The effect of deployment time on growth and biofouling on cultivated Sugar kelp (*Saccharina latissima*)

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Front page: Cultivated kelp from the study in April 2019. Photo by Xinxin Wang

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Abstract

Commercial cultivation of seaweeds has been practiced in east Asian countries since the 1950's but has been gaining attention in Europe over the last decades. In Norway the species being cultivated the most is the kelp *Saccharina latissima* (Linnaeus) C.E. Lane, C. Mayes, Druehl & G.W. Saunders. Products intended for human consumption, must be as clean as possible, and this is achieved by harvesting before the onset of biofouling. The timing of biofouling onset is normally between May and June but varies with latitude. The cultivated kelp is therefore harvested in late spring. In this study *S. latissima* sporophytes were deployment at three different times on the west coast of southern Norway. Deployment times were October, November and January. Samples from each deployment were taken each month between October 2018 and May 2019, and area, biomass and biofouling were measured. The final area and biomass per thallus of each batch was compared to find which deployment time resulted in the greatest yield and with the least amount of biofouling. The greatest yield came from the earliest deployment, in October, and the yield declined with later deployment times. However, the onset of biofouling was found to be similar for all deployment times. From this study it is possible to say that deploying *Saccharina latissima* in late fall is preferable over winter deployment on the west coast of southern Norway.

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1 Introduction

Algae is a collective term for both macro- and microalgae. Macroalgae are often referred to as seaweeds, and are found in the four phyla: Charophyta (Freshwater green algae), Chlorophyta (green algae), Rhodophyta (Red algae) and Ochrophyta (Brown algae) with over 10,000 described species collectively (Levine, 2016). Especially the large brown seaweeds, known as kelps (order Laminariales), are important foundation species in our oceans. Kelp create natural underwater forests that function as a three-dimensional habitat and has been shown to host a wide variety of organisms, from invertebrates to fish (Smale et al., 2013).

1.1 Applications of seaweed

Seaweeds have multiple areas of application, from food additives, medicine and direct consumption, to fish feed, biofuel and as fertilizers (McHugh, 2003; Delaney et al., 2016; Graham et al., 2016). The practice of using seaweeds to feed livestock goes back centuries and continues to this day, to some degree (Mouritsen et al., 2013; Delaney et al., 2016). This is evident from the common Norwegian names of seaweeds like 'grisetang' (*Ascophyllum nodosum*), 'butare' (*Alaria esculenta*), and 'sauetang' (*Pelvetia caniculata*). Brown seaweeds were used to make potash and glass in both Norway and France in the 17th century, an activity which gradually developed into an industry of iodine production in the 19th century, and then later alginate extraction in the 20th century (Delaney et al., 2016). Today there is a global industry of using red and brown seaweeds for hydrocolloids (alginate, carrageenan and agar), which is growing by 1-3% every year, with agar and alginate being the most profitable (Bixler and Porse, 2011).

Direct consumption of seaweeds by humans has a long history. In Japan the use of seaweed in cuisine dates back to at least the fourth century, and in China it dates back to the sixth century (McHugh, 2003; Yang et al., 2017). The Norwegian Vikings likely brought the red seaweed *Palmaria palmata* ('dulse' or 'dillisk') with them on long trips at sea and might have helped to protect them against scurvy (Mouritsen et al., 2013). In china brown seaweeds has been used to treat goitre since the 16th century because of their high content of iodine (Levine, 2016).

Species such as *S. latissima* and *Palmaria palmata* have a great potential future in the Nordic cuisine because of their high content of iodine and minerals, their distinct umami taste and

potential for cultivation (Mouritsen et al., 2012). Potentially toxic chemicals can accumulate in some seaweeds, depending on species and season, and consumption must be done with care (Duinker, 2014; Schiener et al., 2015). The tolerable daily dose of iodine is 0.6 mg (Roleda et al., 2018), and *Saccharina latissima* has been recorded with 2103-3378 (Duinker, 2014) and 1655 (Lüning and Mortensen, 2015) mg iodine per kg dry weight. The iodine concentration can be decreased by for example boiling the kelp, as found by Lüning and Mortensen (2015).

1.2 Global production of seaweed

Early examples of cultivation of seaweed in East Asia was to clean rocks, and then later used concrete blocks, to make extra available substrate for seaweed to settle on, to increase the harvest (Hasegawa, 1976; Tseng, 1993; Yang et al., 2017). An important progress followed the discovery in 1949 by Kathleen Drew when she cracked the code for successful cultivation of the red algae *Porphyra* (famously used for making nori) (Blouin et al., 2011). The life cycle of this algae was prior to this discovery unknown, making it hard to cultivate. Cultivation of brown algae on long lines was initiated by cultivating the introduced species *Saccharina japonica* in 1952 (Tseng, 1993).

Several methods for cultivation in the sea exists, and many are modifications of either 'hanging ropes' or 'horizontal ropes' (Doty et al., 1987). An important progress in kelp cultivation was the development of 'forced cultivation' in the 1960s which decreased the cultivation time form two years to less than one (Hasegawa, 1976).

Global yields from harvest of natural populations has been exceeded by yields from farmed seaweeds since the early 1970's (Barbier et al., 2019). In 2015, 1.09 million metric tons wild growing seaweed was harvested globally, 175 642 metric tons came from brown algae (FAO, 2018). Compared to yields from seaweed production, harvest from wild populations are only a small part of the industry. The global yield of farmed seaweed harvested in 2015 was 29.3 million metric tons, and it was the largest yield recorded since 2006 (FAO, 2018). For the last ten years, the global production of seaweeds has been growing by 6.8% every year (Barbier et al., 2019). Today the biggest producers of seaweeds in the world are China, Indonesia and the Republic of Korea, and the most commercially important genera farmed are *Saccharina*, *Undaria*, *Porphyra*, *Eucheuma*/*Kappaphycus* and *Gracilaria* (FAO, 2018).

Seaweed aquaculture has gained interest in European countries in the last decades, and has seen a rapid development (Buschmann et al., 2017; Barbier et al., 2019; Buschmann and Camus,

2019). Development of seaweed aquaculture is a sustainable alternative of food production, as it does not require land area and little to no fresh water and fertilizers (Duarte et al., 2009). As natural harvest of seaweeds risks overexploitation, cultivation is an alternative. Research on seaweed aquaculture has been intensive in most European countries; Norway (Forbord et al., 2012; Handå et al., 2013; Førde et al., 2016; Matsson et al., 2019), Faroe islands (Bak et al., 2018), Spain (Peteiro and Freire, 2009, 2013; Freitas et al., 2016), UK (Kain et al., 1990; Rolin et al., 2017) and Denmark (Boderskov et al., 2016). Most of these studies are on small-scale seaweed productions. Large-scale production in Europe has not yet become profitable enough, as it is still a developing market (Stévant et al., 2017).

Seaweeds are extractive species because they can utilize inorganic nutrients from the surrounding waters. The potential for seaweeds to utilize inorganic aquaculture effluents has been a driver to develop an aquaculture with seaweeds and other species, called Multi-Tropic Aquaculture (IMTA) (Chopin et al., 2001, 2012). Several studies have been done on the potential effects of integrating seaweeds such as *Saccharina latissima* in IMTAs to exploit the effluents from fish-farms (Marinho et al., 2015b; Bruhn et al., 2016; Freitas et al., 2016). It has potential, but there are challenges, like the mis-match of the peak in nutrient release from fish farms during summer and the harvest time of the cultivated kelp in spring (Broch et al., 2013; Handå et al., 2013).

1.3 Norwegian seaweed industry

Natural populations of *Laminaria hyperborea* (Atlantic oarweed) have been harvested in Norway since 1964 for its high concentration of alginate, which is used in food and in the colloid industry (Vea and Ask, 2011). In 2015 Norway was the third biggest harvester of wild seaweeds globally, with 130-180 000 metric tons (wet weight) of *L. hyperborea* being harvested yearly (Vea and Ask, 2011; FAO, 2018). Kelp harvesting in Norway is subjected to a management regime and fields are only harvested every fifth year to allow for restoration of the community (Steen et al., 2016).

In 2005 experimental trials of seaweed cultivation started in Norway, and the first permits for commercial production were granted in 2014. Since then several seaweed farms has emerged along the Norwegian coast, and as per January 2019 there were 83 localities according to the Norwegian Directorate of Fisheries (2019a). Most of the cultivation sites are in the southern part of Norway, with 30% of them found in Hordaland county and only 14% situated north of

Trøndelag county (Directory of Fisheries, 2019a). *Saccharina latissima* (Sugar kelp) and *Alaria esculenta* (Winged kelp) are the most commonly cultivated species in Norway (Bak et al., 2018) although many seaweed producers have permits for several other species (Directory of Fisheries, 2019b). In 2018 a total of 165 metric tons of sugar kelp, and an additional 2 metric tons of winged kelp was cultivated in Norway (Directory of Fisheries, 2019a).

1.4 Study species: *Saccharina latissima*

Saccharina latissima (Linnaeus) C.E Lane, C. Mayes, Druehl & G.W Saunders (former *Laminaria saccharina*) (Lane et al., 2006) is a species of kelp within the family Laminariaceae, class Phaeophyceae (brown algae).

Saccharina latissima can be recognised by its characteristic wavy frond with no midrib, often with two rows of bullations along the blade. The lamina is flat and frilly with a dark brown to yellow colour. *S. latissima* is a perennial seaweed and is thought to have a life span of three years (Parke, 1948; Sjøtun, 1993). It is a circumpolar species distributed from Svalbard to Portugal in Europe and found form the lower shore to 10-20 m depth in sheltered to semi-exposed areas (Bartsch et al., 2008). It is attached to hard substrate like rocks and stones by a holdfast with root-like haptera (Bartsch et al., 2008; Parke, 1948). *S. latissima* is a cold-temperate species with optimal growth in temperatures ranging from 10 to 15 °C and salinities ranging between 23 and 31 PSU (Fortes and Lüning, 1980; Bartsch et al., 2008). It can acclimate to temperatures and create ecotypes, but the southern distribution is limited by ocean temperatures reaching above 20°C, which negatively impacts growth and photosynthesis (Fortes and Lüning, 1980; Andersen et al., 2013). Temperatures over 23°C for prolonged periods are shown to be lethal (Bolton and Lüning, 1982).

Growth in the sporophyte occurs in the meristem, which in sugar kelp is the section from the stipe and up to 10-15 cm on the lamina (Parke, 1948). The main factors affecting the growth of kelp species in general is temperature, light conditions and available nutrients (Bartsch et al., 2008). *Saccharina latissima* never stops growing throughout its life, but rather has periods of high and low growth rates. Between January and June is the period of high growth, while the period of slow growth is between July and December (Parke, 1948). Both the highest and lowest growth rates are found in the last four months in each of these periods (Parke, 1948). Fortes and Lüning (1980) showed that increasing day lengths increased the growth rates in *S. latissima*.

The chemical composition of kelp varies through the season, and in production the deployment and harvest season will thus depend on what the application of the crop is (Bruhn et al., 2016). During the summer the sporophytes collect and store carbohydrates, that are being used as an energy source during winter (Black, 1950). Nutrients are stored when the environmental concentrations are high and are used for high growth in the first half of the year (Bartsch et al., 2008). Increase in water nutrients lead to an increase in the amount of nitrogen, fucoxanthin and chlorophyll a found in the thallus, regardless of the light available (Boderskov et al., 2016). A peak in nitrogen content to >2% (of dry weight) is therefore commonly found during the winter, while it drops to 1% or less in late spring and summer (Sjøtun, 1993; Bartsch et al., 2008).

Like other Laminariales, *S. latissima* has a diplohaplontic and strongly heteromorph life cycle. This means that the life cycle alternates between a diploid and a haploid life stage which are very morphologically different. The sporophyte is the macroscopic and diploid stage, and the gametophyte is the microscopic and haploid stage (Kain, 1979). *Saccharina latissima* sporophytes are fertile during the autumn and will form sori (clusters of sporangia) at the centre of the lamina and on the older tissue when fertile. Sorus formation is triggered by changes in daylength and will form after 2-6 weeks of short-days (SD) (8 hours of light) (Lüning, 1988; Forbord et al., 2012). Sorus formation can be artificially induced by subjecting the tissue to SD and making a transverse intersect in the meristematic tissue on the lamina, which restricts the supply of laminarian sporulation inhibiting factors (Pang and Lüning, 2004; Forbord et al., 2012). Sori are made up of clusters of unilocular sporangia, and in each sporangia meiospores are produced by meiosis (Kain, 1979). The ratio of each sex is fixed genetically, and for each sporangium, 32 zoospores are produced, where 16 are male and 16 are female. The spores are haploid and flagellated and after they settle, they grow to either male or female gametophytes. Normally gametophytes become fertile in two weeks, however if the circumstances are sub-optimal, vegetative growth will continue until the conditions change (Kain, 1979). The gametogenesis in the microscopic stage is not influenced by photoperiod, but rather a specific dose of blue light that induces fertility in female gametophytes (Lüning and Dring, 1972; Hurd et al., 2014). The female gametophyte produce and releases the pheromone lamoxirene, which triggers sperm release from the antheridia of the male gametophytes (Bartsch et al., 2008). When the oogonia is fertilized it will become a zygote and grow to be a new sporophyte. The first sporophytes can be seen within four days of spotting the first oogonia at 10°C (Sjøtun and Schoschina, 2002).

1.4.1 Production of *Saccharina latissima* seedlings

In commercial cultivation of *Saccharina latissima*, there are two main ways to develop the seedlings, namely direct and indirect. The following production method is described in greater detail in Druehl et al., (1988). In direct cultivation the natural reproductive cycle of *S. latissima* is followed. Material with visible sorus formation is gathered or artificially induced. Release of meiospores from the sporangia is induced by subjecting the tissue to dehydration and low temperatures followed by rehydration (Pang and Lüning, 2004; Edwards and Watson, 2011). The spore solution is then filtrated and seeded onto string. The germination and fertilization are as described in the previous section. After 50 days the seedlings are deployed in the sea.

In indirect production a vegetative gametophyte culture is made, that can be used for year-round production of sporophytes. The spores are collected in the same way as described for direct production. The spores are then added to microslides and treated with red light in order to prevent fertilization but will still have vegetative growth (Lüning and Dring, 1972). After 1-2 weeks of growth separately in petri dishes, the male and female gametophytes are 3-6 cells and are transferred to vials and kept vegetative for 6-12 months, still treated with red light, which prevents development of fertile structures (Lüning and Dring, 1975). When the gametophytes are going to be used in production, they are grinded in a cold mortar and mixed with KI enriched seawater before being seeded onto string. The rest of the production is the same as for direct production.

The gametophyte culture made in indirect production is used in 'forced cultivation', where the seedlings are produced in the lab around August-September, two months earlier than traditional cultivation practice, with deployment from October (Hasegawa, 1976; Peteiro et al., 2016). The sporophytes will then reach a size comparable to second year sporophytes in just one year (Hasegawa, 1976), which makes it a more time efficient and profitable method.

1.4.2 Biofouling on *Saccharina latissima*

Epibionts, like bryozoans and hydroids, are regularly found on kelp blades where they feed on food particles in the surrounding water (Porter, 2012). These animals are a source of food and habitat to other marine animals, like sea slugs, pycnogonids (sea spiders) and sea urchins (Porter, 2012). Some of epifauna, like encrusting bryozoa, have been associated with decreased growth and increased mortality in kelp (Handå et al., 2013).

Biofouling is a big problem in cultivation of sugar kelp, and is the main reason for harvesting in spring or early summer at our latitudes (Lüning and Mortensen, 2015; Førde et al., 2016). It is mainly for human consumption that biofouling is unwanted, as it decreases the quality of the product (Park and Hwang, 2012). For other applications, like animal feed, a clean thallus is not necessary (Marinho et al., 2015b), but the profitability is lower. There is reason to believe that a combined effect of temperature, currents, sunlight and nutrient availability affects the severity of the biofouling on the crop (Worm and Sommer, 2000; Saunders and Metaxas, 2008; Saunders et al., 2010; Matsson et al., 2019). Saunders et al., (2010) modelled the effect of temperature on fouling on wild kelp beds and found that a difference in ocean temperatures of one and two degrees resulted in an increase of the bryozoa *M. Membranacea* by a factor of nine and 62, respectively. Farms located in higher latitudes could therefore have a delayed onset of biofouling (Table 1.1) due to lower temperatures, and potentially have a longer cultivation season. Multiple partial harvest is thought to give an increased harvest of clean lamina and potentially increase harvest biomass over time (Rolin et al., 2017; Bak et al., 2018). This is done by harvesting once before summer, and then another time at the end of the summer around august. *Saccharina latissima* has a high regrowth rate and is therefore found to be a good candidate for this type of cultivation (Rolin et al., 2017).

Table 1.1 First sightings of biofouling on cultivated *S. latissima* in some European studies. Arranged from locations furthest north to furthest south.

Location	First sighting of biofouling	Reference
Tromsø (Norway)	Mid-July	Matsson et al. (2019)
Frøya (Norway)	Mid-June	Førde et al. (2016)
Trondheim (Norway)	June	Forbord et al. (2012)
Shetland (UK)	May	Rolin et al., (2017)
Lysefjorden (Norway)	May	Lüning and Mortensen (2015)
Horsens Fjord (Denmark)	June	(Marinho et al., 2015b)

1.6 Scope of the study

When cultivating kelp for commercial purposes it is important to know if there are any advantages or disadvantages to deploying early or late in relation to the main growth period.

This can be measured in quantity and quality of the kelp. Differences in quantity produced can be measured by comparing the thallus area and biomass of kelp deployed at different times. Differences in quality can be measured by looking at the amount of biofouling, chemical composition and the dry matter content of the kelp.

An earlier deployment might get an advantage by having a longer cultivation time but will have little available light in the first months at sea. On the other hand, a later deployment will have more available light from the start, but a shorter growth season. Because of large amounts of biofouling in late spring in Norwegian waters, it is usual to harvest commercial crops of *S. latissima* during May-June in South-Norway.

The objectives for this study were to study how the timing of *Saccharina latissima* sporophyte deployment (from October to January) affects the **(1)** development of area and biomass throughout the cultivation time, **(2)** development and composition of fouling taxa, and lastly **(3)** to compare the chemical composition of nitrogen and carbon in the three sporophyte deployments at the harvest time.

2 Material and methods

2.1 Study area and environment

The field experiment was performed at one of Lerøy's commercial seaweed farms located south west of Bergen in Austevoll municipality (Flatøyflu 3, 60° 09'N 5° 13'E) (Figure 2.1). The area has an archipelago-like landscape with several small islands, islets and straits. The farm is situated in a sound and can be described as a semi-exposed site, partly protected from waves by small skerries.

The location of the seaweed farm is roughly 1km south of one of Lerøy's salmon farms, Flatøyflu. Measurements of currents close to both these aquaculture sites show that the main currents are going northwest, and the maximum velocity at 5m depth is measured to be 53 cm/s (Multiconsult, 2017). The water has a marine character with an average salinity of 29.7 ‰ between august 2018 and June 2019 at 3 meters depth (measurements made by Lerøy). Water depth at the location of the farm is approximately 30 meters at max.

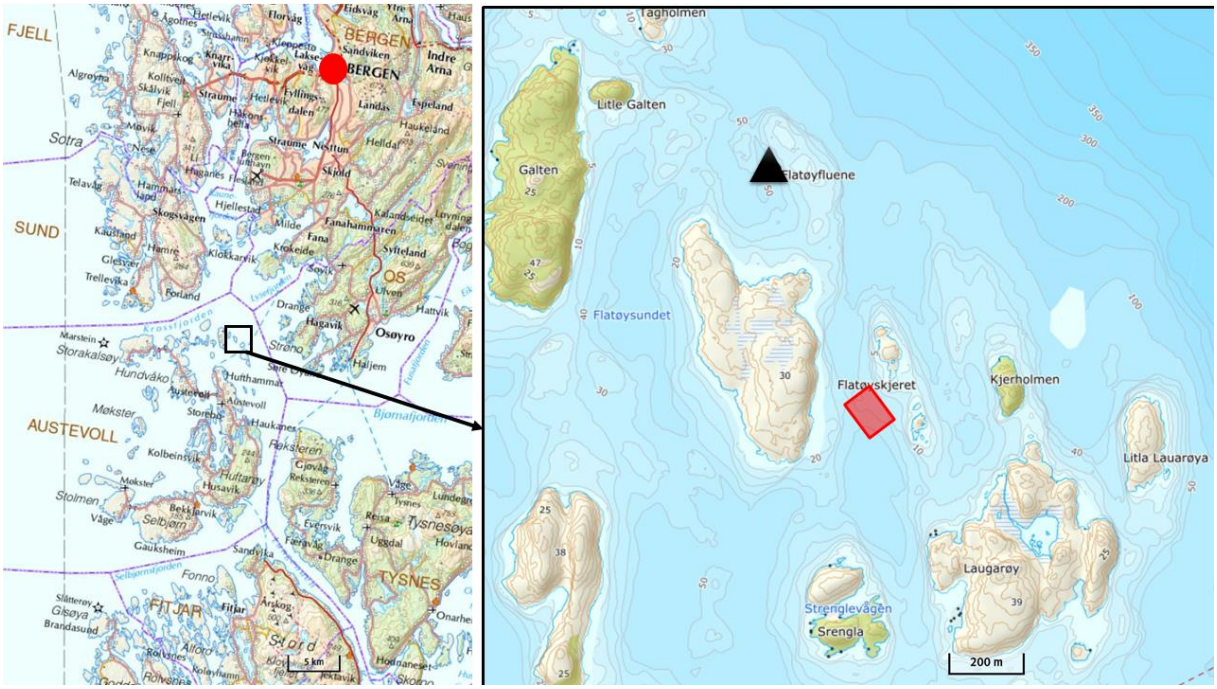

Figure 2.1: Left: Map of the area where the seaweed farm Flatøyflu 3 (black square) is placed, in reference to Bergen (Red dot). **Right:** The seaweed farm is marked as a red rectangle and the salmon farm is marked by a black triangle.

