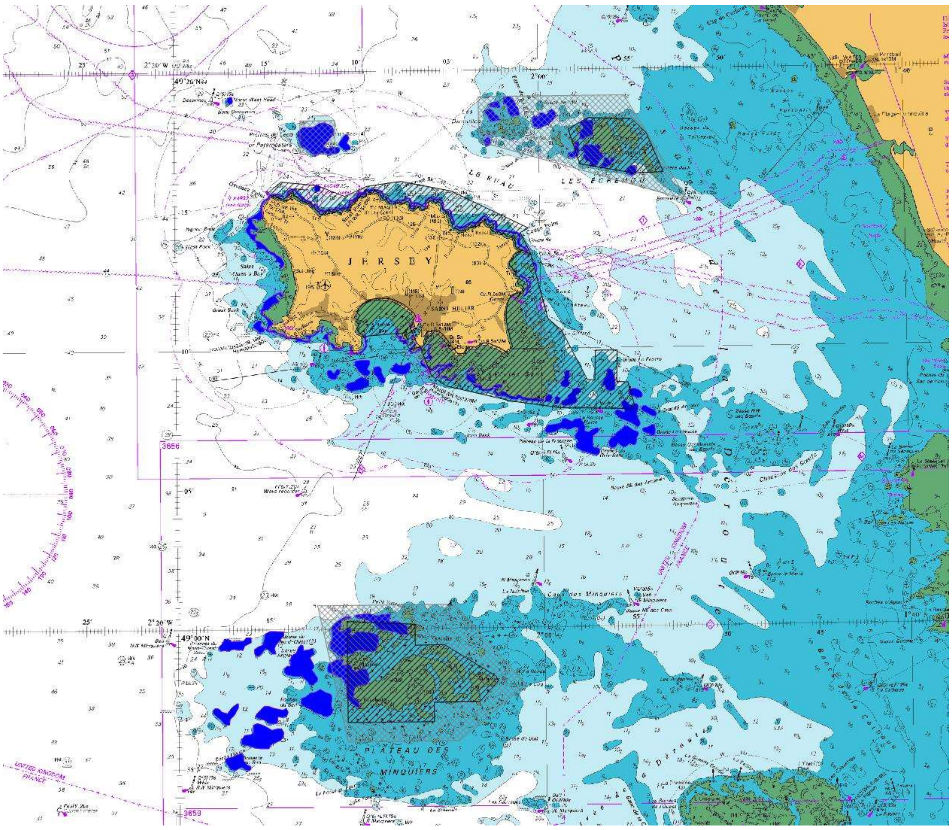

Figure 2 – Offshore kelp areas (blue) in relation to Jersey's no mobile fishing gear zones (cross-hatched) and Ramsar sites (diagonally-lined).

5 – Recommendations

From the available research it seems unlikely that large scale exploitation of the seaweed resource around Jersey is going to become a commercially viable enterprise in the short term. A significant factor in this is the labour and transport costs involved in harvesting and exporting seaweed to UK or EU consumers, especially when set against the costs of doing so from mainland Britain or France. Focusing therefore on current uses of seaweed, it is logical to determine sustainable exploitation rates and propose daily harvesting allowances.

Harvesters would be split into recreational and commercial categories with daily limits set for both but with a license only being required for commercial operators. Daily bag limits would for the majority of Red and Brown seaweeds be set at 5kg for recreational and 10kg for commercial with specific exceptions as follows:

Species		**Recreational**	**Commercial**
Latin name	**English name**	**kg per day**	
Alaria esculenta	Dabberlocks	0	0
Ascophyllum nodosum	Egg Wrack	5	20
Codium bursa	Velvet Horn	0	0
Fucus serratus	Serrated Wrack	10	50
Fucus spiralis	Spiral Wrack	10	50
Fucus vesiculosus	Bladder Wrack	10	50
Himanthalia elongata	Thong Weed	0	0
Laminaria digitata	Oar Weed	10	50
Laminaria hyperborea	Forest Kelp	10	50
Laminaria ochroleuca	Golden Kelp	10	50
Phymatolithon spp.	Maerl	0	0
Lithothamnion spp.	Maerl	0	0
Padina pavonica	Peacocks Tail	0	0
Saccharina latissima	Sugar Kelp	10	50
Sargassum muticum	Wireweed	10	50
Undaria pinnatifida	Wakame	10	50
Red and brown seaweed species not listed above		5	10

Table 2. Proposed seaweed bag limits for hand harvesting in Jersey.

Green seaweed species and storm cast weed are exempt from bag limits both because of their abundance and because mechanical intervention is required for their management.

Following agreement of the above process and quantities drafting of regulations to sit under the Aquatic resources (Jersey) Law 2014 has taken place. At present there are no reasons to make a provision in law for larger scale industrial extraction or aquaculture. Further, without a clearer idea of what form future seaweed use will take and what facilities it will require it does not seem a prudent use of resources to draft potentially unsuitable legislation at this time.

The timeframe for the realisations of energy from Seaweed is likely to be a minimum of 4 years away for areas with a large resource (Scotland, Ireland, and Norway) and 10+ years for smaller scale operations such as Jersey. The situation should be re-examined in 2022, or earlier if there is prompting by industry, to determine of further legislation is required.

Harvesting of attached seaweed will only be permitted by non-mechanised means, hand scissors, shears or an open blade being examples of acceptable tools. Seaweed should not be torn from the rocks especially in the case of species with a strong hold fast on weaker substrate that may give way before the plant.

Unattached seaweed such as storm cast wrack and *Ulva* spp. living on sand will not be subject to any bag limits as they are both plentiful and often considered a nuisance issue on the foreshore.

It is proposed that no exclusive rights (concessions) to gather seaweed within a set area will be established. This said, anyone wishing to cultivate seaweed will be able to apply for space to do so via the Aquaculture licensing scheme. They will then be beholden to the same license conditions as the rest of the aquaculture industry.

6 - Further research

Jersey's nutrient rich, warm waters or a particular local strains of macro algae may prove to have particular properties that would make it desirable to established industry in the UK or Europe. Should these qualities be attractive enough to result in a price that justifies harvesting and export then a business could be established.

Perhaps the best way to examine this would be through a more detailed industry review of the above mentioned uses for seaweed and a series of chemical comparisons between their current supply and Jersey strains. Given the relatively low likelihood of success this would probably be best as a student project as opposed to a commissioned study.

A full evaluation of the island's seaweed resource, its biomass and the habitat / ecosystem service value it creates should be undertaken. This will allow any future requests to exploit the resource to be looked at in the context of the value of the resource in situ.

If S. muticum proves to be an exploitable species in the future it would be useful to know its history of heavy metal concentrations in Jersey. Inclusion of the species in heavy metal testing, once annually in late summer, would seem prudent.

Finally, a watching brief should be kept on the developments in the industry with a review every 24 months on new technology / applications that might be suitable to Jersey and its environs.

7 -REFERENCES

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