2.2 Seedling production

Seedlings of *S. latissima* and ropes used in this study was provided by Lerøy Ocean Forest. Four different batches of kelp seedlings were deployed in this experiment. Details of the seedling production is explained in the next section.

2.2.1 Spore production

The first three batches originated from spore-solution produced in the Netherlands by the company Hortimare. They used *S. latissima* sporophytes collected at Austevoll to produce gametophytes, which was transported to Lerøy's labs in Reksteren, Norway. As mentioned in Bak et al. (2018), Hortimare most likely use a standard protocol for kelp sporulation, described in Edwards and Watson (2011).

The last batch of sugar kelp seedlings, which were deployed in January 2019, was produced by inducing spore release from sporophytes in the lab at Reksteren, using local sugar kelp. The kelp was washed with a moist sponge to get rid of all epiphytic organisms. Tissue that did not contain sori was removed and the pieces with sori was cut into smaller pieces and kept damp. The tissue was then treated in a beaker containing a disinfection medium (4mL/L 15% Sodium hypochlorite to filtrated seawater) for two minutes while stirring. The tissue was then washed in cooled, filtrated and UV-treated seawater three times, using new water for each washing. After they were washed, the pieces were dried with paper and laid in layers in a Styrofoam box with paper separating each layer. The box was stored in a cool place (10-15°C) and after 12 to 48 hours the sori are ready for spore release.

After the dehydration process, the pieces were rehydrated. The pieces were added to beakers and weighed before adding cool sterile seawater equivalent to 2.5 grams per sorus. The water was stirred regularly, and the beaker was covered with plastic or aluminium foil in the meantime. It was made sure that the temperature was kept between 8 and 11 °C. When the water got less clear, measurements of the water was taken to find the concentration of spores in the water. After an hour most spores were released, and then the pieces were removed, and the water was filtrated through a clean plankton mesh to remove any remains of non-spore material.

2.2.2 Seeding onto cultivation string

The three first deployments (October and two November batches) were grown from gametophyte solutions made by Hortimare B.V. These gametophyte cultures were transferred onto spools of thin rope (cultivation string) using a paint brush. The fourth deployment (January) was produced by spore release in Lerøy Ocean Forests own laboratory, in the way described in the previous section. This culture was sprayed onto the cultivation string by a hose and left to dry for ten to fifteen minutes before being installed into a cultivation tank.

In all cases the cultivation string used was made of nylon and measured 1-2 mm in diameter and was wrapped around a PVC pipe before the culture was added onto the string. The PVC pipes wrapped with cultivation string were kept in a cylindrical cultivation tank of either 275L or 325L, or in in tubs of 180L. A cold white light (20-70 $\mu molm^{-2}s^{-1}$) was used in the cultivation, initially set at a low intensity and then increased gradually. In the tubs white fluorescent light was mounted above the tubs, while in the cylindrical tanks LED lights was surrounding the tank. The cultures were initially treated with a 0.5 mL/L germanium dioxide and repeated during the cultivation if necessary, in order to remove any diatom growth in the cultures.

After 40-50 days, the seedling ropes were spun around a 12 mm rope by a machine and deployed at the study site (Figure 2.2).

2.3 Field experiment design

The seaweed farm Flatøyflu 3 measured 200x100 meters and was divided into eight squares, each measuring 50x50 meters (Figure 2.2). The square used in this study was located so that is was surrounded by cultivation ropes with commercial kelp on three of the four sides. This was to avoid the potential of better growth on ropes located at the edges of the cultivation square. Each cultivation square had 25 attachment points on each side, each separated by 2 meters. However, we only used 16 of them in our square and the rest was filled with commercial kelp (Figure 2.3).

Each deployment was assigned two positions in the cultivation square by random draw at the start of the study. Two ropes was then installed in two different places at the cultivation site, and each rope stretched over the square twice, in total four stretches of rope per deployment (Figure 2.3). Each stretch was assigned a rope number, indicating where in the cultivation square it was placed (Figure 2.3). The ropes were initially deployed at roughly 1 m depth, but

as the kelp grew, the ropes started sinking. In January a long rope with buoys was placed underneath and perpendicularly to the production ropes, in order to prevent sinking as the weight of kelp increased. However, there were still variations in the depth along the horizontal ropes (1-2 meters), but this is hard to avoid when growing kelp on horizontal ropes.

Initially four batches of kelp were deployed in this study. However, the second batch of seedlings, which was deployed 15 November 2018 (Table 2.1), was not developing properly in the lab nor in the sea and was therefore excluded from this study. The malfunction of this batch has unclear reasons but might be explained by micro-organism contamination in the lab, as the density on the rope at deployment was low (Appendix D). In spring these ropes were dominated by wild settled *Saccharina latissima* and *Alaria esculenta*.

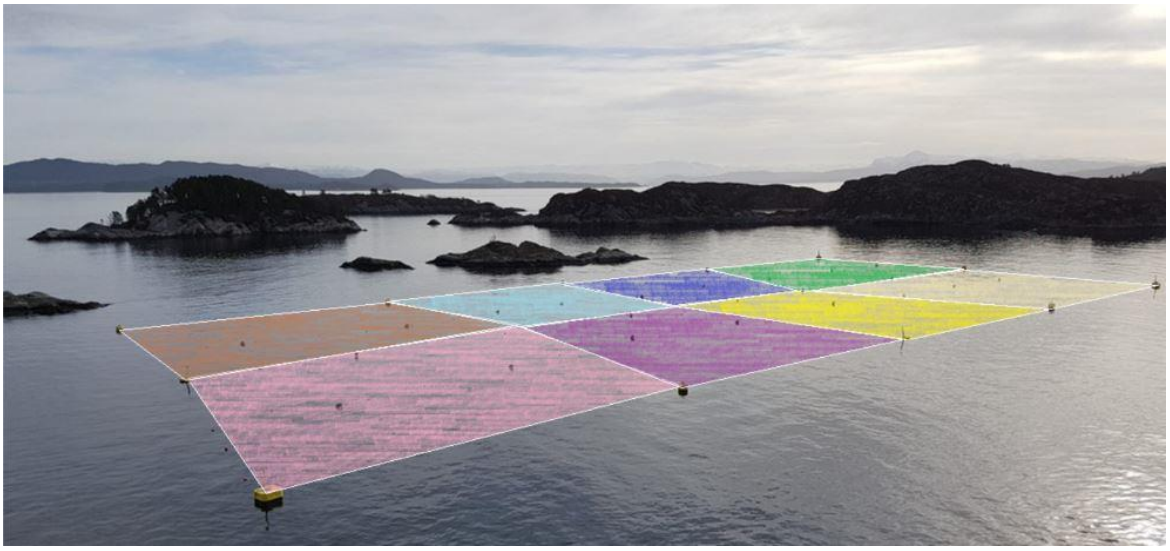

Figure 2.2: Illustration of Flatøyflu 3 with cultivation squares drawn and coloured. The dark blue square is the one used in this study. (Photo by Lerøy Ocean Forest, edit by Sunniva T. Haldorsen)

2.4 Biological measurements

2.4.1 Size and density of sporophytes when deployed

For each batch being deployed, 50-100 cm of the seedling ropes was collected in order to measure initial density and size of the kelp seedlings. One sample was gathered per spool used in the deployment. Number of spools used on each deployment varied (Table 2.1). Samples from the spools were kept in a bottle of seawater and was examined within 24 hours by a stereo microscope. The sample string was cut into five equal lengths where the number of seedlings was counted on a 3 mm section on each piece. Two fronds were picked off from each piece of string, one from each end of the piece, equalling to a total of eight fronds per spool. The area

was measured by taking photos on millimetre paper and outlining the lamina in ImageJ after calibration. The area was measured in mm^2 and later converted to cm^2.

Table 2.1: Overview of the age (days) of each batch at deployment, the deployment date and where in the cultivation square each was deployed, indicated by rope number.

Deployment number	Age at deployment (days)	Date of deployment	Number of spools used	Rope placement
1	43	24.10.2018	3	9-10, 13-14
2*	48	15.11.2018	2	7-8, 11-12
3	37	23.11.2018	2	3-4, 5-6
4	54	10.01.2019	2	1-2, 15-16

*Excluded from the study

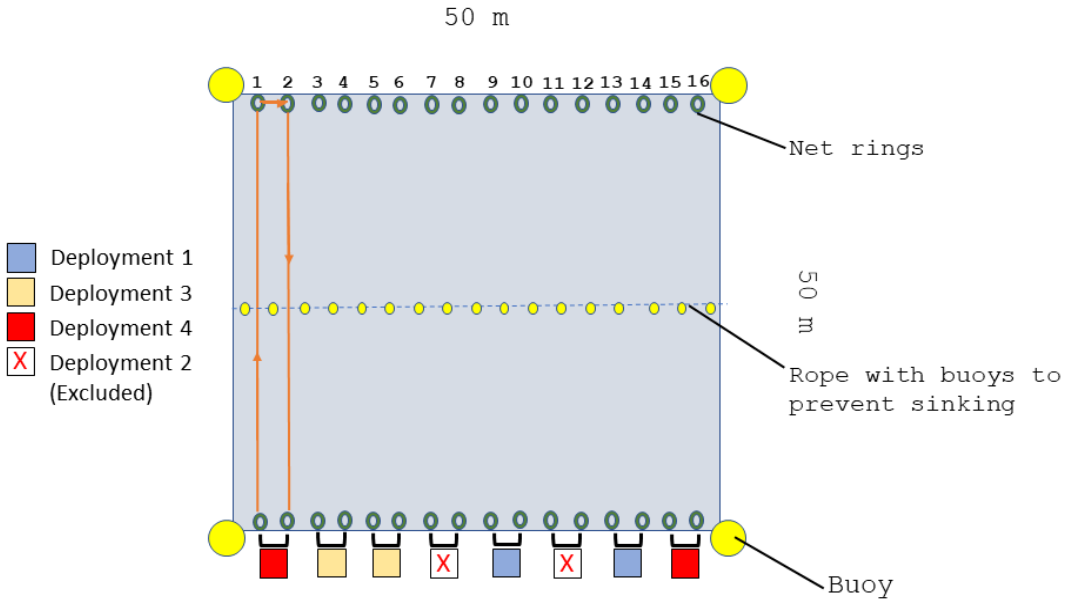

Figure 2.3: Illustration of the experimental field design used for cultivation of *Saccharina latissima* at Flatøyflu 3 in winter 2018-2019. Numbers indicate the stretch of rope, and squares show the placement of each deployment in the cultivation square. The orange line represents the ropes, and the arrows indicate the direction that the rope is stretched over from one side to the other. Deployment 1; October, Deployment 2; excluded, Deployment 3; November, Deployment 4; January.

2.4.2 Biomass and area measurements

The biomass and area of the sporophytes was measured between 23 November and 30 April (Table 2.2). Eight plants were sampled per rope, giving a total of 32 per deployment at most samplings (Table 2.2). The 08 April sample was halved because it was mainly intended for

biofouling examination, as the biofouling was suspected to settle around this time, and the previous sampling was still recent (<two weeks) so a full sampling was deemed unnecessary.

The plants were sampled by random picking every 2 meters. Sampling was started from different sides of the rope each time. This decreased the chance of sampling at the same spot every month, which could affect the growth conditions on the rope. The plants were then kept in marked zip-lock bags containing seawater and kept cool during the transportation to the lab. The samples were taken to the lab at the University of Bergen and kept in seawater at 7-9 degrees before they were examined. Each thallus was photographed for area measurements, weighed and then examined for biofouling. Only the frond and stipe were used in the measurements (the holdfast was not included). The photos were taken on millimetre paper which was used to set the scale when measuring the thallus area in the software Image-J. The weight was not measured in the first sampling post deployment, as the weight of the plants was very low (<0.01 g).

Table 2.2: Overview of sampling dates and which deployment was sampled. Samples contained n=32 plants per deployment normally. Marked dates deviated from the normal sample size. 1=October batch, 2= (Excluded) November batch, 3=January batch. Sample from 05 May was only for DW (dry weight) and CN analysis.

Date of sampling	**Deployment sampled**	n (per batch)
23.11.2018	1	38
19.12.2018	1	5
10.01.2019	1, 2, 3	32
04.02.2019	1, 2, 3, 4	32
05.03.2019	1, 2, 3, 4	32
27.03.2019	1, 2, 3, 4	32
08.04.2019	1, 2, 3, 4	6
30.04.2019	1, 2, 3, 4	32
08.05.2019	1, 2, 3, 4	10

2.4.3 Growth rate

The elongation rate for one month was recorded for all deployments to get a more precise growth rate for the sporophytes in the time of high growth, and to investigate if there was a difference between the deployments. Recording period was from 8 April to 8 May 2019. Five sporophytes on each double rope, equalling 10 plants per deployment. A hole (d=8mm) was

punched at the centre of the frond, 10 cm above where the stipe meets the lamina (l_{t-1}) (Figure 2.4) a method developed by Parke (1948). Each plant was marked and numbered to be able to locate them again. At the next sampling a new hole (l_t) was punched in the same fashion and the length (l) between the two holes was measured as elongation in cm from t-1 to t (Figure 2.4). The elongation of the plant was calculated as average elongation in cm per day. Specific growth rate (SGR) was calculated as percent daily increase as described in Bolton and Lüning (1982). After a month some of the plants had been lost. n=7 for the November and January batch, and n=8 for the October deployment.

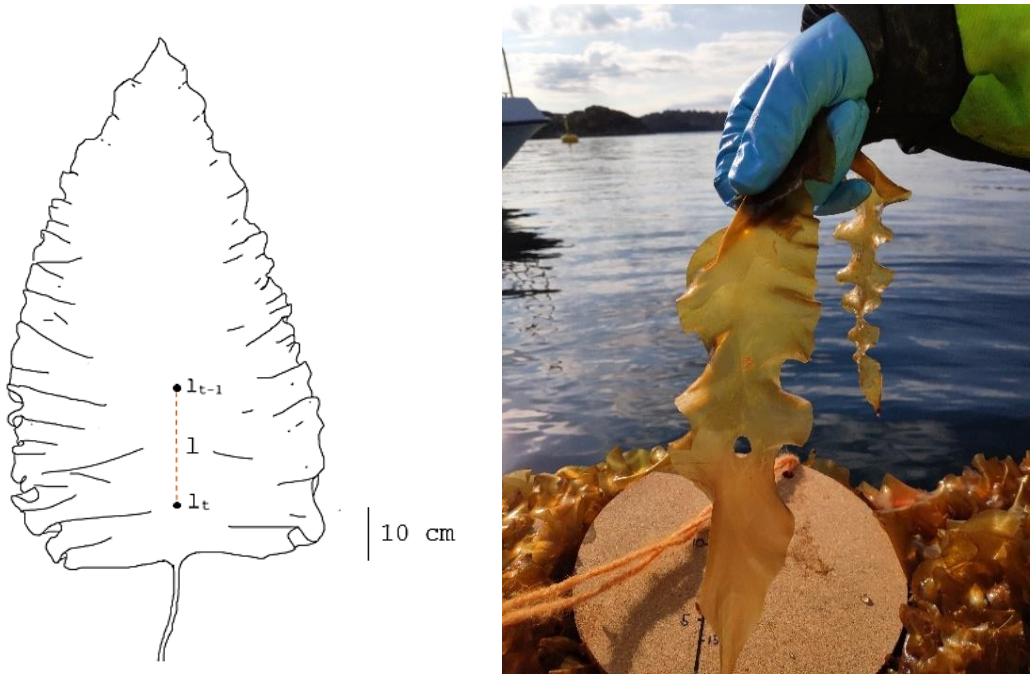

Figure 2.4: **Left:** Illustration of *Saccharina latissima* and how elongation rate of the thallus was measured. l_{t-1} is where the first hole was punched at the start time t-1, while l_t was the second hole punched at time t. L equals the elongation of the thallus from time t-1 to t. **Right:** Photo from the tagging of the plants in April (photo by Xinxin Wang).

2.4.4 Dry weight (DW)

On 8 May the ratio between fresh weight (FW) and dry weight (DW) was measured in 10 plants per deployment. These were initially the same plants measured in the growth rate experiment. Lost plants were replaced so that the total per deployment was 10 plant. For the January batch, as they were still small enough to fit the dryer, the plants were dried in their entirety at 60°C for 19 hours. For the other batches, pieces from the distal, mid and proximal part of the lamina were cut out, weighed and then dried at 60°C for 40-45 hours. All samples were then dried for another 46-48 hours to check if there was any further loss of weight. The final dry weight of each sample was used to calculate the dry matter content by using equation 1.

Dry matter content:

$$\frac{Dry\ weight\ (g)}{Fresh\ Weight\ (g)} * 100 = Dry\ matter\ (\%) \quad (1)$$

2.4.5 Carbon and nitrogen content

These were the same plants used for dry weight measurements. Carbon and nitrogen contents of 10 plants from each deployment was measured at the time of harvest to compare the composition in the final product. Differences in C and N content in different parts of the lamina (Gevaert et al., 2001) was not considered. For each sample a circle with a diameter of 8 mm were cut out from 10 places from the entire lamina and put in small plastic bags containing silica gel. After 23 days in silica gel, the dried pieces were grinded to fine powder and put in separate Eppendorf tubes and analysed in a Flash 2000 elemental analyser (Thermo Fisher Scientific) following the procedure by Pella and Colombo (1973) as explained in Armitage et al., (2017).

2.4.6 Estimates of biofouling

From each sampling some or all the plants from each deployment were examined for epibionts using a stereo microscope (Leica M125 C or MZ9.5). The lamina was divided into distal, mid and proximal parts (Figure 2.5), and examined separately. Taxa and amount of fouling on each part was noted, and close-up photos were taken when needed for further identification, using a Nikon microscope camera (DS-U3) and the NIS-Elements imaging software. The amount of biofouling was later converted to a semi-quantitative scale, ranging from 0 to 4, estimating the presence of the fouling species or taxa (Table 2.3). Only sessile organisms were logged, as motile animals would fall off during transportation and would give faulty measurements. For bryozoan fouling, number of colonies was used to assign a number on the relative scale (Table 2.3). The number of colonies of each bryozoan species on each part of the lamina was logged, to compare where on the lamina each species was dominating. The density of bryozoa was calculated to be able to compare the number of colonies per square cm, as the variance between each batch was very large.

Table 2.3 Ranking system of fouling on *S. latissima* with a description of how fouling levels were assigned

Assigned value	Category	Description
0	Not present	Not observed on thallus
1	Rare	One or a few specimens found on thallus. **Bryozoa**: <10 colonies
2	Common	Found on several smaller areas on thallus. **Bryozoa**: 10-50 colonies.
3	Dominant	Covering a large part of the thallus. **Bryozoa**: >50 colonies
4	Extremely dominant	Covering most, or all, of the thallus.

The biofouling score of all the taxa per thallus was gathered as a total biofouling score, where the maximum score possible was 40, as there were 10 groups of taxa used. The individual score of each taxon per thallus was used to calculate the percent that taxa made up out of the total biofouling score. This percent was used to find the relative taxa composition of each deployment for each sampling. Number of plants examined per sampling varied somewhat throughout the study (Table 2.4).

Figure 2.5 *Saccharina latissima* with definitions of the sections the lamina was divided into in this study

Table 2.4 Number of plants examined of biofouling from each group in each sampling (out of a total n=32, except 19 December 2018 where total n=5 and 8 April where total n=16)

Deployment	19.12.2018	10.01.2019	04.02.2019	05.03.2019	27.03.2019	08.04.2019	30.04.2019
Oktober	5	32	32	8	16	6	12
November	NA	29	32	24	15	6	12
January	NA	10	32	32	12	7	12

2.5 Environmental factors

2.5.1 Light and temperature

Light and temperature data was logged using HOBOware pendants (version UA-002-64K) ("HOBO Pendant Temperature/Light Data Logger 64K," n.d.). Light was measured in LUX (lumens/m^2) and temperature in Celsius (± 0.53°C). A total of eight pendants were deployed randomly at the cultivation ropes and set to log every 1.5 minute. The first five loggers were deployed on the 15th of November (Table 2.5) and supplied with three loggers as more ropes were in place. Data was transferred every month, and the pendants were cleaned of any micro-organisms growing on them. Only the first week of data was used in the study, because of the potential interreference on the measurements from micro-organisms growing on the pendants. Some loggers were removed at times during the experiment to change batteries, and so not all loggers were always deployed.

Table 2.5: Intervals of light and temperature logging. Only the first week of light data per interval was used.

Logged interval
15.11.2018-15.12.2018
10.01.2019-04.02.2019
04.02.2019-05.03.2019
05.03.2019-27.03.2019
27.03.2019-26.04.2019
30.04.2019-08.05.2019

Light irradiance data collected at the meteorological station at Florida, Bergen was downloaded from https://veret.gfi.uib.no (Geofysisk institutt (UiB), nd) and used to compare to the illuminance data from the loggers. This data was originally measured in W/m^2, and it was converted into LUX by multiplying it with the average luminous efficacy of the sunlight in overcast conditions (115 ± 8 lumens/W) (Littlefair, 1988) to get the data in lumens/m^2, which is the unit for LUX. The luminous efficacy is defined as the ratio between illuminance and irradiance (Olseth and Skartveit, 1989). The daily average was calculated for each logger, and

then the maximum value was compared with the data from the meterological station to get an idea about the light intensity accessible to the kelp compared to the terrestrial solar illuminance.

To check how the light levels were in relation to *S. latissimas* compensation point (2-6.8 µmol $m^{-2}s^{-1}$) and saturaton point (170 µmol $m^{-2}s^{-1}$) for photosynthesis (Borum et al., 2002), the values collected by the loggers were converted from lux (lumen/m^2) to Photon Flux Density (PPFD) (µmol $m^{-2}s^{-1}$) by using the equation provided by Fortes and Lüning (1980).

2.5.2 Water nutrients

Water samples were collected every month (15.11.2018, 19.12.2018, 10.01.2019, 04.02.2019, 11.03.2019, 27.03.2019, 30.04.2019) and analysed for ammonium and nutrients. Samples were collected with a Ruttner water sampler from two depths (0.5 and 3 meters) and three replicates was taken for each sample. Exceptions were for the samples from March 11th that did not have any replicates due to a broken water sampler, and the ammonium samples from March 27th which were lost. The samples collected for ammonium analysis were filtrated with a 60 ml syringe, filtrated and frozen before analysis. Nutrient samples were fixated with chloroform and stored in a dark cool place until analysed. Nutrient samples were analysed for NO_3, NO_2, Si and phosphate concentrations. The measuring uncertainty was of 0,07 µmol/L.

2.5.3 Salinity and Chlorophyll *a*

Salinity and fluorescence data were logged by a CDT (SD 200 W, SAIV A/S) deployed at 3 meters depth at the IMR station in Austevoll, located about 7 km south of the cultivation site. Salinity was measured as ppt and fluorescence was measured as mg/l. Measurements were made every 30 minutes from October 24th, 2018 to May 10th, 2019. When the data were analysed it was clear that the salinity probe had not been working properly, and thus the salinity measurements were excluded from the results. Fluorescence data from March 19th to March 21st was removed because of measurements errors. An average per day was calculated for each parameter.

2.6 Data analysis and statistics

All collected data were stored in Microsoft Office Excel 2016. Modelling, statistical analysis, plots and graphs were made in R version 3.6.1, using RStudio version 1.0.153 (RStudio Team,

2016) and packages ggplot2 (Wickham, 2016), gridExtra (Auguie, 2017), nlme (Pinheiro et al., 2019), tidyverse (Wickham, 2017), lubridate (Grolemund and Wickham, 2011), scales (Wickham, 2018) and Multcomp (Hothorn et al., 2008).

For data where Area and biomass had been measured over time, a GLM was used to account for non-constant variance (increased over time). A second-order polynomial was used in the model to account for a curvature in the data. Overdispersion in the data was accounted for by using quasipoisson error-term and an F-test.

Linear mixed effect models (LME) were used to model the area and biomass data at two specific times during the cultivation; one for samples collected at 73-78 days post-deployment for each sporophyte batch, and the other for all sporophytes collected on the 30th of April (last full sample). The same approach was used to compare the growth rate data and bryozoa density data. Rope was used as a random effect in all LME models as the light conditions were thought to potentially be different for plants on different ropes. A post-hoc Tukey-test was used for multiple comparisons of the three deployments in all LME models if the result was significant.

The dry weight data and the nitrogen and carbon content data were recorded as percentages in decimal form and was therefore treated as binomial proportions. This was approached by using a Quasibinomial distribution. A GLM and F-test was used to account for overdispersion in the data.

3 Results

3.1 Environmental factors

The temperature recorded at the site reached a minimum of 5.5°C in March and the highest temperature was 11.0°C in late April (Figure 3.1). Temperatures between January and April were flucuating between 5.5°C and 7°C. A peak in Chlorophyll-*a* levels was found from October to December, as well as in mid March during the spring bloom (4.5 mg/L) (Figure 3.2) with some smaller peaks after this. There was a period of low Chl-*a* concentrations from December to March (Figure 3.2). Concentrations after March were fluctuating a lot.

Light levels (lux) recorded by the HOBO-loggers at the site followed the same pattern as the recorded at the Florida weather station, only with lower values (Figure 3.3). In november 2018 the lowest light condition recoded by the loggers was 38 lux (0.76 µmol $m^{-2}s^{-1}$), and the highest 875 lux (17.5 µmol $m^{-2}s^{-1}$). A maximum of 10251 lux (205 µmol $m^{-2}s^{-1}$) was recorded at the site on the 2 May 2019.

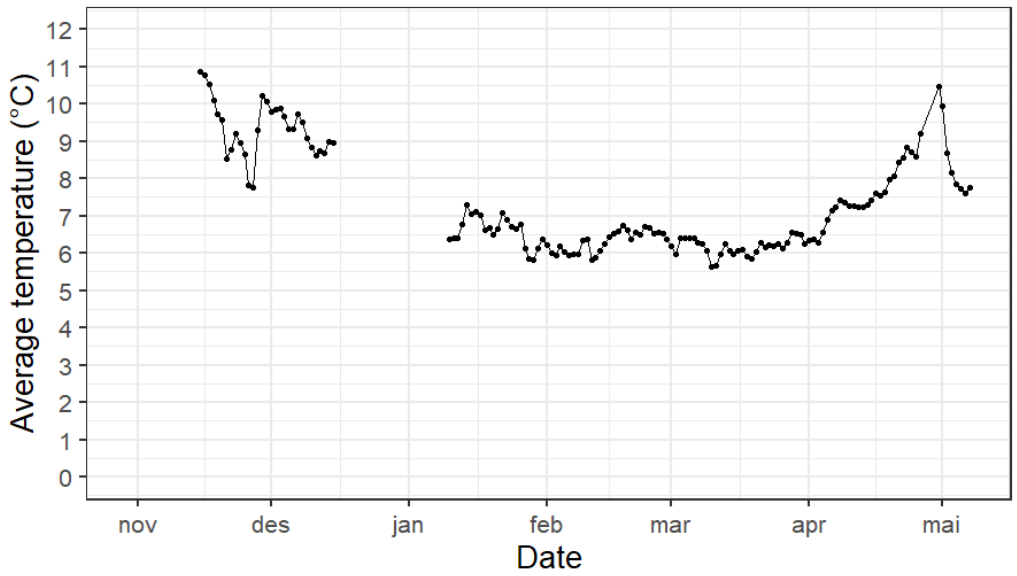

Figure 3.1. Average daily ocean temperature (°C) registered by all HOBO-loggers deployed at the cultivation site. from 15 November 2018 to 8 May 2019. Missing data between 15 December 2018 and 10 January 2019.

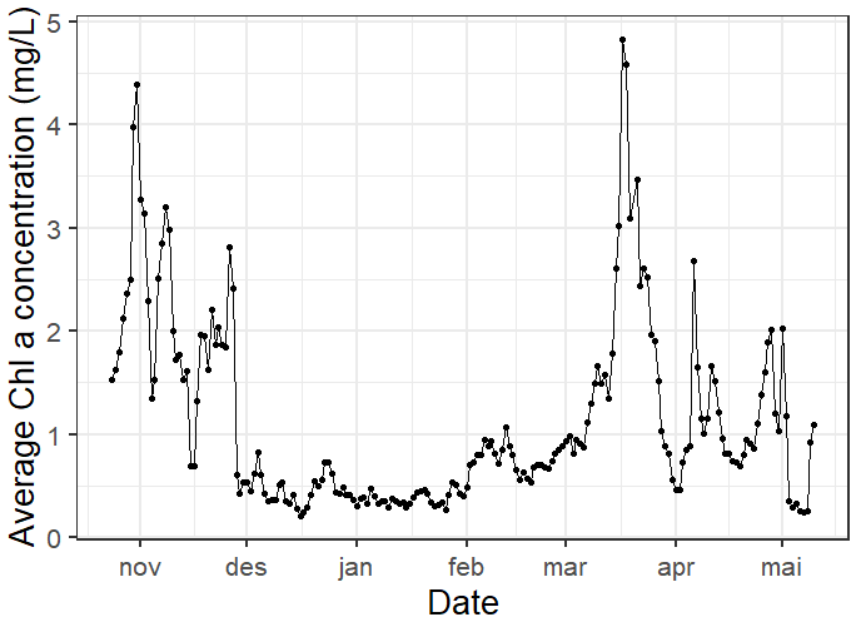

Figure 3.2. Average daily Chlorophyll a concentration between October 2018 and May 2019. Collected at 3 meters depth at the IMR station in Austevoll.

The results of water nutrients measured once a month from the 15 November 2018 to 08 May 2019 showed seasonal changes in the water nutrients, especially in nitrate (No_3) and silica (SiO_2) (Figure 3.4). All forms of nitrogen (NO_3, No_2-, NH_4+) followed the same pattern of high concentration before March, and were in general low in april after the spring bloom. Phosphorous concentrations were high between November and March and decreased in April. Silica had the same pattern as Nitrate; a peak in February and with the lowest concentrations recorded in April.

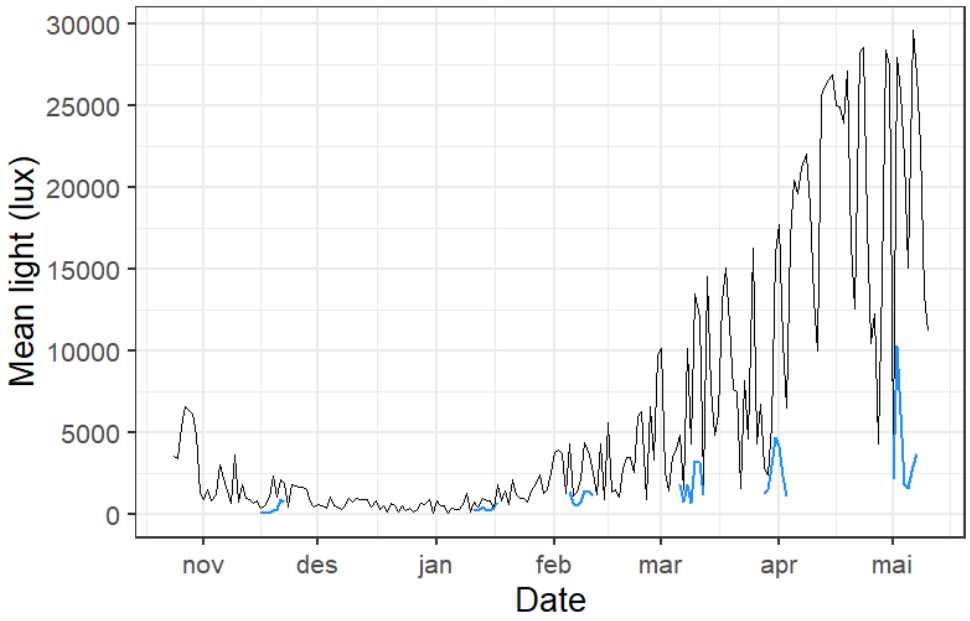

Figure 3.3. Average daily light recorded by the Geophysics institute UiB in Florida, Bergen (black line). The daily maximum light intensity recorded from an average of the loggers at the cultivation site (blue line). Light levels measured at ~1m depth at the cultivation site. Only the data of from the first week after the loggers had been cleaned was used, in case of algae growth on the logger.

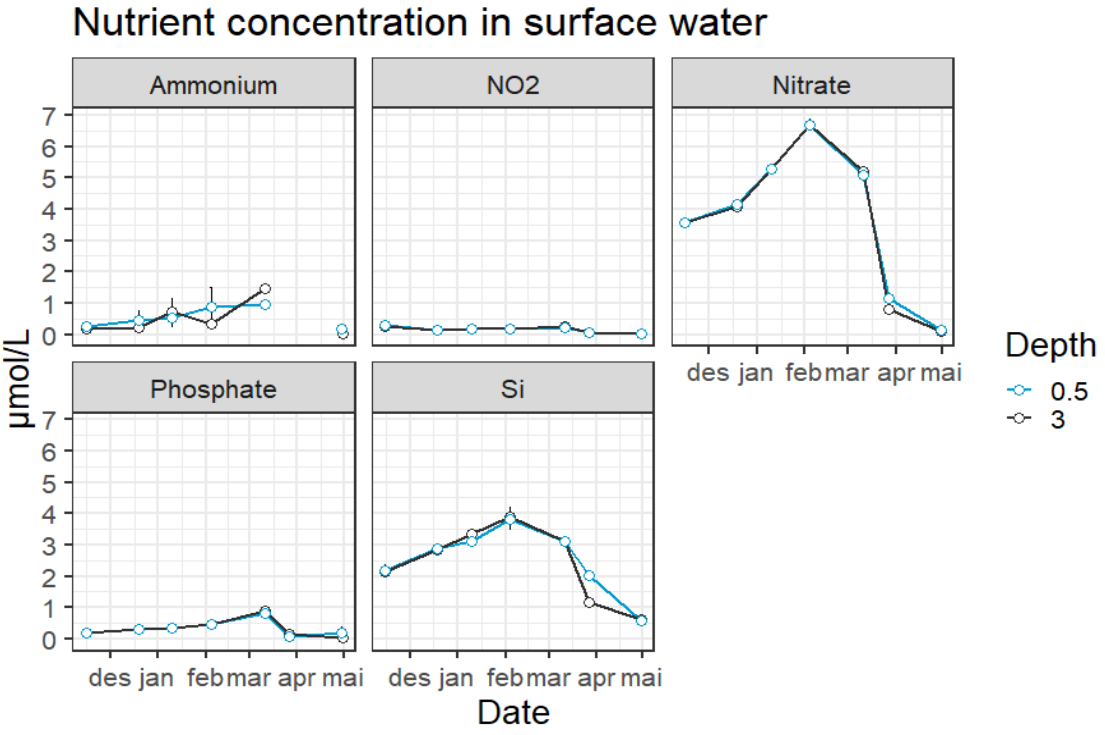

Figure 3.4. Water nutrients from two depths (0.5 and 3m) collected monthly at the cultivation site from November 15th to May 08th. The vertical lines show the standard deviance of the three replicates taken.

3.2 Biomass and area measurements

There was variation in both sporophyte size and density between the deployments and between spools. The lowest density was found in the November deployment, and the smallest sporophytes at deployment was from the January batch (Table 3.1). The October sporophytes were generally larger than the other two deployments.

Table 3.1: Average density and size at the deployment time for the three sporophyte batches (deployments). Number of spools used on each deployment varied because the size of the spools used varied.

Deployment	Spool number	Average density (plants/mm)	Average size (mm^2)
October	1	13.2	0.815
	2	5.9	0.556
	3	10.87	0.821
November	1	7.07	0.283
	2	7.27	0.370
January	1	8.20	0.106
	2	14.93	0.068

The October and November deployments had little growth in the first three months, but the increase in area and biomass from February to May was high (Figure 3.5), especially for the October deployment. At the time point of the January deployment the October and November sporophytes had areas that were three and two orders of magnitude larger, respectively. In March both the October batch and the November batch had a rapid increase in both area and biomass (Figure 3.5). The January batch has a small increase in area and biomass from 27 March to 30 April.

The October, November and January deployments had been cultivated for 189, 159 and 111 days, respectively, on the last biomass- and area sampling (30 April 2019). The final harvest, by the manufacturer, occurred 7 days after this sampling (8 May 2019).

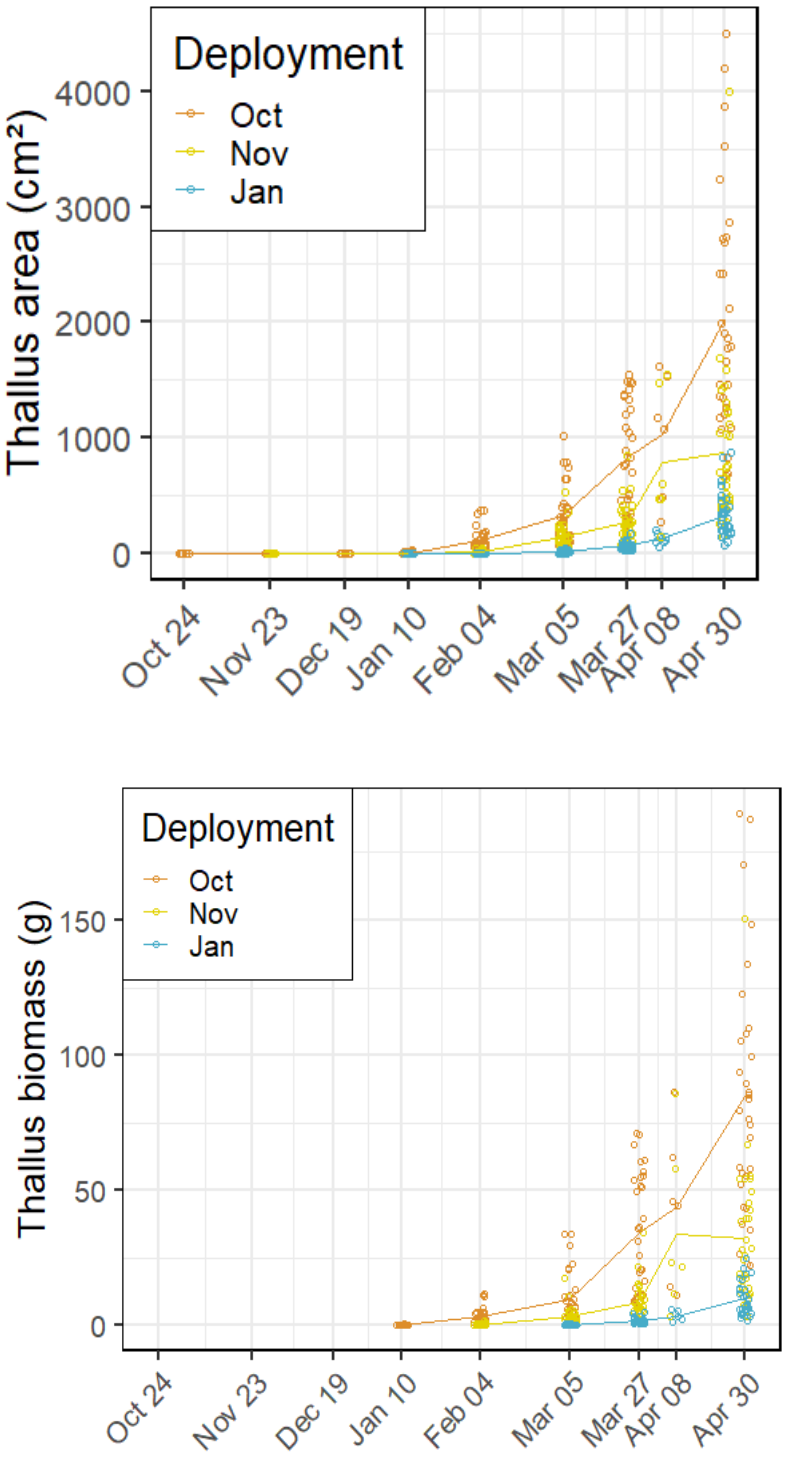

Figure 3.5. Development of lamina area (cm^2) (top) and biomass (g) (bottom) for the three deployments. All marked dates are the dates of sampling. Each circle represents one measurement and the lines are made from the mean value for each deployment from each sampling.

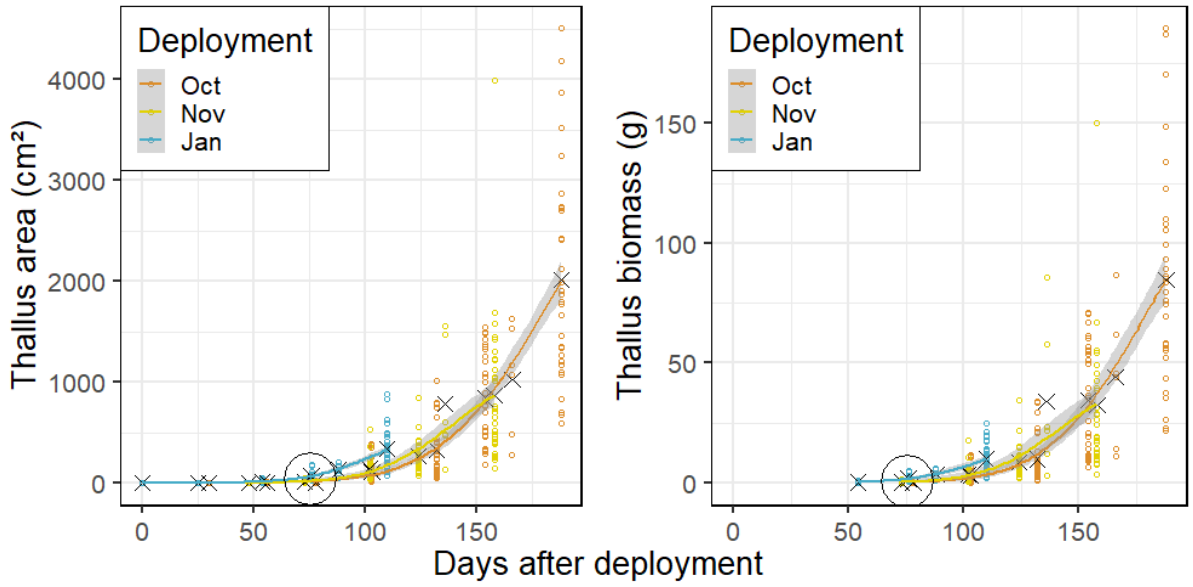

Figure 3.6. Thallus area development in relation to how many days the batches had been deployed. Shadows surrounding each curve is the confidence interval of each curve and crosses are the mean of each sample of each deployment. The encircled area (black circle) shows the time interval (day 73-78) where the curves were statistically compared using a linear mixed effects model.

The area and biomass data were plotted against how many days each batch have been cultivated at each sampling (Figure 3.6). This made it possible to visualise the effect season has on the area and biomass development without the lines being skewed by the different deployment times. The last batch, from January, never reached the area and biomass levels of the two other deployments but had a faster development in area at an earlier time after being deployed (Figure 3.6). The GLM with quasipoisson error-term and F-test showed that the area development was slightly different between the deployments in relation to how many days they had been deployed (GLM; $F_{4,525}$=2.670, p=0.031), but it was not for biomass development (GLM; $F_{4,525}$=1.760, p=0.136).

At one instance, the deployments had been sampled at a point where they had been cultivated for roughly the same time (±3 days), and this was used to compare their development in relation to cultivation time (Figure 3.6, black circle). At this time point the October sporophytes were 78 days old (sampled 10 January 2019), the November sporophytes 73 days (sampled 2 February 2019), and the January sporophytes 76 days old (sampled 27 March 2019). Variance between these samples was analysed by linear mixed effect model (LME) and included the ropes as a random effect. A significant difference between the deployments were found for area (LME; $F_{2,9}$=81.450, p<0.0001) and biomass (LME; $F_{2,9}$=58.457, p<0.0001). A Tukey HSD post

hoc. test showed that the November and October sporophytes were not different from each other in neither area nor biomass (Tukey test, $p \geq 0.335$), while the January sporophytes was significantly larger than both the November and the October batch in both area and biomass after 73-78 days of cultivation (Tukey test, $p < 0.001$) (Figure 3.7).

Wild sporophytes had settled on an empty part of rope 3 (November deployment) and was sampled 5 March to compare with the cultivated kelp. The area of the cultivated sporophytes on rope 3 were much larger (average 133 cm^2) than of the newly settled on rope 3 (average 17 cm^2). Samples from the January batch (average 16 cm^2) were closer in size to the wild settled sporophytes at this sampling time.

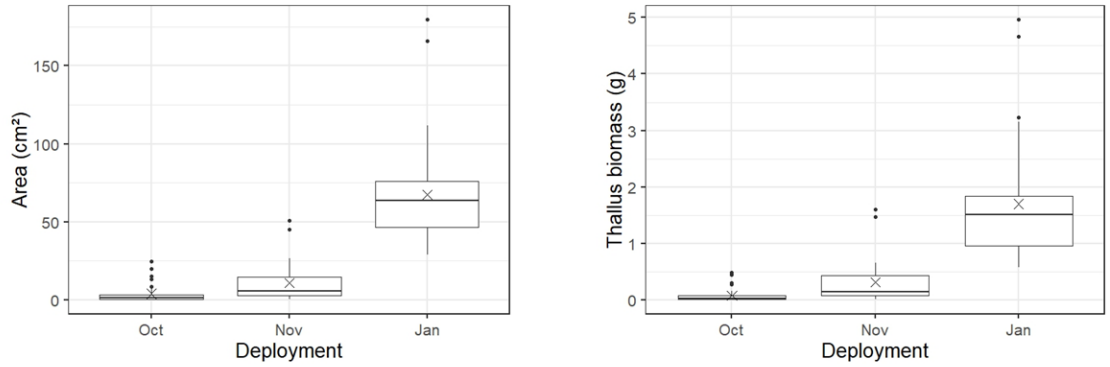

Figure 3.7. Comparison of the sporophytes area (left) and biomass (right) of the three deployment batches when they had been cultivated for; 78 (October), 73 (November) and 76 (January) days. Sampling times were 10 January, 2 February and 27 march, respectively

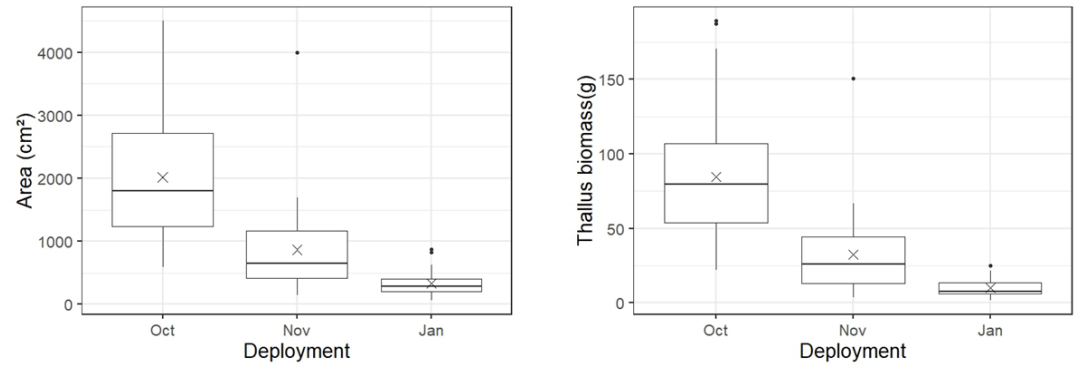

Figure 3.8. Comparison of the sporophyte area (left) and biomass (right) of the three deployments at the final measurement sampling (30 April 2019). Commercial harvest was done by Ocean Forest eight days later.

In the last sampling (30. April) the sporophytes had an average area of 2017 cm^2 (oct), 868 cm^2 (Nov) and 335 cm^2 (Jan), and average biomass of 85g (Oct) 32g (Nov), and 10g (Jan). The LME

with rope as a random effect showed that the differences in deployments were significant for both area (LME; $F_{2,9}$=15.804, p=0.001), and biomass (LME; $F_{2,9}$=22.004, p=0.0003) at the final sampling. Using a Tukey HSD post hoc test to compare the deployments showed that the October batch was significantly larger in both area and biomass than both the November and January batches (Tukey-test, $p \leq 0.001$) at the final sampling (30 April 2019). Area and biomass of the January batch and the November batch was not significantly different from each other on the final sampling in neither area nor biomass (Tukey-test, p>0.1) (Figure 3.8).

3.3 Growth rate

Out of the 40 plants initially tagged on the 8th of April 2019 to study growth rate of plants from different deployment times in a specific period, 31 were recovered on the 8 May 2019. Twenty-two plants were used in the data analysis, as one of the batches was excluded in this study. Three plants were lost from the January batch, three from the November batch and two from the October batch.

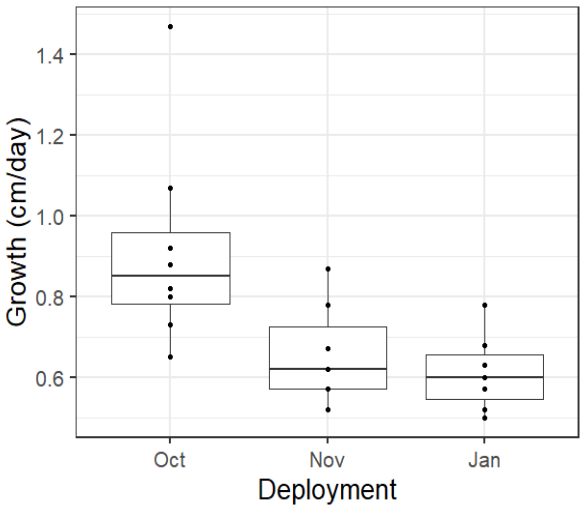

Figure 3.9. Daily growth measured between 8 April to 8 May (30 days). For the January and November batch n=7, for the October batch n=8.

In the measured interval, the October, November and January batches had an overall average daily growth of 0.92, 0.65 and 0.61 cm per day, respectively (Figure 3.9). There was no significant difference between the batches when compared using an LME with rope as a random factor ($F_{2,3}$=6.452, p=0.08). Specific growth rate (SGR) measured was between 3.05-4.03% (average 3.46%) for the January deployment, 3.12-4.27% (average 3.60%) for the November deployment, and 3.61-5.62% (average 4.35%) for the October deployment.

Of the 22 plants that were found after a month, the five plants with the highest growth rates were all from the October batch. The highest increase found was 44 cm (1.47 cm day^{-1}) and was measured on a plant from the October deployment. The November deployment had the second largest growth rate of the three deployments, the largest plant of which had grown 26 cm (0.87 cm day^{-1}). The highest growth recorded in the January deployment was 23.5 cm (0.78 cm day^{-1}).

3.4 Dry weight (DW)

The GLM with quasibinomial error-term showed that there was not a significant difference among the three deployments in regard to dry matter contents (GLM; $F_{2,27}$=1.545, p=0.231).

The average dry matter content of the October, November and January plants were 13,7% 12,2% and 13.3 %, respectively (Figure 3.10). The lowest measured content of dry matter from one plant was 8.2% (November) and the highest was 18.9 % (January).

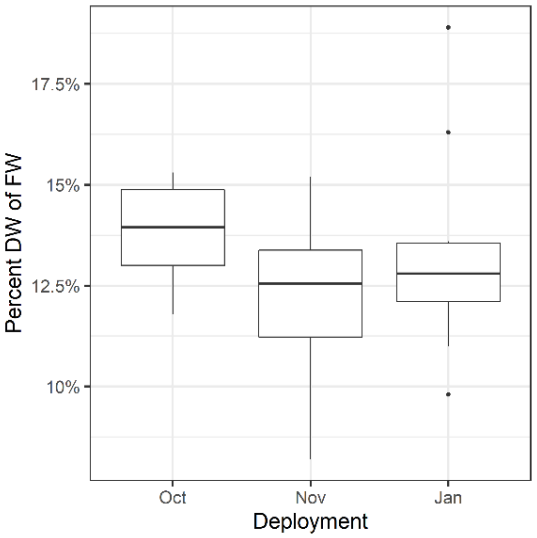

Figure 3.10. Dry matter content of the thallus as percent of the fresh weight (FW) for the three sporophyte batches.

3.5 Carbon and nitrogen content

Both nitrogen and carbon content in the tissue of the kelp plants were similar across the deployment groups (Figure. 3.11). The GLM with quasibinomial error-term did not show any difference between the deployments in tissue dry content of nitrogen (GLM; $F_{2,27}$=0.576, p=0.569) or carbon (GLM; $F_{2,27}$=1.270, p=0.297). The average nitrogen contents of tissue dry weight in the three deployments were 0.96%, 0.80% and 0.84%, for the October, November and January deployments, respectively. Some samples from each deployment were found to be above 1% N, and most of these were from the October deployment. One sample from the January deployment was found to have a nitrogen concentration of 2%, hence the large spread in Figure 3.11.

The carbon content of tissue dry weight was an average of 30.14%, 34.31%, and 33.21% for the October, November and January deployments, respectively. The largest concentration found was 54.61% in the November batch, and the lowest was 14.78%, in the October batch. C:N ratio was ranging between 20.8 and 61.8, with an average for each deployment being 34.0 (Oct), 43.8 (Nov) and 44.0 (Jan).

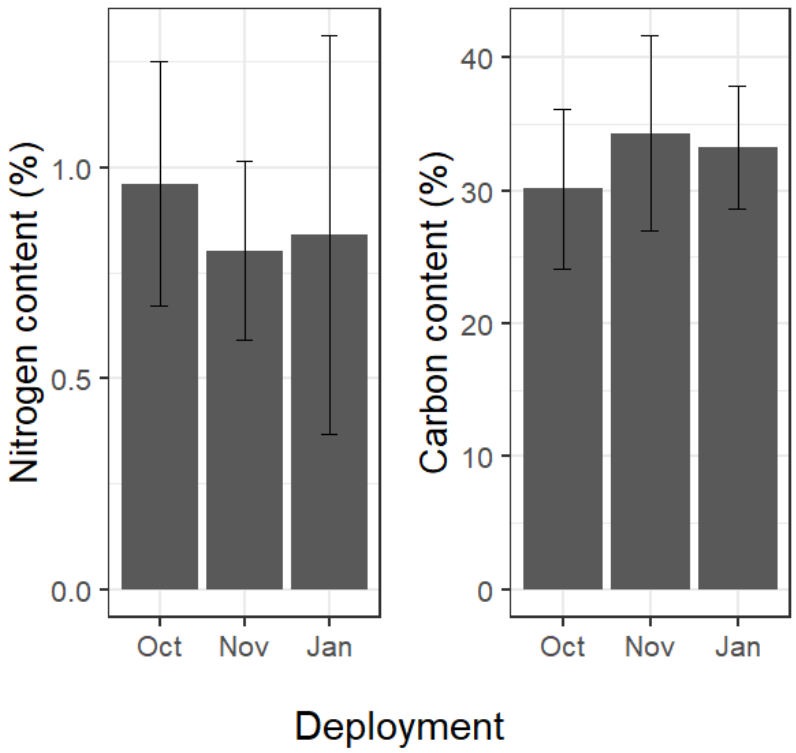

Figure 3.11: Nitrogen and carbon content of dry weight (%) of *S. latissima* from the three deployments. Bars showing the means +- standard deviation (SD).

3.6 Biofouling of *Saccharina latissima*

In all the samples biofouling was recorded in various degrees, except from the first month post-deployment for each batch. A total biofouling score was calculated for each batch for each sampling time. The max score was 40, as the biofouling as categorized in 10 different groups, and the score ranged from 0 to 4. The largest score found in this study was 13, which was found for two plants from the October batch on 30 April (Figure 3.12a). In relation to the sampling dates (3.12a) the October batch had a significantly larger score than the other deployments until April, after which all plants eventually reached a very similar amount of biofouling. The GLM with quasipoisson error-term and F-test showed that the biofouling development was different between the deployments in relation to how many days they had been deployed (GLM; $F_{4, 350} = 6.826$, $p<0.001$). When the groups were compared, it was found that the development of biofouling on the January batch was significantly different from the November batch ($t=4.604$, $df=350$, $p<0.001$), and the October batch($t=-3.964$, $df=350$, $p<0.001$). The fouling on the November and October batch were not differently affected by amount of days deployed ($t=1.946$, $df=350$, $p=0.052$).

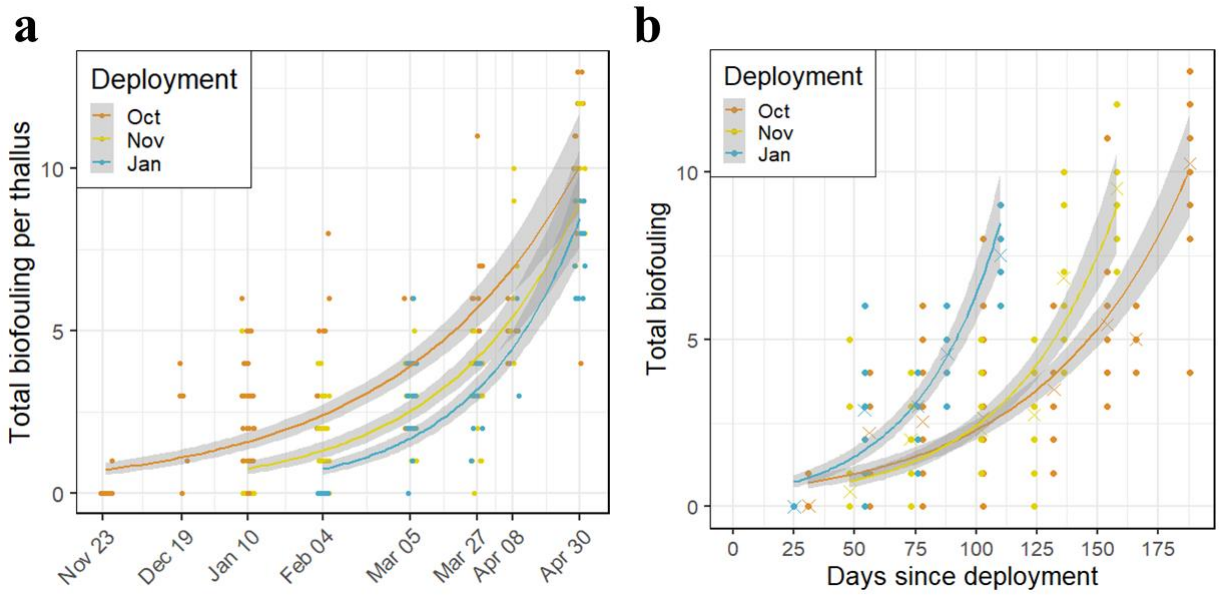

Figure 3.12 a-b Biofouling in relation to the season (a) and the age of the deployment (b). Total biofouling is the sum of ranking 0-4 of all the fouling species found, of 10 possible taxa groups. Dark grey field shows the 95% confidence intervals of the GLM (lines) with error term quasipoisson. The crosses show the average value for each group at each sampling.

However, the development of total biofouling was faster on the January batch relative to how many days it had been in the sea (Figure 3.12b). After 60-70 days deployed, the biofouling of the January plants increased more rapidly than it did on the two other deployments (Figure 3.12b). The GLM with error term quasipoisson added to figure 3.12b showed that the development of biofouling on the January deployment was different from the two others, as it increased more rapidly.

From November to the end of April there were a variety of epiphytic organisms growing on *S. latissima*, and the composition of the community changed throughout the study (Figure 3.13). In December to March, fouling was mainly composed of the diatom *Licmophora* sp. (Figure 3.14c) and a few juvenile red algae. Some of the red algae that were possible to identify were *Melanothamnus harveyi*, *Polysiphonia stricta* and *Ceramium* sp. Alongside *Lichmophora* sp., stalked ciliates were often spotted throughout the study (Figure 3.14b).

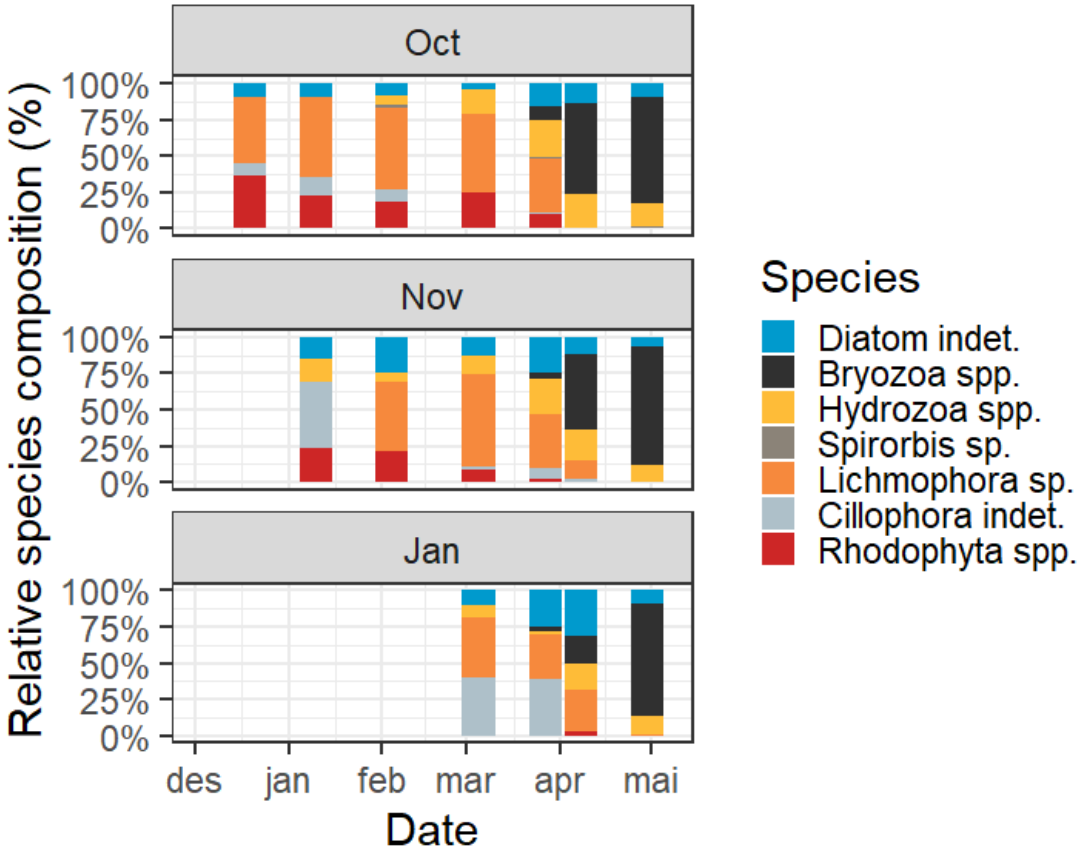

Figure 3.13 Relative composition of fouling taxa found on the plants from 10 January 2019 to 30 April 2019. The three bryozoa species (*E. pilosa*, *M. membranacea* and *Celleporella* sp.) has been added together in one group (Bryozoa spp.) for this figure.

In the end of March and the following sampling dates, a growing number of hydroids were observed and were sometimes covering the entire distal part of the lamina. The hydroids found on the kelp were mainly from the family Campanulariidae, genus *Clytia*, and either *Laomedea* or *Obelia* (Figure 3.14a). A few *Ectopleura larynx* were found, usually on the holdfasts.

The first bryozoans on the kelp were observed in the end of March and were from the genus *Celleporella* (Figure 3.15b). At the start of April a few small colonies of *Electra pilosa* and *Membranipora membranacea* was spotted on all deployments and rapidly increased toward the end of April. In late April, the meristems were covered in bryozoan larvae (Figure 3.15a), while the mid part was covered in several small bryozoan colonies. The bryozoa species recorded consisted mainly of *Electra pilosa* and *Membranipora membranacea* in April (Figure 3.15 c,d). The bryozoan *Celleporella* sp. (Figure 3.15b) was recorded a few times, but in comparison to *M. membranacea* and *E. pilosa*, the presence of this bryozoan was miniscule.

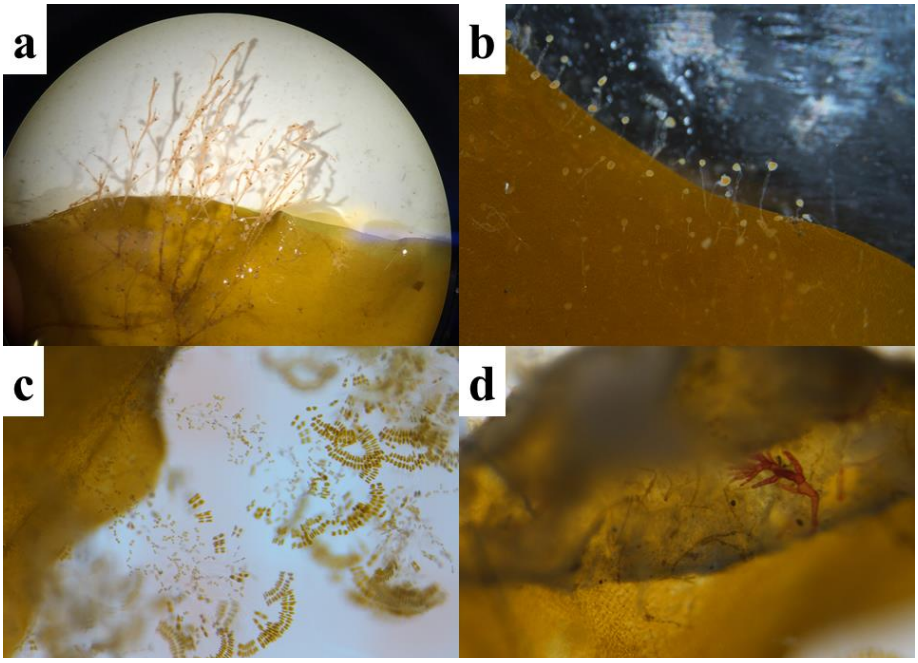

Figure 3.14 Fouling taxa. **a;** Family Campanulariidae, genus *Laomedea* or *Obelia*, **b;** Stalked ciliates, **c;** Family Licmophoraceae, genus *Licmophora*. **d;** Red algae (Unidentified).

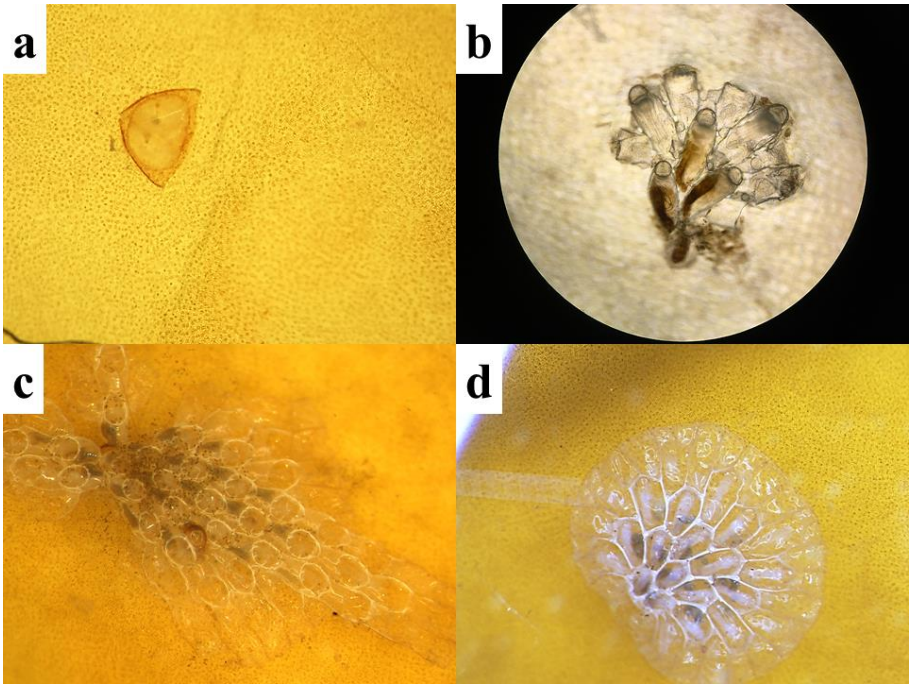

Figure 3.15 Different bryozoans found on the kelp. **a;** Bryozoa larvae, **b**; *Celleporella* sp. **c;** *Electra pilosa*. **d;** *Membranipora membranacea.*

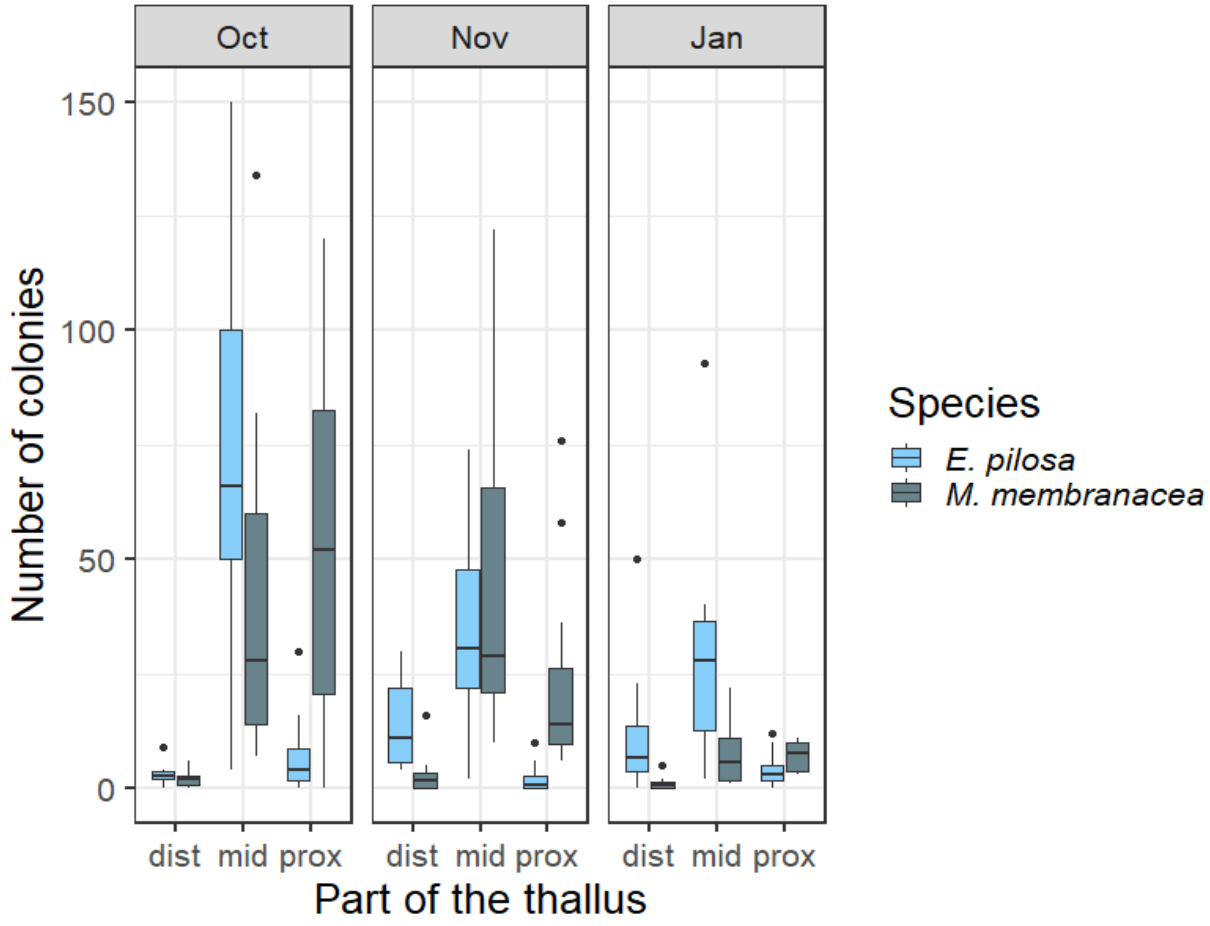

Figure 3.16. Number of bryozoa colonies from the last sampling (30 April 2019) found from each species (*Electra pilosa* and *Membranipora membranacea*) in the different part of the lamina. Dist; distal, mid; middle, prox; proximal (see Figure 2.5 for clarity).

In the late April sample, *E. pilosa* was often dominating in the middle parts of the lamina, while the newer part (proximal) was dominated by *M. membranacea* (Figure 3.16) and, closer to the stipe on the meristem, newly settled larvae dominated. The density of larvae was so high that it was impossible to count. The density of bryozoa colonies calculated showed that the October batch had the lowest density, despite for having the highest number of bryozoa colonies due to a larger lamina. The highest density of bryozoa colonies was found on the January sporophytes (average 0.079 colonies cm^{-2}). *E. pilosa* density was largest on the January batch (average 0.061 colonies cm^{-2}). The density of *M. membranacea* was largest on the November batch (average 0.047 colonies cm^{-2}). The LME with F-test and rope as an error term showed that there was no significant difference between the deployments in bryozoa density (LME; $F_{2,8}$ = 2.305, p=0.162).

What might be some sort of chytrid, or marine fungi, was found inside the tissue of the kelp in March and in several of the later samples. Sample of this endophyte was taken and sent to the

University of Tromsø where it was studied for morphological features and isolated by Teppo Rämä. Unfortunately, the taxon is yet not identified.

Other macroalgae were found to be settling from wild populations onto the cultivation ropes, like *Saccorhiza polyschides* and *Alaria esculenta,* which were found in March and April. Non-sedentary organisms were often found, but the amount or number of mobile organisms was not properly recoded. The crustacean *Caprella mutica* and nudibranchs *Dendronotus frondosus* and *Flabellina lineata* was frequently spotted in-field on the kelp while sampling. Tiny mussels (likely *Mytilus edulis*) as well as small *Lacuna vincta* were spotted when examining the lamina in the stereo microscope in April.

Natural growing kelp sampled close to the cultivation site were also investigated, although only two plants collected at one occasion. These showed a slightly different composition of fouling species. These plants had more of the bryozoa *Celleporella sp.* and less hydroids than the farmed kelp. More spirorbid worms were found on the natural growing sugar kelp than on the farmed sugar kelp. Fish eggs were observed on the natural growing kelp.

A visual investigation of the January batch was done 21 June, after the commercial harvest, as some plants from this deployment were left at the cultivation site after the study ended. By this time most of the thallus was overgrown by bryozoans (Figure 3.17), and the plants were not noticeably bigger than in May.

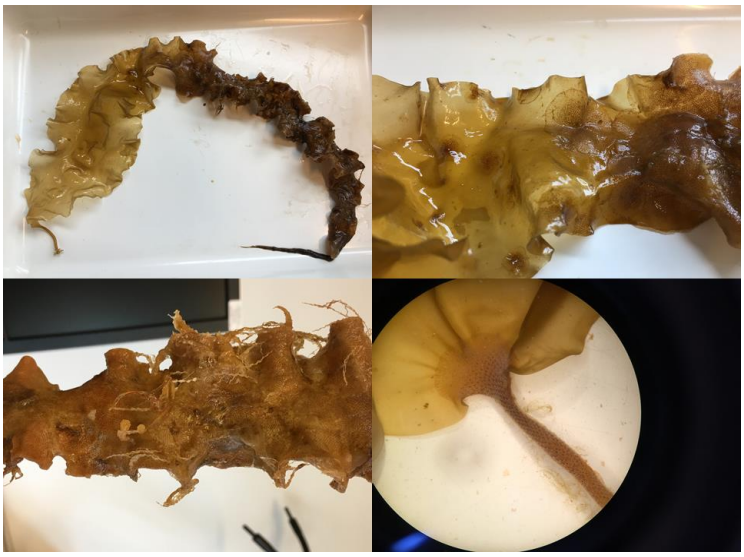

Figure 3.17 January plants visually investigated 21 June, overgrown by bryozoa.

4 Discussion

Improvement of kelp production in Norway is important in order to make it more profitable. In order to do this, the yields in form of biomass needs to be maximised without compromising the quality of the production. It is therefore important to find out how much the timing of the seedling deployment affects the harvested product in regard of quantity and quality. The objectives for this study were to study how the timing of *Saccharina latissima* sporophyte deployment (from October to January) affects the (1) development of area and biomass throughout the cultivation time, (2) development and composition of fouling taxa, and lastly (3) to compare the chemical composition of nitrogen and carbon in the three sporophyte deployments at the harvest time.

4.1 Uncertainties of result

Depth has been found to be one of the main factors affecting biomass in cultivated kelp (Matsson et al., 2019), as increased depth results in decreased light. As the kelp in this study was growing, the increase in weight would cause the ropes to sink, causing the depth of the ropes, and thus variance within each deployment, to vary a lot thought the study. 'Rope' was therefore added as a random factor in statistical analyses, so this effect was accounted for to some degree.

At deployment of the November batch, there was not enough seedling string to cover the entirety of rope 3, and this resulted in an empty field of approximately 8-10 meters without seedlings. The empty field could possibly result in better light conditions on parts of rope 4 and rope 2, but as plants were collected along the entire ropes, this effect would likely be minor. In February small *S. latissima* plants were found growing on this empty part, indicating that wild kelp had settled on the ropes between November and February. These were sampled 5 March and, when compared to the November samples from the same rope, found to be much smaller in area. They were similar in size to the January batch 5 March. Some wild kelp could therefore have been mistake for January plants when sampling.

Growth rate measurements in this study were taken at 10 cm above the lamina/stipe junction. However, some growth (7.5% of total growth) is found at 10-15 cm above the junction in larger plants (Sjøtun, 1993). Therefore, this study might not show the full growth of the plants in the hole-punching experiment. This was evident in the largest tagged plant from the October-

deployment, where the hole that was punched one-month prior had visibly expanded in diameter during this time, indicating some growth above the 10 cm point.

Lack of experience in identifying the various fouling taxa, resulted in some uncertainty in the identifications. Most of the categories used are therefore only identified to a higher taxonomic level, and not to species level. The other reason is that many of the individuals were juveniles, which make identification hard or impossible. To be able to identify down to a specific species is however not very important in a commercial production perspective.

The values from converting lux to Photosynthetic Photon Flux Density (PPFD) (µmol $m^{-2}s^{-1}$), and from global solar irradiance (Wm^{-2}) to lux must be interpreted with caution. PPFD is measured within 400-700 nm, while global solar irradiance is measured from 1100 to 400 nm. The conversion factor used on W m^{-2} to lux changes with variables such as cloud cover, condensation, time of the year and solar altitude meaning there is no global conversion factor (Littlefair, 1988; Olseth and Skartveit, 1989). However, for the comparison of seasonally available sunlight, the margin of error between the conversions is unimportant for this study.

4.2 Environmental factors

October and November deployments were subjected to temperatures above 10°C between November and December, which is optimal temperatures for growth in *S. latissima* (Fortes and Lüning, 1980). As the last batch was deployed in January the temperatures were between 5.5 and 7.5°C, possibly yielding a slower growth due to influence of low temperatures. Bolton and Lüning, (1982) found that in small sporophytes the growth and temperature had a linear relationship between 1 and 10°C.

The compensation point for photosynthesis for sporophytes is 2-6.8 µmol $m^{-2}s^{-1}$, while the photosynthesis of *Saccharina latissima* is saturated at light intensities of 170 µmol $m^{-2}s^{-1}$ (Borum et al., 2002). Converting the light measured at the cultivation site from lux to µmol $m^{-2}s^{-1}$ showed that the light available to the plants was very close to the compensation point in November, but sometimes below. In early January the measurements were above the compensation point and increasing throughout spring and reached the saturation levels on 2 May.

Nutrient conditions were good at all deployment times. Concentrations of nitrate were above 5 µmol L^{-1} from January to March. The growth of *S. latissima* is saturated at concentrations of 5-

10 µmol L^{-1} of Nitrate, with a half saturation point at 1-2 µmol L^{-1} (Wheeler and Weidner, 1983). This indicates that the nitrate conditions were good through most of the cultivation time, but not in the last month when it was below 1 µmol/L. Nutrient concentrations in surrounding water has been found to affect the dry tissue concentrations of nitrogen (Wheeler and Weidner, 1983; Boderskov et al., 2016) which could explain the concentrations of N found in the plants in May. Phosphate is normally not a limiting factor for growth in seaweed (Hurd et al., 2014).

A substantial drop in water nutrients and a rapid increase in chlorophyll-a, indicate that the spring bloom took place in March.

4.3 Growth and biomass development

Because of biofouling, all plants were harvested at the same time in spring, meaning the cultivation time decreases with later deployment time. The October, November and January batch were cultivated for 189, 159 and 111 days, respectively, and the size and biomass of the deployments at the final harvest ranged thereafter.

Even though the light was limited during winter, the growth did not stagnate completely in the October and November deployment plants, as the light levels observed were above the compensation point most of the time. This was evident when comparing the October and November plants to the newly deployed batch in January. It is possible that having a slightly larger area when the light increased made it possible for them to utilize the light more efficiently, which could have given them an advantage.

At 76 days the January sporophytes, having had a greater initial increase in area and biomass after being deployed than the other deployments, had larger area and biomass than the other batches at the same age (±3 days). This indicate that light was more important for their growth than the relative low temperature in spring. Given the same amount of time (i.e harvested later), the January sporophytes would probably have reached the same sizes as seen in the October or November batches. However, when visually inspected on 21 June (cultivated for 163 days), they had not increased in size, but was almost completely covered in bryozoans (Figure 3.17). It is very likely that the bryozoans were affecting the growth, as was found by Handå et al. (2013).

In cultivation studies of *Saccharina japonica* in China, it was found that using summer sporelings (‘forced cultivation’) and deploying them at sea in autumn resulted in an increase of

30-50% in production, mainly because they had two more months to grow (Tseng, 1993). There have only been a few studies in Europe on the effect of different deployment time that are comparable to this study, as many studies on *S. latissima* cultivation has focused cultivation at different depths (Luning, 1979; Forbord et al., 2012; Handå et al., 2013), or in proximity to fish farms (Handå et al., 2013; Marinho et al., 2015b; Freitas et al., 2016).

Different deployment times for *Saccharina latissima* has been tested in both in the UK (Kain et al., 1990), Ireland (Edwards and Watson, 2011) and in the species southern range, NW Spain (Peteiro and Freire, 2009). All three studies were performed at lower latitudes than this study. Kain et al. (1990) deployed the sporophytes on 2 meters depth in November, December, February and April, while Peteiro and Freire (2009) deployed at 2 meters depth in November and February. Edwards and Watson, (2011) deployed the sporophytes on several 3-meters droplets from a horizontal rope in October and January.

The results from Kain et al. (1990) contradict with the results in this study somewhat, as they found sporophytes deployed in December and February had the best growth, while plants deployed in November had a lower biomass (DW) at harvesting and was therefore deemed too early. Peteiro and Freire (2009) found a better harvest potential when deploying earlier (November vs February), as was found in this study as well. It is important to point out that in the study from Spain the November deployment got harvested in April before the temperatures got too high, while the February deployment got ruined by high temperatures in May. Similar to this study, Edwards and Watson (2011) got the largest yield from the October deployment compared to the January deployment. The outplanting window for *S. latissima* in the UK, Spain and Norway are probably different due to latitudinal difference affecting the temperature, light and nutrients available in the cultivation period. There are no universal deployment and harvesting times that can be applied everywhere, and differences on cultivated kelp can even be seen at sites that are situated relatively close to each other (Matsson et al., 2019).

At the final harvesting in May, most samples had N contents below 1%, and a C content around 30-35%. Concentrations of > 1% nitrogen in tissue dry weight in *Saccharina latissima* has been found to indicate that nitrate is being stored intracellularly (Asare and Harlin, 1983). However, most of the samples in this study had N contents below 1% of dry weight, indicating that nitrate was not being stored in early May. This might be because they were still experiencing high growth, as indicated by the specific growth rates (3-5 %), and an elongation rate of 0.5 to 1.5 cm per day. The measured SGR is somewhat low compared to nitrate saturated plants, which have been found to have a SGR of 10% per day (Wheeler and Weidner, 1983),

and further indicates that the plants were nitrate limited. The October sporophytes had the higher SGR and nitrate concentrations and lowest carbon concentrations (although not significantly) compared to the other deployments, which indicate that they were less nitrate depleted compared to the two other groups. This may be because their laminas were larger, and therefore able to store more nutrients to use for growth. Lower nitrogen content means lower concentrations of proteins (Marinho et al., 2015a), which are preferred to be high in products intended for human consumption.

4.4 Biofouling

The development of biofouling happened much quicker on the January batch, as they did not have a long time to grow before the onset of biofouling started. It is therefore safe to assume that the biofouling correlates more with the time of year than the age of each deployment. As the fouling score was similar for the three deployments in late April, and January plants were much smaller, there was not found a relationship between thallus size and an increase in fouling.

The relative species composition (Figure 3.13) was slightly different between the deployments. The October and November plants had more red algae found on them from December through March, while none was found in the samples of the January plants, indicating that there were more red algae spores in the water in late fall than in the winter and spring. Less red algae were found after April, which might be because of erosion of the distal part where it was growing. A lot of the biofouling was made up of hydroids and diatoms. The effects of that the different groups of epibionts has on the kelp was not investigated in this study, but a study by Hepburn et al., (2006) showed that the encrusting bryozoa *M. Membranipora* had a more negative effect on the kelp tissue of *Macrocystis pyrifera* than stoloniferous hydroids like *Obelia geniculata*. It is even possible that some of the epibionts have a mutualistic relationship with the kelp (Hepburn and Hurd, 2005).

Free living larvae from marine invertebrates are triggered by environmental cues to settle. Temperature has been found to be one important trigger for the increase in biofouling cover on kelp (Matsson et al., 2019). Larvae from both *M. membranacea* and *E. pilosa* exists in the water column almost year round, but mainly settles in the summer (Førde et al., 2016). Temperature was found to influence cover of the bryozoan *Membranipora membranacea* in a model developed by Saunders et al. (2010). This is possibly why there is a latitudinal trend for a later onset of biofouling with increasing latitudes, as ocean temperatures are lower in spring further

north (as presented in Table 1.1). In this study the biofouling score increased with the increasing temperatures throughout April. Biofouling was found earlier in this study than one would expect at this latitude. The lamina was very closely examined with stereo microscope throughout the study, which made it possible to spot small and juvenile biofouling that was not visible by eye early and could possibly be an explanation.

Celleporella sp. was the first bryozoa that was found, late in March, but disappeared in later samples, maybe because it was displaced by *E. pilosa* and *M. membranacea*. In early April the number of newly formed colonies and larvae increased, and by the end of April most of the biofouling was composed of bryozoans.

Number of bryozoa colonies counted on the October plants on samples from 30 April were higher compared to the November and January plants, as a larger lamina can host a higher number of bryozoa colonies. When the density of bryozoa colonies was calculated to account for the lamina area differences, there was an insignificant difference which means that the density of bryozoans was roughly equal on all deployments, regardless of lamina size.

A higher number of bryozoa colonies were found at the proximal part compared to on the older parts of the lamina. Especially the larvae very clearly settled on the proximal part of the lamina and were found in large quantities in April. Settling on the meristem/proximal part would provide them with a substrate until the lamina grow out and the older part is eventually is eroded or lost. The same pattern of bryozoa larvae on the meristem and more colonies further up on the lamina was also spotted by Seed (1976), who argued that it is a good strategy in competition for space. There seem to be a preference for settling on the newly formed lamina, but it is uncertain how the larvae find the meristem. There is a pattern of more *E. pilosa* in the middle part of the lamina, with *M. membranacea* toward the meristematic part was also found by (Denley et al., 2014) and it is possibly due to a competitive advantage that *M. membranacea* has over *E .pilosa*. The only known way to avoid the crop being ruined by encrusting bryozoa is to harvest at an earlier time. Other slightly mitigating options is to cultivate deeper and less turbid waters where there will be less food for suspension feeding organisms like bryozoans, but this did not have a large effect according to Førde et al., (2016). In this study I found that within three weeks of the first spotting of bryozoans, they were already covering a lot of the thallus. A good practice is to start investigating the laminas under a stereo microscope regularly from March in order to detect the fouling at the earliest point possible.

4.5 Conclusion: Best seasonal timing of *Saccharina latissima* cultivation

An earlier deployment time can potentially give a larger harvestable biomass of *Saccharina latissima* on the west coast of southern Norway, if harvested before the onset of biofouling. Through the cultivation period it was found that both area and biomass developed similarly in all sporophytes, but the plants that were deployed later did not reach the same size because of a shorter cultivation time. Tissue dry content of N and C was not affected significantly by deployment times, and N contents were low in most of the sporophytes at the harvest time. Biofouling increased rapidly in March and was dominated by diatoms and hydroids and, in late spring, the bryozoans *E. pilosa* and *M. membranacea*. The deployments had to be harvested in early May, due to a rapid increase in encrusting bryozoa. This results in a growing season from October to May, and sporophytes deployed early in the growing season will thus have a longer growth period resulting in a greater area and biomass yield.

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Appendix

A: Growth rate and chemical composition (C and N) data

Raw data of the individuals investigated for chemical composition, dry matter content and daily growth rate on tagged plants. Individuals marked with 'NA' for growth rate was lost plants

from the growth study, which were replaced with new plants for chemical composition. Growth rate was measured 08.04.2019 - 08.05 2019. Samples for chemical composition and dry matter content collected on 08.05.2019. Individual numbers are related to the number the plant was tagged with in the field and is related to its position. SGR; Specific Growth Rate.

Ind.	Deployment	Rope	C (%)	N (%)	Dry matter content (%)	Growth rate (cm day^{-1})	SGR (%)
1	January	1	45.17	2.17	16.33	NA	NA
2	January	1	34.38	0.65	18.91	0.50	3.05
3	January	1	32.96	0.73	12.52	0.52	3.12
4	January	1	28.59	0.71	9.76	NA	NA
5	January	1	30.53	0.79	10.97	0.57	3.32
6	November	3	34.21	0.57	12.25	NA	NA
7	November	3	28.48	0.76	10.91	0.52	3.12
8	November	3	33.58	0.62	8.19	0.67	3.66
9	November	3	33.59	0.95	12.47	0.57	3.31
10	November	3	33.19	0.73	15.15	0.62	3.49
11	November	5	29.87	0.75	13.67	0.78	4.03
12	November	5	32.57	0.80	10.46	NA	NA
13	November	5	31.03	0.85	13.63	0.57	3.31
14	November	5	31.97	0.67	12.58	0.87	4.27
15	November	5	54.61	1.32	12.68	NA	NA
16	Excluded*	8	33.59	0.73	15.12	0.50	3.05
17	Excluded*	8	33.03	0.71	13.83	0.52	3.12
18	Excluded*	8	33.46	0.93	16.17	0.67	3.66
19	Excluded*	8	33.84	0.76	15.09	0.58	3.37
20	Excluded*	8	34.92	0.86	14.16	0.72	3.82
21	October	10	33.40	1.03	12.87	0.73	3.88
22	October	10	30.07	1.17	13.45	0.80	4.08
23	October	10	35.99	1.29	14.50	1.07	4.78
24	October	10	33.01	0.84	14.99	0.92	4.41
25	October	10	14.78	0.24	15.06	0.88	4.32
26	Excluded*	12	30.31	0.65	16.00	0.55	3.25
27	Excluded*	12	31.03	0.72	14.01	0.58	3.37
28	Excluded*	12	32.72	0.63	12.50	0.67	3.66

29	Excluded*	12	33.92	0.58	14.32	0.73	3.88
30	Excluded*	12	29.77	0.99	13.10	NA	NA
31	October	14	32.08	0.87	13.32	0.65	3.61
32	October	14	32.45	1.18	14.41	1.47	5.62
33	October	14	33.36	1.02	15.30	0.82	4.13
34	October	14	26.40	0.98	11.83	NA	NA
35	October	14	29.81	0.99	11.76	NA	NA
36	January	16	30.62	0.75	12.42	0.78	4.03
37	January	16	31.95	0.65	13.41	NA	NA
38	January	16	33.98	0.67	13.62	0.63	3.55
39	January	16	33.89	0.55	13.09	0.60	3.43
40	January	16	30.08	0.73	11.96	0.68	3.72

* deployed November 11, 2019

B: Chl-a data and temperature & light data from the loggers

Average daily fluorescence (Chl-a) measured from 24.10.2018 to 10.05.2019 at 3m depth at the IMR station in Austevoll. Light (LUX) is the maximum daily illuminance, calculated from the average of all HOBO-loggers per timestep (every 1.5 minute). Light was measured at the cultivation site (only first week of data used).

Date	Chl-a	Temp (°C)	Light (lux)	Date	Chl-a	Temp (°C)	Light (lux)
24.10.2018	1.524			30.01.2019	0.429	6.135	
25.10.2018	1.631			31.01.2019	0.397	6.372	
26.10.2018	1.794			01.02.2019	0.483	6.237	
27.10.2018	2.120			02.02.2019	0.704	6.000	
28.10.2018	2.362			03.02.2019	0.730	5.931	
29.10.2018	2.503			04.02.2019	0.803	6.192	
30.10.2018	3.983			05.02.2019	0.806	6.044	1314.234
31.10.2018	4.389			06.02.2019	0.942	5.930	646.297
01.11.2018	3.277			07.02.2019	0.883	5.975	496.099
02.11.2018	3.143			08.02.2019	0.935	5.987	752.626
03.11.2018	2.292			09.02.2019	0.812	6.331	1379.547
04.11.2018	1.350			10.02.2019	0.718	6.372	1305.713
05.11.2018	1.523			11.02.2019	0.855	5.823	1084.862
06.11.2018	2.508			12.02.2019	1.065	5.868	
07.11.2018	2.850			13.02.2019	0.888	6.065	
08.11.2018	3.201			14.02.2019	0.797	6.252	
09.11.2018	2.983			15.02.2019	0.655	6.427	
10.11.2018	2.002			16.02.2019	0.558	6.541	
11.11.2018	1.725			17.02.2019	0.629	6.578	
12.11.2018	1.770			18.02.2019	0.573	6.743	
13.11.2018	1.527			19.02.2019	0.538	6.637	
14.11.2018	1.608			20.02.2019	0.679	6.372	
15.11.2018	0.686	10.860		21.02.2019	0.703	6.560	
16.11.2018	0.688	10.785		22.02.2019	0.702	6.501	
17.11.2018	1.322	10.536	47.195	23.02.2019	0.678	6.704	
18.11.2018	1.962	10.111	38.550	24.02.2019	0.667	6.677	
19.11.2018	1.948	9.731	206.736	25.02.2019	0.735	6.521	
20.11.2018	1.631	9.576	281.971	26.02.2019	0.807	6.559	
21.11.2018	2.209	8.535	875.255	27.02.2019	0.855	6.520	
22.11.2018	1.871	8.788	726.533	28.02.2019	0.886	6.383	
23.11.2018	2.034	9.202		01.03.2019	0.936	6.178	
24.11.2018	1.871	8.946		02.03.2019	0.979	5.971	
25.11.2018	1.842	8.663		03.03.2019	0.807	6.405	
26.11.2018	2.820	7.831		04.03.2019	0.941	6.404	
27.11.2018	2.411	7.762		05.03.2019	0.906	6.401	
28.11.2018	0.609	9.301		06.03.2019	0.877	6.418	1805.150
29.11.2018	0.422	10.216		07.03.2019	1.118	6.288	767.582
30.11.2018	0.539	10.063		08.03.2019	1.301	6.239	1799.914
01.12.2018	0.535	9.779		09.03.2019	1.493	6.058	661.996
02.12.2018	0.451	9.867		10.03.2019	1.667	5.652	3211.899
03.12.2018	0.621	9.876		11.03.2019	1.486	5.665	3187.096
04.12.2018	0.823	9.662		12.03.2019	1.581	5.984	

05.12.2018	0.608	9.321	
06.12.2018	0.419	9.345	
07.12.2018	0.356	9.726	
08.12.2018	0.361	9.511	
09.12.2018	0.369	9.100	
10.12.2018	0.508	8.832	
11.12.2018	0.539	8.613	
12.12.2018	0.351	8.739	
13.12.2018	0.323	8.681	
14.12.2018	0.418	9.006	
15.12.2018	0.280	8.969	
16.12.2018	0.212		
17.12.2018	0.243		
18.12.2018	0.290		
19.12.2018	0.418		
20.12.2018	0.545		
21.12.2018	0.501		
22.12.2018	0.553		
23.12.2018	0.726		
24.12.2018	0.730		
25.12.2018	0.618		
26.12.2018	0.434		
27.12.2018	0.420		
28.12.2018	0.488		
29.12.2018	0.413		
30.12.2018	0.419		
31.12.2018	0.366		
01.01.2019	0.307		
02.01.2019	0.375		
03.01.2019	0.391		
04.01.2019	0.326		
05.01.2019	0.469		
06.01.2019	0.406		
07.01.2019	0.329		
08.01.2019	0.352		
09.01.2019	0.355		
10.01.2019	0.289	6.384	
11.01.2019	0.381	6.399	300.426
12.01.2019	0.358	6.419	207.364
13.01.2019	0.330	6.787	440.897
14.01.2019	0.344	7.285	185.275
15.01.2019	0.295	7.056	215.391
16.01.2019	0.329	7.121	343.785
17.01.2019	0.393	7.023	760.44
18.01.2019	0.436	6.613	
19.01.2019	0.451	6.682	
20.01.2019	0.460	6.506	
21.01.2019	0.420	6.661	
22.01.2019	0.341	7.097	
23.01.2019	0.303	6.907	
13.03.2019	1.344	6.256	
14.03.2019	1.781	6.067	
15.03.2019	2.603	5.971	
16.03.2019	3.025	6.071	
17.03.2019	4.830	6.098	
18.03.2019	4.586	5.910	
19.03.2019	3.094	5.860	
20.03.2019	NA	6.032	
21.03.2019	3.475	6.276	
22.03.2019	2.439	6.155	
23.03.2019	2.605	6.229	
24.03.2019	2.522	6.193	
25.03.2019	1.971	6.264	
26.03.2019	1.899	6.138	
27.03.2019	1.514	6.290	
28.03.2019	1.032	6.549	1284.039
29.03.2019	0.881	6.533	1522.416
30.03.2019	0.809	6.512	2952.991
31.03.2019	0.561	6.248	4700.711
01.04.2019	0.464	6.335	4158.377
02.04.2019	0.461	6.371	2325.474
03.04.2019	0.726	6.276	1017.463
04.04.2019	0.844	6.550	
05.04.2019	0.887	6.893	
06.04.2019	2.679	7.134	
07.04.2019	1.647	7.237	
08.04.2019	1.154	7.429	
09.04.2019	1.011	7.371	
10.04.2019	1.155	7.272	
11.04.2019	1.657	7.283	
12.04.2019	1.522	7.229	
13.04.2019	1.214	7.242	
14.04.2019	0.953	7.284	
15.04.2019	0.812	7.410	
16.04.2019	0.811	7.598	
17.04.2019	0.745	7.553	
18.04.2019	0.725	7.629	
19.04.2019	0.696	7.964	
20.04.2019	0.806	8.056	
21.04.2019	0.944	8.431	
22.04.2019	0.914	8.567	
23.04.2019	0.865	8.840	
24.04.2019	1.103	8.705	
25.04.2019	1.386	8.597	
26.04.2019	1.603	9.217	
27.04.2019	1.896	10.454	
28.04.2019	2.010	9.944	
29.04.2019	1.205	8.696	
30.04.2019	1.030	8.164	
01.05.2019	2.032	7.853	2087.444

24.01.2019	0.321	6.700	02.05.2019	1.180	7.730	10251.057
25.01.2019	0.338	6.662	03.05.2019	0.357	7.596	6105.151
26.01.2019	0.268	6.766	04.05.2019	0.291	7.754	1827.709
27.01.2019	0.408	6.122	05.05.2019	0.328	10.762	1581.708
28.01.2019	0.539	5.841	06.05.2019	0.260	20.744	2943.651
29.01.2019	0.510	5.808	07.05.2019	0.248	21.730	3660.196

C: Data from bryozoa counts

Bryozoa counts from 30.04.2019. Part refers to the division of the lamina in Figure 1.1. This data is presented in Figure 3.16. Density is measured by the total colonies of bryozoa found on the lamina divided by the total area (cm^2) for both sides.

Deployment	Rope	Ind	Part	*Electra pilosa*	Density (*E.pilosa* cm^{-2})	*Membranipora membranacea*	Density (*M.membranacea* cm^{-2})
Oct	13	1	dist..	0	0.027	0	0.012
Oct	13	1	mid.	66		28	
Oct	13	1	prox.	0		0	
Oct	13	2	dist.	0	0.013	0	0.034
Oct	13	2	mid.	50		14	
Oct	13	2	prox.	2		120	
Oct	13	3	dist.	0	0.033	0	0.021
Oct	13	3	mid.	93		54	
Oct	13	3	prox.	30		24	
Oct	14	4	dist.	9	0.020	2	0.003
Oct	14	4	mid.	100		12	
Oct	14	4	prox.	0		0	
Oct	14	5	dist.	3	0.024	2	0.035
Oct	14	5	mid.	150		134	
Oct	14	5	prox.	4		90	
Oct	14	6	dist.	2	0.028	0	0.023
Oct	14	6	mid.	150		60	
Oct	14	6	prox.	6		72	
Oct	10	7	dist.	0	0.020	3	0.030
Oct	10	7	mid.	12		7	
Oct	10	7	prox.	16		32	
Oct	10	8	dist.	2	0.018	0	0.010
Oct	10	8	mid.	50		18	
Oct	10	8	prox.	0		10	
Oct	10	9	dist.	4	0.003	6	0.047
Oct	10	9	mid.	4		82	
Oct	10	9	prox.	4		80	
Nov	5	10	dist.	30	0.046	3	0.093
Nov	5	10	mid.	12		70	
Nov	5	10	prox.	0		12	
Nov	5	11	dist.	27	0.055	0	0.019
Nov	5	11	mid.	50		17	
Nov	5	11	prox.	0		10	

Nov	5	12	dist.	14	0.030	1	0.014
Nov	5	12	mid.	47		13	
Nov	5	12	prox.	1		16	
Nov	4	13	dist.	21	0.036	3	0.039
Nov	4	13	mid.	28		32	
Nov	4	13	prox.	4		23	
Nov	4	14	dist.	25	0.043	2	0.025
Nov	4	14	mid.	31		22	
Nov	4	14	prox.	0		8	
Nov	4	15	dist.	18	0.017	0	0.008
Nov	4	15	mid.	25		10	
Nov	4	15	prox.	0		10	
Nov	6	16	dist.	4	0.017	0	0.025
Nov	6	16	mid.	42		28	
Nov	6	16	prox.	10		58	
Nov	6	17	dist.	5	0.033	1	0.073
Nov	6	17	mid.	74		100	
Nov	6	17	prox.	2		76	
Nov	6	18	dist.	5	0.012	0	0.045
Nov	6	18	mid.	30		122	
Nov	6	18	prox.	0		6	
Nov	3	19	dist.	6	0.013	4	0.111
Nov	3	19	mid.	3		64	
Nov	3	19	prox.	2		23	
Nov	3	20	dist.	7	0.051	5	0.047
Nov	3	20	mid.	64		30	
Nov	3	20	prox.	6		36	
Nov	3	21	dist.	8	0.013	16	0.059
Nov	3	21	mid.	2		23	
Nov	3	21	prox.	0		6	
Jan	1	22	dist.	12	0.159	0	0.006
Jan	1	22	mid.	93		1	
Jan	1	22	prox.	10		3	
Jan	1	23	dist.	4	0.064	0	0.006
Jan	1	23	mid.	32		1	
Jan	1	23	prox.	8		3	
Jan	1	24	dist.	23	0.090	0	0.009
Jan	1	24	mid.	36		3	
Jan	1	24	prox.	4		3	
Jan	2	25	dist.	6	0.040	1	0.027
Jan	2	25	mid.	38		22	
Jan	2	25	prox.	3		9	
Jan	2	26	dist.	0	0.018	0	0.012
Jan	2	26	mid.	28		11	
Jan	2	26	prox.	3		10	
Jan	2	27	dist.	6	0.029	0	0.013
Jan	2	27	mid.	40		11	
Jan	2	27	prox.	3		11	
Jan	15	28	dist.	2	0.101	0	0.012

Jan	15	28	mid.	28			1	
Jan	15	28	prox.	12			4	
Jan	15	29	dist.	7		0.058	1	0.017
Jan	15	29	mid.	18			2	
Jan	15	29	prox.	2			5	
Jan	15	30	dist.	18		0.086	1	0.036
Jan	15	30	mid.	13			3	
Jan	15	30	prox.	2			10	
Jan	16	31	dist.	2		0.006	2	0.027
Jan	16	31	mid.	4			17	
Jan	16	31	prox.	0			8	
Jan	16	32	dist.	50		0.064	2	0.021
Jan	16	32	mid.	2			8	
Jan	16	32	prox.	0			7	
Jan	16	33	dist.	7		0.019	5	0.028
Jan	16	33	mid.	11			11	
Jan	16	33	prox.	0			11	

D: Deployment density data

Density of sporophytes per spool at deployment. Counted from 3 mm of the seedling rope, five places on each spool sample.

Deployment	**Spool**	**Sporophytes per 3 mm (5 samples)**					**Average**
Oct	1	30	47	58	32	32	39.8
	2	18	6	24	16	25	17.8
	3	25	44	23	39	32	32.6
Excluded*	1	3	2	1	4	4	2.8
	2	0	7	8	10	11	7.2
Nov	1	12	48	6	25	15	21.2
	2	47	5	17	13	27	21.8
Jan	1	45	19	5	42	12	24.6
	2	35	52	42	32	63	44.8

E: Water nutrient data

All nutrients are in µmol/l.

Date	Depth	Replicate	NO_2	NO_3	PO_4	S_i	Ammonium
15.11.2018	0.5	A	0.27	3.6	0.15	2.0	0.37
15.11.2018	0.5	B	0.23	3.5	0.22	2.4	0.29
15.11.2018	0.5	C	0.38	NA	NA	2.1	0.15
15.11.2018	3	A	0.28	3.5	0.24	2.2	0.15
15.11.2018	3	B	0.25	3.6	0.18	2.1	0.14
15.11.2018	3	C	0.26	3.6	0.19	2.1	0.25
19.12.2018	0.5	A	0.12	4.0	0.29	2.9	0.18
19.12.2018	0.5	B	0.12	4.1	0.31	2.9	0.82
19.12.2018	0.5	C	0.14	4.3	0.31	2.9	0.29
19.12.2018	3	A	0.12	4.2	0.30	2.8	0.17
19.12.2018	3	B	0.14	4.1	0.31	2.9	0.25
19.12.2018	3	C	0.12	3.9	0.31	2.8	0.19
10.01.2019	0.5	A	0.2	5.2	0.35	3.1	0.85
10.01.2019	0.5	B	0.18	5.4	0.33	3.2	0.36
10.01.2019	0.5	C	0.17	5.3	0.36	3.1	0.32
10.01.2019	3	A	0.16	5.3	0.32	3.2	0.33
10.01.2019	3	B	0.21	5.3	0.34	3.5	1.17
10.01.2019	3	C	0.21	5.3	0.42	3.3	0.71
04.02.2019	0.5	A	0.18	6.6	0.47	3.4	0.56
04.02.2019	0.5	B	0.18	6.6	0.45	4.1	1.59
04.02.2019	0.5	C	0.17	6.9	0.48	4.0	0.45
04.02.2019	3	A	0.17	6.8	0.46	3.9	0.33
04.02.2019	3	B	0.17	6.5	0.46	3.8	0.27
04.02.2019	3	C	0.17	6.8	0.43	4.0	0.40
11.03.2019	0.5	A	0.23	5.1	0.83	3.1	0.96
11.03.2019	3	A	0.27	5.2	0.91	3.1	1.46
27.03.2019	0.5	A	0.08	1.2	0.11	2.1	NA
27.03.2019	0.5	B	0.08	1.1	0.08	1.9	NA
27.03.2019	0.5	C	0.07	1.1	0.09	2.1	NA
27.03.2019	3	A	0.04	NA	NA	1.2	NA
27.03.2019	3	B	0.08	0.8	0.15	1.2	NA
27.03.2019	3	C	0.08	0.8	0.12	1.1	NA
30.04.2019	0.5	A	0.03	0.2	0.04	0.6	0.25
30.04.2019	0.5	B	0.04	0.0	0.41	0.6	0.24
30.04.2019	0.5	C	0.03	0.2	0.07	0.6	0.05
30.04.2019	3	A	0.03	0.1	0.00	0.6	0.00
30.04.2019	3	B	0.03	0.1	0.04	0.6	0.03
30.04.2019	3	C	0.03	0.1	0.10	0.7	0.08

F: Raw data from area, biomass and biofouling measurements

Raw data of samples between 24. October 2018 and 30. April 2019. Rope is NA as the sporophytes were deployed. as they were collected from the spool prior to deployment. Samples were not weighed when they were very small (<0.001g). Biofouling was not registered on the deployment time, as the plants had not yet been in the sea. Biofouling was only registered for some of the plants in each sample (see table 2.4). For further information on the numbers assigned for biofouling degree in each group see table 2.3.

Date(year-month-day)	Rope	Deployment	Ind	Area (cm^2)	Weight (g)	*Licmophora* sp.	Diatome (indet)	Rhodophyta spp.	Hydrozoa spp.	Cillophora indet.	*Spirorbis* sp	Bryozoa larvae	*E.pilosa*	*M.membranacea*	*Cellep orella*.sp
2018-10-24	NA	Oct	1	0.0304	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018-10-24	NA	Oct	2	0.02727	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018-10-24	NA	Oct	3	0.00515	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018-10-24	NA	Oct	4	0.00266	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018-10-24	NA	Oct	5	0.00365	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018-10-24	NA	Oct	6	0.00248	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018-10-24	NA	Oct	7	0.0411	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018-10-24	NA	Oct	8	0.00792	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018-10-24	NA	Oct	9	0.00711	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018-10-24	NA	Oct	10	0.00201	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018-11-23	9	Oct	1	0.02488	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	9	Oct	2	0.02121	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	9	Oct	3	0.17913	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	9	Oct	4	0.14238	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	9	Oct	5	0.1288	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	9	Oct	6	0.01332	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	9	Oct	7	0.0068	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	9	Oct	8	0.01783	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	9	Oct	9	0.05018	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	9	Oct	10	0.00817	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	10	Oct	1	0.06083	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	10	Oct	2	0.08382	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	10	Oct	3	0.19279	NA	0	0	0	0	0	0	0	0	0	0

2018-11-23	10	Oct	4	0.00389	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	10	Oct	5	0.40708	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	10	Oct	6	0.04145	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	10	Oct	7	0.00723	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	10	Oct	8	0.00215	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	10	Oct	9	0.00586	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	13	Oct	1	0.08999	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	13	Oct	2	0.02103	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	13	Oct	3	0.22269	NA	0	0	0	0	1	0	0	0	0	0
2018-11-23	13	Oct	4	0.26727	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	13	Oct	5	0.10884	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	13	Oct	6	0.04812	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	13	Oct	7	0.05474	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	13	Oct	8	0.0113	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	13	Oct	9	0.01302	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	13	Oct	10	0.77294	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	14	Oct	1	0.11079	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	14	Oct	2	0.01879	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	14	Oct	3	0.05704	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	14	Oct	4	0.19031	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	14	Oct	5	0.14733	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	14	Oct	6	0.00722	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	14	Oct	7	0.01047	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	14	Oct	8	0.01177	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	14	Oct	9	0.11886	NA	0	0	0	0	0	0	0	0	0	0
2018-11-23	NA	Nov	1	0.0001	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018-11-23	NA	Nov	2	0.00033	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018-11-23	NA	Nov	3	0.00044	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018-11-23	NA	Nov	4	0.00011	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018-11-23	NA	Nov	5	0.0069	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018-11-23	NA	Nov	6	0.00174	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Date(year-month-day)	Rope	Deployment	Ind	Area (cm^2)	Weight (g)	*Licmophora* sp.	Diatome (indet)	Rhodophyta spp.	Hydrozoa spp.	Cillophora indet.	*Spirorbis* sp	Bryozoa larvae	*E.pilosa*	*M.membranacea*	*Celleporella*.sp
2018-11-23	NA	Nov	7	0.00501	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018-11-23	NA	Nov	8	0.00019	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018-11-23	NA	Nov	9	0.01032	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018-11-23	NA	Nov	10	0.00605	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018-12-19	13	Oct	1	2.81344	NA	0	0	0	0	0	0	0	0	0	0
2018-12-19	13	Oct	2	6.39801	NA	2	1	1	0	0	0	0	0	0	0
2018-12-19	13	Oct	3	5.20032	NA	2	0	1	0	0	0	0	0	0	0
2018-12-19	13	Oct	4	0.26752	NA	0	0	1	0	0	0	0	0	0	0
2018-12-19	13	Oct	5	0.4646	NA	1	0	1	0	1	0	0	0	0	0
2019-01-10	3	Nov	1	0.3106	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	3	Nov	2	0.23002	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	3	Nov	3	0.01991	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	3	Nov	4	0.06534	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	3	Nov	5	0.02952	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	3	Nov	6	0.00155	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	3	Nov	7	0.00543	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	3	Nov	8	0.00387	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	4	Nov	1	0.02725	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	4	Nov	2	0.08875	NA	0	0	1	0	0	0	0	0	0	0
2019-01-10	4	Nov	3	0.01325	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	4	Nov	4	0.04293	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	4	Nov	5	0.02558	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	4	Nov	6	0.019	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	4	Nov	7	0.00505	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	4	Nov	8	0.01236	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	5	Nov	1	0.03666	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	5	Nov	2	0.01082	NA	0	1	0	0	0	0	0	0	0	0
2019-01-10	5	Nov	3	0.01042	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	5	Nov	4	0.00495	NA	0	0	0	0	0	0	0	0	0	0

2019-01-10	5	Nov	5	0.06613	NA	0	0	1	0	0	0	0	0	0	0
2019-01-10	6	Nov	1	0.69749	NA	0	0	1	0	2	0	0	0	0	0
2019-01-10	6	Nov	2	0.01524	NA	0	1	0	0	0	0	0	0	0	0
2019-01-10	6	Nov	3	0.02774	NA	0	0	0	0	1	0	0	0	0	0
2019-01-10	6	Nov	4	0.01682	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	6	Nov	5	0.09327	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	6	Nov	6	1.01528	NA	0	0	0	2	3	0	0	0	0	0
2019-01-10	6	Nov	7	0.02597	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	6	Nov	8	0.02414	NA	0	0	0	0	0	0	0	0	0	0
2019-01-10	9	Oct	1	4.27719	0.11	2	1	0	0	0	0	0	0	0	0
2019-01-10	9	Oct	2	2.88216	0.062	1	0	1	0	0	0	0	0	0	0
2019-01-10	9	Oct	3	0.50556	0.013	1	0	1	0	0	0	0	0	0	0
2019-01-10	9	Oct	4	0.96999	0.021	2	0	0	0	1	0	0	0	0	0
2019-01-10	9	Oct	5	0.73473	0.0145	1	0	1	0	1	0	0	0	0	0
2019-01-10	9	Oct	6	0.27863	0.0049	1	0	0	0	0	0	0	0	0	0
2019-01-10	9	Oct	7	0.38506	0.0102	1	1	0	0	0	0	0	0	0	0
2019-01-10	9	Oct	8	0.07008	0.0008	1	0	0	0	0	0	0	0	0	0
2019-01-10	10	Oct	1	2.00688	0.045	2	0	1	0	0	0	0	0	0	0
2019-01-10	10	Oct	2	1.03718	0.02	0	0	0	0	0	0	0	0	0	0
2019-01-10	10	Oct	3	0.50973	0.014	0	0	0	0	0	0	0	0	0	0
2019-01-10	10	Oct	4	0.18796	0.006	1	0	0	0	0	0	0	0	0	0
2019-01-10	10	Oct	5	0.33371	0.009	1	0	0	0	0	0	0	0	0	0
2019-01-10	10	Oct	6	0.20731	0.008	0	0	1	0	1	0	0	0	0	0
2019-01-10	10	Oct	7	0.17324	0.006	1	0	0	0	0	0	0	0	0	0
2019-01-10	10	Oct	8	0.17295	0.009	1	0	0	0	0	0	0	0	0	0
2019-01-10	13	Oct	1	13.26901	0.27	2	0	2	0	1	0	0	0	0	0
2019-01-10	13	Oct	2	24.77589	0.45	2	0	1	0	0	0	0	0	0	0
2019-01-10	13	Oct	3	19.76915	0.477	2	0	1	0	2	0	0	0	0	0
2019-01-10	13	Oct	4	6.94581	0.15	1	0	1	0	1	0	0	0	0	0
2019-01-10	13	Oct	5	2.56889	0.05	2	0	2	0	2	0	0	0	0	0
2019-01-10	13	Oct	6	3.07143	0.049	1	0	0	0	0	0	0	0	0	0

Date(year-month-day)	Rope	Deployment	Ind	Area (cm^2)	Weight (g)	*Licmophora* sp.	Diatome (indet)	Rhodophyta spp.	Hydrozoa spp.	Cillophora indet.	*Spirorbis* sp	Bryozoa larvae	*E.pilosa*	*M.membranacea*	*Celleporella*.sp
2019-01-10	13	Oct	7	1.48241	0.04	2	0	2	0	0	0	0	0	0	0
2019-01-10	13	Oct	8	2.48104	0.043	2	2	0	0	1	0	0	0	0	0
2019-01-10	14	Oct	1	15.22614	0.294	2	0	1	0	0	0	0	0	0	0
2019-01-10	14	Oct	2	6.6277	0.136	2	0	0	0	1	0	0	0	0	0
2019-01-10	14	Oct	3	8.30005	0.137	2	1	3	0	0	0	0	0	0	0
2019-01-10	14	Oct	4	0.99483	0.0168	2	0	0	0	0	0	0	0	0	0
2019-01-10	14	Oct	5	1.94419	0.0265	2	1	0	0	1	0	0	0	0	0
2019-01-10	14	Oct	6	1.35435	0.019	2	1	1	0	0	0	0	0	0	0
2019-01-10	14	Oct	7	2.09218	0.044	2	0	1	0	0	0	0	0	0	0
2019-01-10	14	Oct	8	0.33198	0.009	2	0	0	0	0	0	0	0	0	0
2019-01-10	NA	Jan	1	0.00155	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-01-10	NA	Jan	2	0.00043	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-01-10	NA	Jan	3	0.00268	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-01-10	NA	Jan	4	0.00229	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-01-10	NA	Jan	5	0.0005	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-01-10	NA	Jan	6	0.00056	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-01-10	NA	Jan	7	0.00018	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-01-10	NA	Jan	8	0.00062	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-01-10	NA	Jan	9	0.00031	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-01-10	NA	Jan	10	0.00025	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-02-04	9	Oct	1	39.75818	0.82	2	0	0	0	0	0	0	0	0	0
2019-02-04	9	Oct	2	85.88732	2.36	2	0	0	0	0	0	0	0	0	0
2019-02-04	9	Oct	3	55.74782	1.54	3	1	1	2	0	1	0	0	0	0
2019-02-04	9	Oct	4	93.08071	2.54	3	0	0	0	0	0	0	0	0	0
2019-02-04	9	Oct	5	186.4529	4.75	0	0	0	0	0	0	0	0	0	0
2019-02-04	9	Oct	6	247.8765	6.61	2	0	2	0	1	0	0	0	0	0
2019-02-04	9	Oct	7	86.4965	2.61	2	0	0	1	0	0	0	0	0	0
2019-02-04	9	Oct	8	30.21183	0.68	2	2	1	0	0	0	0	0	0	0
2019-02-04	10	Oct	1	81.5478	2.18	1	1	2	1	0	1	0	0	0	0

2019-02-04	10	Oct	2	65.3596	1.99	2	1	0	0	0	0	0	0	0	0
2019-02-04	10	Oct	3	109.636	3.18	0	0	2	0	0	0	0	0	0	0
2019-02-04	10	Oct	4	175.239	4.71	2	0	0	0	0	0	0	0	0	0
2019-02-04	10	Oct	5	374.925	11.3	2	1	1	0	0	0	0	0	0	0
2019-02-04	10	Oct	6	29.44908	0.82	2	0	0	0	0	0	0	0	0	0
2019-02-04	10	Oct	7	68.69059	1.41	2	0	0	0	0	0	0	0	0	0
2019-02-04	10	Oct	8	18.91071	0.54	3	0	0	0	0	0	0	0	0	0
2019-02-04	13	Oct	1	71.18611	2.38	2	0	1	0	0	0	0	0	0	0
2019-02-04	13	Oct	2	65.48329	1.7	2	0	2	1	0	0	0	0	0	0
2019-02-04	13	Oct	3	71.6607	2.49	2	0	0	0	0	0	0	0	0	0
2019-02-04	13	Oct	4	348.5168	11.6	0	0	0	0	0	0	0	0	0	0
2019-02-04	13	Oct	5	156.5181	4.88	2	1	2	0	0	0	0	0	0	0
2019-02-04	13	Oct	6	44.5576	1.08	2	0	0	0	0	0	0	0	0	0
2019-02-04	13	Oct	7	15.395	0.36	2	0	0	0	0	0	0	0	0	0
2019-02-04	13	Oct	8	7.6039	0.18	2	0	0	0	0	0	0	0	0	0
2019-02-04	14	Oct	1	59.39823	1.72	1	0	0	0	1	0	0	0	0	0
2019-02-04	14	Oct	2	380.3202	10.63	0	0	0	0	0	0	0	0	0	0
2019-02-04	14	Oct	3	53.78868	1.9	0	0	0	0	0	0	0	0	0	0
2019-02-04	14	Oct	4	79.96898	2.03	0	0	0	0	0	0	0	0	0	0
2019-02-04	14	Oct	5	174.5751	5.04	0	0	0	0	2	0	0	0	0	0
2019-02-04	14	Oct	6	143.1381	4.46	1	0	1	0	1	0	0	0	0	0
2019-02-04	14	Oct	7	25.5154	0.604	1	0	0	0	0	0	0	0	0	0
2019-02-04	14	Oct	8	22.0528	0.511	1	0	1	0	2	0	0	0	0	0
2019-02-04	3	Nov	1	45.1624	1.6	2	2	0	0	0	0	0	0	0	0
2019-02-04	3	Nov	2	18.0799	0.54	2	0	1	0	0	0	0	0	0	0
2019-02-04	3	Nov	3	22.4697	0.65	1	0	0	0	0	0	0	0	0	0
2019-02-04	3	Nov	4	8.43102	0.18	1	0	0	0	1	0		0	0	0
2019-02-04	3	Nov	5	15.9423	0.39	2	0	2	0	0	0	0	0	0	0
2019-02-04	3	Nov	6	2.7922	0.076	1	0	1	0	0	0	0	0	0	0
2019-02-04	3	Nov	7	3.4049	0.1	1	0	0	0	0	0	0	0	0	0
2019-02-04	3	Nov	8	4.9996	0.13	1	0	0	0	0	0	0	0	0	0

Date(year-month-day)	Rope	Deployment	Ind	Area (cm^2)	Weight (g)	*Licmophora* sp.	Diatome (indet)	Rhodophyta spp.	Hydrozoa spp.	Cillophora indet.	*Spirorbis* sp	Bryozoa larvae	*E.pilosa*	*M.membranacea*	*Celleporella*.sp
2019-02-04	4	Nov	1	26.4790	0.65	1	1	2	0	0	0	0	0	0	0
2019-02-04	4	Nov	2	50.8889	1.47	1	0	1	0	0	0	0	0	0	0
2019-02-04	4	Nov	3	2.8725	0.12	1	1	0	0	0	0	0	0	0	0
2019-02-04	4	Nov	4	5.3707	0.22	1	2	0	0	0	0	0	0	0	0
2019-02-04	4	Nov	5	4.30424	0.07	1	0	0	0	0	0	0	0	0	0
2019-02-04	4	Nov	6	14.4512	0.35	1	1	0	0	0	0	0	0	0	0
2019-02-04	4	Nov	7	4.3896	0.11	1	0	0	0	0	0	0	0	0	0
2019-02-04	4	Nov	8	0.8886	0.03	1	0	0	0	0	0	0	0	0	0
2019-02-04	5	Nov	1	10.5122	0.56	0	1	1	2	0	0	0	0	0	0
2019-02-04	5	Nov	2	4.7745	0.11	1	0	1	1	0	0	0	0	0	0
2019-02-04	5	Nov	3	15.8243	0.54	0	1	1	0	0	0	0	0	0	0
2019-02-04	5	Nov	4	1.9058	0.049	0	2	0	0	0	0	0	0	0	0
2019-02-04	5	Nov	5	2.4892	0.062	2	1	1	0	0	0	0	0	0	0
2019-02-04	5	Nov	6	0.9672	0.03	1	0	0	0	0	0	0	0	0	0
2019-02-04	5	Nov	7	2.3642	0.04	1	0	0	0	0	0	0	0	0	0
2019-02-04	5	Nov	8	0.2310	0.01	1	0	0	0	0	0	0	0	0	0
2019-02-04	6	Nov	1	12.1003	0.215	1	1	0	0	0	0	0	0	0	0
2019-02-04	6	Nov	2	20.4626	0.6	1	0	0	1	0	0	0	0	0	0
2019-02-04	6	Nov	3	5.1544	0.12	1	1	1	0	0	0	0	0	0	0
2019-02-04	6	Nov	4	9.9284	0.22	1	1	0	0	0	0	0	0	0	0
2019-02-04	6	Nov	5	13.9960	0.35	1	0	0	0	0	0	0	0	0	0
2019-02-04	6	Nov	6	0.8661	0.019	0	0	1	0	0	0	0	0	0	0
2019-02-04	6	Nov	7	6.0271	0.105	0	0	0	0	0	0	0	0	0	0
2019-02-04	6	Nov	8	7.8675	0.16	1	0	0	0	0	0	0	0	0	0
2019-02-04	1	Jan	1	0.0167	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	1	Jan	2	0.007	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	1	Jan	3	0.02117	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	1	Jan	4	0.01216	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	1	Jan	5	0.01591	NA	0	0	0	0	0	0	0	0	0	0

2019-02-04	1	Jan	6	0.07359	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	1	Jan	7	0.04644	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	1	Jan	8	0.06072	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	2	Jan	1	0.08662	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	2	Jan	2	0.03171	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	2	Jan	3	0.0361	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	2	Jan	4	0.02757	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	2	Jan	5	0.00368	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	2	Jan	6	0.00133	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	2	Jan	7	0.09217	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	2	Jan	8	0.00328	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	15	Jan	1	0.02196	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	15	Jan	2	0.01158	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	15	Jan	3	0.02868	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	15	Jan	4	0.04785	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	15	Jan	5	0.02907	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	15	Jan	6	0.01281	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	15	Jan	7	0.04669	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	15	Jan	8	0.05762	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	16	Jan	1	0.02564	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	16	Jan	2	0.07279	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	16	Jan	3	0.01547	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	16	Jan	4	0.05035	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	16	Jan	5	0.00312	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	16	Jan	6	0.01378	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	16	Jan	7	0.0019	NA	0	0	0	0	0	0	0	0	0	0
2019-02-04	16	Jan	8	0.00119	NA	0	0	0	0	0	0	0	0	0	0
2019-03-05	9	Oct	1	223.8217	6	2	0	0	0	0	0	0	0	0	0
2019-03-05	9	Oct	2	137.3411	3.46	1	0	0	0	0	0	0	0	0	0
2019-03-05	9	Oct	3	174.8977	4.18	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	9	Oct	4	309.83	7.05	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Date(year-month-day)	Rope	Deployment	Ind	Area (cm^2)	Weight (g)	*Licmophora* sp.	Diatome (indet)	Rhodophyta spp.	Hydrozoa spp.	Cillophora indet.	*Spirorbis* sp	Bryozoa larvae	*E.pilosa*	*M.membranacea*	*Celleporella*.sp
2019-03-05	9	Oct	5	394.0	11.13	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	9	Oct	6	789.924	20.76	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	9	Oct	7	750.7604	29.61	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	9	Oct	8	159.6674	4.9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	10	Oct	1	287.3811	7.26	2	0	0	0	0	0	0	0	0	0
2019-03-05	10	Oct	2	788.3840	33.79	2	1	1	2	0	0	0	0	0	0
2019-03-05	10	Oct	3	246.9415	6.81	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	10	Oct	4	162.5626	4.48	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	10	Oct	5	288.631	8.67	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	10	Oct	6	320.3399	9.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	10	Oct	7	101.1760	2.75	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	10	Oct	8	43.92892	1.04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	13	Oct	1	1018.26	33.69	2	0	1	0	0	0	0	0	0	0
2019-03-05	13	Oct	2	430.7615	13.23	2	0	2	0	0	0	0	0	0	0
2019-03-05	13	Oct	3	59.17181	1.28	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	13	Oct	4	399.987	8.12	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	13	Oct	5	173.6439	3.86	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	13	Oct	6	74.26575	1.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	13	Oct	7	134.9382	3.22	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	13	Oct	8	230.4107	4.69	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	14	Oct	1	349.563	9.71	2	0	2	2	0	0	0	0	0	0
2019-03-05	14	Oct	2	228.0454	5.6	2	0	1	1	0	0	0	0	0	0
2019-03-05	14	Oct	3	406.18	10.78	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	14	Oct	4	158.0451	4.48	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	14	Oct	5	650.2814	21.38	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	14	Oct	6	83.66123	1.74	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	14	Oct	7	651.0505	22.77	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	14	Oct	8	279.7557	6.49	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	3	Nov	1	192.8723	5.15	1	0	0	0	0	0	0	0	0	0

2019-03-05	3	Nov	2	239.5771	5.99	1	0	0	0	0	0	0	0	0	0
2019-03-05	3	Nov	3	125.7199	2.83	1	0	0	0	0	0	0	0	0	0
2019-03-05	3	Nov	4	64.26208	1.14	1	1	0	0	0	0	0	0	0	0
2019-03-05	3	Nov	5	115.6236	2.98	1	1	0	0	0	0	0	0	0	0
2019-03-05	3	Nov	6	115.3707	2.35	1	0	1	0	0	0	0	0	0	0
2019-03-05	3	Nov	7	41.75053	0.65	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	3	Nov	8	170.0522	3.58	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	4	Nov	1	104.1875	3.04	2	1	0	1	0	0	0	0	0	0
2019-03-05	4	Nov	2	535.6	17.76	2	1	1	1	0	0	0	0	0	0
2019-03-05	4	Nov	3	49.39143	1.2	2	0	0	1	0	0	0	0	0	0
2019-03-05	4	Nov	4	90.64099	1.78	1	0	1	0	0	0	0	0	0	0
2019-03-05	4	Nov	5	61.35598	1.21	1	0	0	0	0	0	0	0	0	0
2019-03-05	4	Nov	6	131.7560	3.01	1	0	0	0	0	0	0	0	0	0
2019-03-05	4	Nov	7	75.75178	1.45	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	4	Nov	8	46.45945	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	5	Nov	1	103.1032	2.36	2	1	0	0	0	0	0	0	0	0
2019-03-05	5	Nov	2	210.9521	4.73	2	0	0	0	0	0	0	0	0	0
2019-03-05	5	Nov	3	179.6458	4.38	2	0	0	0	0	0	0	0	0	0
2019-03-05	5	Nov	4	225.6126	5.41	2	0	0	1	0	0	0	0	0	0
2019-03-05	5	Nov	5	75.06063	1.87	2	0	0	1	0	0	0	0	0	0
2019-03-05	5	Nov	6	71.47534	1.66	2	0	0	2	0	0	0	0	0	0
2019-03-05	5	Nov	7	52.52561	1.15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	5	Nov	8	65.35813	1.26	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	6	Nov	1	136.1710	2.82	1	1	0	0	0	0	0	0	0	0
2019-03-05	6	Nov	2	194.1525	4.35	1	0	1	0	1	0	0	0	0	0
2019-03-05	6	Nov	3	113.0182	2.07	2	0	0	0	0	0	0	0	0	0
2019-03-05	6	Nov	4	245.9918	5.62	2	0	0	0	0	0	0	0	0	0
2019-03-05	6	Nov	5	134.1917	3.18	1	1	1	0	0	0	0	0	0	0
2019-03-05	6	Nov	6	358.580	10.75	1	0	0	0	0	0	0	0	0	0
2019-03-05	6	Nov	7	124.7056	2.46	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-05	6	Nov	8	150.9482	2.91	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Date(year-month-day)	Rope	Deployment	Ind	Area (cm^2)	Weight (g)	*Licmophora* sp.	Diatome (indet)	Rhodophyta spp.	Hydrozoa spp.	Cillophora indet.	*Spirorbis* sp	Bryozoa larvae	*E.pilosa*	*M.membranacea*	*Celleporella*.sp
2019-03-05	1	Jan	1	14.24339	0.23	1	0	0	0	1	0	0	0	0	0
2019-03-05	1	Jan	2	4.90476	0.135	1	1	0	0	1	0	0	0	0	0
2019-03-05	1	Jan	3	9.34298	0.328	1	0	0	0	1	0	0	0	0	0
2019-03-05	1	Jan	4	6.56694	0.12	1	0	0	0	1	0	0	0	0	0
2019-03-05	1	Jan	5	12.82776	0.25	1	0	0	0	1	0	0	0	0	0
2019-03-05	1	Jan	6	21.27337	0.399	1	1	0	0	1	0	0	0	0	0
2019-03-05	1	Jan	7	16.91332	0.283	1	1	0	0	1	0	0	0	0	0
2019-03-05	1	Jan	8	6.89633	0.074	1	0	0	0	1	0	0	0	0	0
2019-03-05	2	Jan	1	8.14356	0.131	1	0	0	0	1	0	0	0	0	0
2019-03-05	2	Jan	2	16.00907	0.286	1	0	0	0	1	0	0	0	0	0
2019-03-05	2	Jan	3	33.59439	0.589	2	1	0	0	1	0	0	0	0	0
2019-03-05	2	Jan	4	19.12748	0.329	0	0	0	0	0	0	0	0	0	0
2019-03-05	2	Jan	5	32.98081	0.565	2	0	0	0	1	0	0	0	0	0
2019-03-05	2	Jan	6	26.77203	0.461	2	0	0	0	2	0	0	0	0	0
2019-03-05	2	Jan	7	15.05695	0.253	1	0	0	0	1	0	0	0	0	0
2019-03-05	2	Jan	8	22.60046	0.305	2	0	0	0	1	0	0	0	0	0
2019-03-05	15	Jan	1	16.33444	0.338	1	0	0	0	3	0	0	0	0	0
2019-03-05	15	Jan	2	9.76236	0.13	1	1	0	0	1	0	0	0	0	0
2019-03-05	15	Jan	3	44.93987	0.862	1	0	0	0	1	0	0	0	0	0
2019-03-05	15	Jan	4	23.5218	0.41	2	1	0	0	1	0	0	0	0	0
2019-03-05	15	Jan	5	5.87954	0.089	1	0	0	0	3	0	0	0	0	0
2019-03-05	15	Jan	6	7.17618	0.106	1	0	0	0	2	0	0	0	0	0
2019-03-05	15	Jan	7	6.34383	0.095	1	1	0	0	2	0	0	0	0	0
2019-03-05	15	Jan	8	8.86532	0.144	1	0	0	0	3	0	0	0	0	0
2019-03-05	16	Jan	1	14.93714	0.3	2	1	0	0	3	0	0	0	0	0
2019-03-05	16	Jan	2	16.07955	0.36	1	0	2		1	0	0	0	0	0
2019-03-05	16	Jan	3	8.10815	0.14	1	0	0	0	0	0	0	0	0	0
2019-03-05	16	Jan	4	8.87824	0.19	1	1	0	1	1	0	0	0	0	0
2019-03-05	16	Jan	5	15.17305	0.28	1	0	0	2	0	0	0	0	0	0

2019-03-05	16	Jan	6	16.59867	0.31	1	0	0	2	0	0	0	0	0	0
2019-03-05	16	Jan	7	26.90764	0.52	1	0	0	1	0	0	0	0	0	0
2019-03-05	16	Jan	8	7.26318	0.1	1	0	0	2	0	0	0	0	0	0
2019-03-27	13	Oct	1	1002.39	39.75	2	2	1	1	0	0	0	0	0	0
2019-03-27	13	Oct	2	892.34	36.54	2	1	2	1	0	0	0	0	0	0
2019-03-27	13	Oct	3	185.86	6.37	2	0	0	1	0	0	0	0	0	0
2019-03-27	13	Oct	4	1208.18	51.48	2	0	0	2	0	0	0	0	0	0
2019-03-27	13	Oct	5	1356.14	54.01	2	0	1	1	0	0	0	0	0	0
2019-03-27	13	Oct	6	284.11	9.35	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	13	Oct	7	516.96	20.78	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	13	Oct	8	314.01	10.21	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	10	Oct	1	1048.37	55.38	2	1	1	2	0	0	0	0	0	0
2019-03-27	10	Oct	2	1370.99	54.85	2	0	1	1	0	0	0	0	0	1
2019-03-27	10	Oct	3	507.41	19.49	2	0	0	1	0	0	0	0	0	0
2019-03-27	10	Oct	4	836.88	30.94	1	0	0	1	0	0	0	0	0	1
2019-03-27	10	Oct	5	756.08	35.75	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	10	Oct	6	291.89	9.41	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	10	Oct	7	338.43	11.58	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	10	Oct	8	771.59	26.02	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	14	Oct	1	1089.49	51.03	2	1	0	2	0	0	0	0	0	0
2019-03-27	14	Oct	2	1485.51	67.12	1	1	0	1	0	0	0	0	0	1
2019-03-27	14	Oct	3	1494.72	61.21	1	2	0	3	0	0	0	0	0	1
2019-03-27	14	Oct	4	1547.87	71.04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	14	Oct	5	471.38	13.95	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	14	Oct	6	1419.32	60.51	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	14	Oct	7	336.64	10.9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	9	Oct	1	1331.23	56.71	3	0	0	3	0	0	0	0	0	1
2019-03-27	9	Oct	2	463.34	16.29	2	2	1	0	0	0	1	0	0	0
2019-03-27	9	Oct	3	1248.56	49.86	3	2	1	1	0	0	0	0	0	0
2019-03-27	9	Oct	4	1478.28	70.71	3	2	1	1	1	1	1	0	0	1
2019-03-27	9	Oct	5	325.03	11.77	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Date(year-month-day)	Rope	Deployment	Ind	Area (cm^2)	Weight (g)	*Licmophora* sp.	Diatome (indet)	Rhodophyta spp.	Hydrozoa spp.	Cillophora indet.	*Spirorbis* sp	Bryozoa larvae	*E.pilosa*	*M.membranacea*	*Cellepporella*.sp
2019-03-27	9	Oct	6	700.97	25.8	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	9	Oct	7	556.77	20.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	9	Oct	8	332.37	11.31	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	3	Nov	1	254.86	9.54	0	0	0	0	0	0	0	0	0	0
2019-03-27	3	Nov	2	257.76	7.01	1	1	0	0	0	0	0	0	0	0
2019-03-27	3	Nov	3	201	6.46	1	1	0	0	0	0	1	0	0	0
2019-03-27	3	Nov	4	377.65	11.61	0	1	0	0	0	0	0	0	0	0
2019-03-27	3	Nov	5	113.19	4.43	0	0	0	1	0	0	0	0	0	0
2019-03-27	3	Nov	6	210.39	6.92	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	3	Nov	7	96.14	2.44	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	3	Nov	8	75.97	2.08	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	5	Nov	1	549.23	15.13	1	1	0	1	0	0	1	0	0	0
2019-03-27	5	Nov	2	844.03	34.26	1	1	1	2	0	0	0	0	0	0
2019-03-27	5	Nov	3	368.16	10.91	2	1	0	1	0	0	0	0	0	0
2019-03-27	5	Nov	4	261	6.82	1	1	0	1	0	0	0	0	0	0
2019-03-27	5	Nov	5	228.03	5.46	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	5	Nov	6	173.73	4.84	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	5	Nov	7	254.66	6.96	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	5	Nov	8	204.56	4.35	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	6	Nov	1	347.14	11.56	1	0	0	0	1	0	0	0	0	0
2019-03-27	6	Nov	2	417.95	14.64	1	0	0	0	0	0	0	0	0	0
2019-03-27	6	Nov	3	273.31	8.27	1	1	0	0	1	0	0	0	0	0
2019-03-27	6	Nov	4	283.23	9.03	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	6	Nov	5	149.23	3.43	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	6	Nov	6	162.46	5.84	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	6	Nov	7	120.02	3.49	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	6	Nov	8	223.36	5.82	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	4	Nov	1	279.53	8.69	2	0	0	3	0	0	0	0	0	0
2019-03-27	4	Nov	2	552.89	21.9	2	1	0	1	0	0	0	0	0	0

2019-03-27	4	Nov	3	412.97	15.45	1	1	0	0	1	0	0	0	0	0
2019-03-27	4	Nov	4	174.97	5.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	4	Nov	5	94.92	2.78	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	4	Nov	6	102.01	2.75	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	4	Nov	7	254.76	6.55	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	4	Nov	8	240.05	5.55	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	1	Jan	1	111.68	3.15	1	1	0	0	2	0	0	0	0	0
2019-03-27	1	Jan	2	104.73	2.61	1	1	0	0	1	0	0	0	0	0
2019-03-27	1	Jan	3	78.59	2.19	1	1	0	0	2	0	0	0	0	0
2019-03-27	1	Jan	4	66.54	1.52	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	1	Jan	5	75.71	1.91	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	1	Jan	6	58.35	1.51	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	1	Jan	7	56.59	1.41	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	1	Jan	8	47.91	1.32	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	2	Jan	1	165.79	4.66	1	0	0	1	1	0	1	0	0	0
2019-03-27	2	Jan	2	65.91	1.56	1	1	0	0	1	0	0	0	0	0
2019-03-27	2	Jan	3	68.5	2.2	0	1	0	0	1	0	0	0	0	0
2019-03-27	2	Jan	4	50.56	1.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	2	Jan	5	66.06	1.66	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	2	Jan	6	35.44	0.75	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	2	Jan	7	28.99	0.57	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	2	Jan	8	42.24	0.96	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	15	Jan	1	179.85	4.97	2	1	0	0	1	0	0	0	0	0
2019-03-27	15	Jan	2	61.53	1.46	1	1	0	0	1	0	0	0	0	0
2019-03-27	15	Jan	3	71.45	1.77	1	1	0	0	1	0	0	0	0	0
2019-03-27	15	Jan	4	48.43	1.2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	15	Jan	5	33.33	0.87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	15	Jan	6	32.81	0.71	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	15	Jan	7	71.26	1.67	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	15	Jan	8	36.8	0.91	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	16	Jan	1	107.31	3.23	0	0	0	0	1	0	0	0	0	0

Date(year-month-day)	Rope	Deployment	Ind	Area (cm^2)	Weight (g)	*Licmophora* sp.	Diatome (indet)	Rhodophyta spp.	Hydrozoa spp.	Cillophora indet.	*Spirorbis* sp	Bryozoa larvae	*E.pilosa*	*M.membranacea*	*Celleporella*.sp
2019-03-27	16	Jan	2	83.64	1.82	1	1	0	0	1	0	0	0	0	0
2019-03-27	16	Jan	3	29.05	0.78	1	0	0	0	1	0	0	0	0	0
2019-03-27	16	Jan	4	77.1	1.55	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	16	Jan	5	51.5	0.95	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	16	Jan	6	49.88	1.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	16	Jan	7	31.62	0.71	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-03-27	16	Jan	8	71.11	1.56	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-08	1	Jan	1	94.07	2.49	2	1	1	1	0	0	0	0	0	0
2019-04-08	1	Jan	2	206.86	6	2	2	0	1	0	0	1	0	0	0
2019-04-08	1	Jan	3	95.03	2.11	2	1	0	1	0	0	1	0	0	0
2019-04-08	1	Jan	4	117.44	3.15	1	1	0	1	0	0	1	0	0	0
2019-04-08	16	Jan	1	173.23	5.47	0	1	0	1	0	0	1	0	0	0
2019-04-08	16	Jan	2	137.63	4.21	1	2	0	1	0	0	1	0	0	0
2019-04-08	16	Jan	3	51.71	1.19	1	2	0	0	0	0	1	0	0	0
2019-04-08	14	Oct	1	1624.68	62.02	0	0	0	0	0	0	3	1	0	0
2019-04-08	14	Oct	2	1527.77	86.56	0	1	0	2	0	0	0	1	0	1
2019-04-08	14	Oct	3	1174.68	44.2	0	0	0	2	0	0	2	0	0	1
2019-04-08	10	Oct	1	1071.33	45.9	0	1	0	0	0	0	3	1	0	0
2019-04-08	10	Oct	2	481.27	14.26	0	1	0	1	0	0	2	1	0	0
2019-04-08	10	Oct	3	278.2	11.36	0	1	0	2	0	0	2	1	0	0
2019-04-08	3	Nov	1	475.59	22	1	1	0	1	1	0	2	0	0	0
2019-04-08	3	Nov	2	597.17	23.09	0	1	0	1	0	0	1	1	0	0
2019-04-08	3	Nov	3	137.53	3.15	0	1	0	1	0	0	1	1	0	0
2019-04-08	5	Nov	1	1552.35	85.86	2	0	0	2	0	0	3	2	0	1
2019-04-08	5	Nov	2	1475.55	57.85	1	1	0	3	0	0	3	1	0	0
2019-04-08	5	Nov	3	478.38	11.98	1	1	0	1	0	0	2	1	0	0
2019-04-30	13	Oct	1	1204.94	43.6	0	1	0	2	0	0	3	3	3	0
2019-04-30	13	Oct	2	1988.05	93.5	0	2	0	2	0	0	3	2	3	0
2019-04-30	13	Oct	3	1866.53	83.5	0	2	0	2	0	0	3	3	3	0

2019-04-30	13	Oct	4	4504.13	187.41	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	13	Oct	5	1354.75	55.52	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	13	Oct	6	3867.34	170.58	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	13	Oct	7	2118.9	89.51	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	13	Oct	8	1093.77	37.38	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	10	Oct	1	694.942	56.47	0	1	0	2	0	0	3	2	2	0
2019-04-30	10	Oct	2	1463.38	57.97	0	1	0	1	0	0	3	3	2	0
2019-04-30	10	Oct	3	1771.56	76.34	0	0	0	1	0	0	3	1	3	0
2019-04-30	10	Oct	4	2418.04	110.17	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	10	Oct	5	587.36	22.58	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	10	Oct	6	1076.76	35.57	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	10	Oct	7	678.56	22.04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	14	Oct	1	2722.9	108.04	0	0	0	2	0	0	3	3	2	1
2019-04-30	14	Oct	2	3238.47	133.74	0	2	0	2	0	0	3	3	3	0
2019-04-30	14	Oct	3	2868.03	122.63	0	0	0	3	0	1	0	0	0	0
2019-04-30	14	Oct	4	2415.5	86.31	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	14	Oct	5	1909.81	79.66	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	14	Oct	6	2699.38	99.41	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	14	Oct	7	1662.19	58.32	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	14	Oct	8	1173.1	43.46	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	9	Oct	1	832.32	26.49	0	1	1	2	0	0	3	2	2	0
2019-04-30	9	Oct	2	3523.63	148.58	0	1	0	0	0	0	3	2	2	1
2019-04-30	9	Oct	3	1796.25	69.51	0	1	0	1	0	0	3	2	3	0
2019-04-30	9	Oct	4	4189.6	189.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	9	Oct	5	2741.81	105.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	9	Oct	6	1460.38	74.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	9	Oct	7	1260.64	85.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	9	Oct	8	1342.14	52.36	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	3	Nov	1	411.07	17.77	0	0	0	1	0	0	3	1	3	0
2019-04-30	3	Nov	2	758.88	28.76	0	0	0	1	0	0	3	3	3	0
2019-04-30	3	Nov	3	381.59	10.97	0	1	0	0	0	0	3	1	2	0

Date(year-month-day)	Rope	Deployment	Ind	Area (cm^2)	Weight (g)	*Licmophora* sp.	Diatome (indet)	Rhodophyta spp.	Hydrozoa spp.	Cillophora indet.	*Spirorbis* sp	Bryozoa larvae	*E.pilosa*	*M.membranacea*	*Celleporella*.sp
2019-04-30	3	Nov	4	487.01	12.01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	3	Nov	5	594.06	19.04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	3	Nov	6	252.07	9.54	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	3	Nov	7	415.04	13.99	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	5	Nov	1	456.09	16.67	0	0	0	1	0	0	3	2	3	0
2019-04-30	5	Nov	2	703.36	24.41	0	0	0	2	0	0	3	3	2	0
2019-04-30	5	Nov	3	1046.46	42.72	0	1	0	1	0	0	3	3	2	0
2019-04-30	5	Nov	4	234.13	7.9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	5	Nov	5	284.66	10.08	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	5	Nov	6	393.22	12.45	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	5	Nov	7	268.69	7.47	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	5	Nov	8	149.74	3.58	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	6	Nov	1	1693.01	66.81	0	1	0	2	0	0	3	3	3	0
2019-04-30	6	Nov	2	1217.3	54.22	0	1	0	2	0	0	3	3	3	0
2019-04-30	6	Nov	3	1421.01	49.44	0	1	0	1	0	0	3	2	3	0
2019-04-30	6	Nov	4	3994.13	150.41	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	6	Nov	5	1584.38	54.36	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	6	Nov	6	1301.67	38.39	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	6	Nov	7	1119.78	39.46	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	6	Nov	8	519.41	18.81	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	4	Nov	1	740.25	31.67	0	1	0	1	0	0	3	2	2	0
2019-04-30	4	Nov	2	649.34	28.24	0	1	0	1	0	0	3	2	2	0
2019-04-30	4	Nov	3	1231.06	55.23	0	1	0	1	0	0	3	2	1	0
2019-04-30	4	Nov	4	1016.77	45.64	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	4	Nov	5	656.77	26.16	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	4	Nov	6	1452.68	54.15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	4	Nov	7	1037.99	39.56	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	4	Nov	8	430.67	14.41	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	1	Jan	1	362.18	11.77	0	1	0	1	0	0	3	3	1	0

2019-04-30	1	Jan	2	342.14	10.47	0	1	0	1	0	0	2	2	1	0
2019-04-30	1	Jan	3	351.17	11.41	0	1	0	1	0	0	2	3	1	0
2019-04-30	1	Jan	4	207.77	5.78	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	1	Jan	5	281.32	8.21	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	1	Jan	6	226.36	7.41	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	1	Jan	7	167.39	4.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	1	Jan	8	107.08	3.31	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	2	Jan	1	588.67	19.28	0	0	0	1	0	0	2	2	2	0
2019-04-30	2	Jan	2	874.59	25.05	0	1	0	1	0	0	3	2	2	0
2019-04-30	2	Jan	3	831.57	21.47	0	1	0	1	0	0	3	2	2	0
2019-04-30	2	Jan	4	295.57	8.23	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	2	Jan	5	375.39	9.85	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	2	Jan	6	152.81	4.06	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	2	Jan	7	405.67	2.72	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	2	Jan	8	67.8	1.77	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	15	Jan	1	207.45	6.58	0	1	0	0	0	0	1	3	1	0
2019-04-30	15	Jan	2	231.67	7.05	1	1	0	0	0	0	1	2	1	0
2019-04-30	15	Jan	3	192.53	6.21	0	0	0	1	0	0	1	2	2	0
2019-04-30	15	Jan	4	235.56	7.16	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	15	Jan	5	255	6.9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	15	Jan	6	407.49	11.96	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	15	Jan	7	140.59	4.19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	15	Jan	8	201.16	6.19	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	16	Jan	1	500.23	19.81	0	1	0	1	0	0	2	1	2	0
2019-04-30	16	Jan	2	404.95	13.26	0	0	0	1	0	0	2	3	2	0
2019-04-30	16	Jan	3	478.85	17.2	0	0	0	2	0	0	2	2	2	0
2019-04-30	16	Jan	4	454.74	14.04	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	16	Jan	5	630.81	17.66	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	16	Jan	6	350.28	13.55	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	16	Jan	7	192.51	4.58	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2019-04-30	16	Jan	8	207.02	5.89	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA