A study of two morphotypes of the brown algae *Fucus serratus* (Linnaeus) at Tjongspollen, Bømlo, Norway

Signe Gunborg Bentzrød Svensson

Master of Science in Marine Biology

University of Bergen

June 2019

Front page picture: The small *Fucus* morphotype from Tjongspollen in treatment tank at the laboratory. Photo: Signe B. Svensson 2019.

Acknowledgements

First I would like to thank my supervisor Kjersti Sjøtun. Thank you for all your patience, guidance and encouragement. I could not have wished for a better supervisor and I have learned so much through my thesis. Also, a big thanks to Mari Eilersten who steped in as a supervisor when Kjersti was not available. Your knowledge about experimental set-ups, guidance in writing and data recording has been invaluable.
Thank you Knut-Helge for the help with data and statistics. Your always kind replies to my questions and encouragement has meant a great deal to me through this thesis, also thank you for the Swedish coffee.

I would also like to thank all technicians at the University of Bergen, especially Solveig Thorkildsen, Julie Skadal, Heikki Savolainen, Lousie Maria Lindblom, Kenneth Meland and Hilde Rief Armo. Thank you so much for helping me in the field and in the laboratory no matter what day of the week or hour of the day.

Friends at bio, you are the best. My master experience would never have been the same without you, I wish you all the best. To all my other friends and family thank you for supporting, cheering and helping me see the end of the tunnel. Also, thank you my special someone. Thank you for always picking up the phone, even if you know what's coming, you are simply great.

Finally there is one person who deserves special thanks. My grandmother Kerstin Svensson. I cannot count the hours and days that we have spent in the forest together with my siblings and cousins. You thought us about the flowers, birds and insects and how the smallest things are beautiful and fascinating, you are the reason I wanted to become a biologists. Thanks to you I have memories with Anna, Karl-Henrik, Erik, Christoffer and Andreas I will never forget.

Abstract

The genus *Fucus* contains several key forming species occupying rocky shores in the Northern Hemisphere. *Fucus* is known to have a great capacity for phenotypic plasticity and ability to expand in to marginal habitats. Assumed recent species radiation within *Fucus* complicates the process of describing and separating between distinct species. One species in the genus *Fucus* is Serrated Wrack (*Fucus serratus*), a canopy forming fucoid occupying the low intertidal in rocky shores.

In Bømlo, situated on the west coast of Norway, a landlocked fjord (poll) is inhabited by a small *Fucus* morphotype that is most likely derived from *F. serratus*. This small morphotype occupy the zone of *F. serratus* inside the poll, where *F. serratus* is observed to have a very restricted distribution. This small morphotype has not yet been thoroughly investigated and many questions exists around its origin, possible adaptations and possible ability to hybridize with *F. serratus*, which is found in great abundance on the outside of this poll.

To investigate these morphotypes this study applied several methods. A common garden experiment was used to see the effect on growth in different salinities and temperatures representing inside and outside poll conditions during late summer/autumn. Morphometric measurements was used to compare morphological characters between morphotypes. Reproductive crossings were conducted in order to test possible reproductive barriers between morphotypes in different salinities. Sequencing of a relatively variable mitochondrial gene, the mitochondrial intergenic spacer (mtIGS), was done to look for genetic differences between the two morphotypes.

The common garden experiment did not show significant differences in absolute growth, but some difference in the progression of growth between treatments was found. A surprising result in this experiment was that a substantial number of *F. serratus* individuals were damaged from bacterial infections, especially in the poll conditions, while the small morphotype was unaffected. Morphometrics clearly separated these morphotypes, and a few characters were found to be more characterizing for the small morphotype, the most obvious being lack of serration, adventitious branching and variation in receptacle shape. Crossing showed a capacity for hybridizing between morphotypes, both in poll and marine conditions. Sequencing of mtIGS revealed one mutation to be common in the small morphotypes, while there was no variation in *F. serratus*.

For future studies a reciprocal transplant and whole genome sequencing is suggested in order to further resolve questions about the adaptations and status of the small *Fucus* morphotype.

Table of content

1 Introduction

1.1 The role of canopy forming algae in coastal systems

Marine, canopy forming macroalgae are an essential part of coastal systems (Hurd 2000;Middelboe and Binzer 2004). They have significant impacts on production, water motion and nutrient flux of marine bottom substrates (Barrón et al., 2003;Lawson et al., 2012;Valiela 2013). They contribute to diversity in the marine flora by serving as settlement substrate for epiphytic algae and animals. (Schultze et al., 1990). Macroalgae host a wide variety of marine fauna such as juvenile fish, gastropods, crustaceans and bryozoans (Keats et al., 1987;Fredriksen et al., 2005;Christie et al., 2009). Coastal canopy forming algae has also become important for humans and are, for example, used in the production of mineral supplements and agricultural fertilizers (Fleurence et al., 1994;Ugarte et al., 2010;Craigie 2011).

In the Northern Hemisphere, brown algae (class Phaeophyceae) belonging to the family Fucaceae are especially important and widespread (Serrao et al., 1999a). Fucaceae is a family containing four genera, and 27 species (Guiry 2019). One of these genera is the genus *Fucus*. *Fucus* is a genus with species characterized by apical growth, a diplontic life cycle and reproductive structures called receptacles (Fensholt 1955). On rocky shores in the Northern Hemisphere *Fucus* spp. constitute the largest biomass (Lüning 1990). They occupy the intertidal zone were they function as canopy forming key species, and sustain high biodiversity (Thompson et al., 1996;Christie et al., 2009).

1.2 Rocky shore communities

Rocky shore communities are harsh intertidal habitats structured by a combination of both biological and physical factors (Connell 1972;Thompson et al., 1996;Bertness and Leonard 1997). Important physical stressors are strong fluctuations in UV-radiation, temperature, salinity and wave exposure (Stephenson and Stephenson 1949;Murray, Ambrose & Dethier 2006). Important biological factors structuring rocky shore communities include grazing and competition between different species for space (Schonbeck and Norton 1978;Schiel and Foster 2006). In order to successfully occupy this stressful environment some macroalgae have developed adaptations such as storage of carbon dioxide and nutrients, and flexible thalli to withstand wave action (Rai and Gaur 2012). More specifically, some *Fucus* species show a well-developed capacity for thermal acclimatization as a response to fluctuations in temperature (Jueterbock et al., 2014). They also have been shown to have the ability to change pigment composition when light intensity changes (Ramus et al., 1977).
The zonation pattern between different fucoids on rocky shores are, by some, thought to mainly be determined by interspecific competition and not exclusively by physical factors as earlier assumed (Schonbeck and Norton 1980;Lubchenco 1980).

1.3 Evolutionary history of Fucaceae, where do they come from?

The family Fucaceae probably originated in the Pacific and diversified in the late or mid Miocene (Cánovas et al., 2011). In the Pacific the ancestor to Fucaceae probably split from the sister taxa Xiphophoraceae (Serrao et al., 1999a). Cánevas et al. (2011) suggest that the genus *Fucus* originated during or just after crossing the opening of the Bering Strait from the North Pacific to the North Atlantic in the late Pliocene (Cánovas et al., 2011). The main species radiation within *Fucus* appear to have happened relatively quickly and recent, about 2. 5 million years ago (Leclerc et al., 1998;Coyer et al., 2006b). *Fucus* species diverged in to two clades or linages. One clade have a more temperate distribution while the other also occupied more southern ranges (Cánovas et al., 2011). Both hermaphroditic and dioecious reproduction modes existed in these linages, and these different modes of reproduction seem to have driven further speciation within the genus, acting as barriers to hybridization (Cánovas et al., 2011).

Of the different genera which have crossed the Bering Strait, the genus *Fucus* that has had the most extensive species radiation and has been able to occupy several novel habitats. Their distribution today is most likely a reflection of glacial cycles that forced splitting of populations in to glacial refugia, followed by recolonizations (Cánovas et al., 2011). The close phylogenetic relationship could possibly be an explanation for why several hybridising species within *Fucus* are observed today (Bolwell et al., 1977;Kim et al., 1997).

1.4 Speciation and adaptions within the genus *Fucus*

Once a population starts to split up as a result of a shift in habitat preference, it is possible that a disruptive selection would favour a bimodal distribution of phenotypic traits (Rice and Salt 1988). A combination of natural selection and assortative mating can, in this way, be an important and strong force in speciation (Rice 1987). Incomplete separation of species can possibly allow hybridization that can be either successful on their own or maladaptive (Rieseberg and Willis 2007).

Some species differentiate while living in close proximity. If hybrids develop between incipient species and these are maladapted to their environment, processes preventing hybrid formation can evolve, driving the process of speciation. This can, for example, be separation by difference in timing of reproduction, such as asynchronous spawning (Monteiro et al., 2012). If, on the other hand, hybrids are successful, this can enable them to occupy new habitats (Cruzan and Arnold 1993).

For the genus *Fucus*, studies of successful hybrids and adaptions to marginal habitats has been reported in several places (Coyer et al., 2006c;Bergström et al., 2005;Sjøtun et al., 2017). Hybridization within *Fucus* species can, as recorded for *F. serratus* and *F. evanescens* be asymmetrical where successful hybridization only occurs between female *F. evanescens* and male *F. serratus* (Coyer et al., 2002a). However, a restricted degree of hybridization has been found in nature (e.g. Moalic et al., 2011), even where many *Fucus* species grow close to each other and artificial hybrids are relatively easy to produce (Bolwell et al., 1977). This suggests that adaptive processes that act against hybridization are present.

One example of adaptive processes acting against hybridization is a recently described case in the Baltic Sea. The Baltic Sea is a brackish environment with perennial *Fucus* species as the only canopy forming plants in the coastal zone (Kautsky and Kautsky 2000). A frequently observed morphotype of *F. vesicolosus* was described as a miniature version with more narrow fronds and lack of bladders compared to the common *F. vesicolosus* (Bergström et al., 2005). Further investigation of this morphotype showed that it is both morphologically and genetically separate from *F. vesiculosus.* This led to the smaller morphotype gaining a species status; *F. radicans*. Further, they had evolved asexual reproduction and this made them more adapted to lower salinity in addition to maintaining a reproductive barrier to *F. vesicolosus* (Bergström et al., 2005;Johannesson et al., 2011).

A recent study conducted on the coast of Northern Portugal illustrates another example of speciation by adaption to an environmental gradient in *Fucus* spp. *Fucus spiralis* and *F. guiryi* (previously *F. spiralis* var. *platycarpus*) were earlier categorized as two morphotypes. Common garden experiments and morphometric recordings showed that they had adapted to different tolerances to desiccation in the vertical zone and were significantly distinct in morphology (Zardi et al., 2011). The genetic results further showed that *Fucus spiralis* var. *platycarpus* was genetically distinct when growing allopatric, but that they in sympatric populations with *F. spiralis* and *F. vesicolosus* showing strong signs of gene flow. However, the morphological traits and physiological adaptions were maintained for *Fucus spiralis* var. *platycarpus*, and therefore it was suggested to upgrade it to a species status; *Fucus guiriyi* (Zardi et al., 2011).

Ployploidization is a recognized mechanism for speciation, and is often a result of interspecific hybridization (Leitch and Leitch 2008). Polyploidization is reported in *Fucus* species and can be another aspect of their ability to adapt to marginal habitats (Coyer et al., 2006c). An interesting example of this in *Fucus* species is the populations of a salt marsh adapted, dwarf-like *Fucus* morphotype called *Fucus cottonii* (Coyer et al., 2006c).
Genetic studies has found that *Fucus cottonii* is a grouping of several populations with independent evolution and the similarity in morphology is most likely due to the combination of hybridization, polyploidy and environmental effects (Neiva et al., 2012a;Sjøtun et al., 2017).

1.5 Definition of a *Fucus* species

A "species" is by many acknowledged as an fundamental unit when describing systems in nature and the process of evolution (De Queiroz 2005). There is however great controversy about how to best define a species, and there is an ongoing debate on several definitions (Mallet 1995;De Queiroz 2007). Species from the genus *Fucus* have, as mentioned, a high degree of plasticity and hybridization potential that is likely due to recent species radiation (Serrao et al., 1999a). Some *Fucus* species have a large capacity to alter morphology as a response to environmental changes (Cairrao et al., 2009). This creates difficulties when trying to resolve *Fucus* down to species level (Billard et al., 2005).

To investigate the diversity within the genus *Fucus*, previous studies have used multiple genetic markers, shown to be variable enough to separate at species level (Billard et al., 2005;Kucera and Saunders 2008). The use of morphometric data for *Fucus* species (and suspected "hidden" species) has proved to be useful when recording how *Fucus* species are affected by differences in environmental parameters, and how the characthers separating species morphologically take form (Bergström et al., 2005;Cairrao et al., 2009).

1.6 The *Fucus* morphotypes of this study

This study treats two morphotypes of *F. serratus* (Linnaeus 1753); the regular morphotype (Figure 1), and a small morphotype (Figure 2) found in a land-locked fjord (Tjongspollen) on the southwestern coast of Norway. While the two morphotypes show widely different morphology, they both grow in the lower intertidal, and a small study that sequenced 18 individuals of each morphotype showed that they share the mitochondrial cox1 sequence (Nøland 2015). In addition, some preliminary results from analysing microsatellites show that they have a close relationship with *F. serratus* (unpublished data, K. Sjøtun pers. Com.)

Figure 1. The brown algae Serrated wrack (*Fucus serratus*) from Tjongspollen. Photo: Signe B. Svensson, 2018.

Fucus serratus is an intertidal, perennial and canopy forming alga growing on semi-exposed rocky shores in the northern hemisphere (Guiry, n.d). It is considered a key species (Menge 1976) occupying the lower zone. The morphology of *F. serratus* is characterized with a distinct midrib, dichotomous branching and serrated leaf edges (Guiry, n.d). The growth rate for *F. serratus* (elongation) has been estimated to be around 0.7 millimetre per day (Knight 1950). This species can grow in waters with temperatures ranging from 0 to 25 degrees Celsius with optimal temperatures around 15 degrees (Lüning 1990) and individuals normally live between three to five years (Rees 1932). Their distribution are registered to be from northern Europe to the western North Atlantic (Lüning 1990), and they have been introduced by humans to both the Faroes Islands and Iceland (Coyer et al., 2006a), and to North America (Brawley et al., 2009).

Their reproductive period along the oceanic coasts range from autumn to spring with two peaks occurring in September and March (Malm et al., 2001). *Fucus serratus* is dioecious, meaning that it has separate male and female plants and reproduce sexually (d`Avack 2015).Their reproductive structures, receptacles, develop on apical tips. Receptacles contain the gamete producing structures called conceptacles. The female's conceptacles contain oogonia, which is the structure responsible for producing eggs. In all *Fucus* species the oogonia divide into eight egg cells. Male plants produce gametes in structures called antheridia. *Fucus* sperm is motile and female *Fucus* plants can release pheromones to attract sperm (Maier and Muller 1986;Biovitenskap 2011).

They have a restricted dispersal distance with eggs that are negatively buoyant which make them sink in close proximity to the parental plant (Jaffe 1968, pp. 295-328;Arrontes 1993). Results from microsatellites studies suggest panmictic units of 0.5-2 km (Coyer et al., 2003). They also have high fecundity and high juvenile mortality (Coyer et al., 2008). In an evolutionary context this species is most closely related to *F. distichus* and these two form a monophyletic group (Kucera and Saunders 2008).

In Tjongspollen, situated on the island Bømlo on the southwest coast of Norway, the small *Fucus* morphotype was discovered in 2006.
The small *Fucus* morphotype (Figure 2) grow in a poll (or landlocked fjord), which is a relatively unusual marine habitat. Restricted exchange of sea water in combination with run off from land creates differences in temperature and salinity gradients in comparison to the adjacent open sea. Polls are therefore more brackish compared to sea water outside the poll.

Figure 2. The small *Fucus* morphotype (*Fucus* x) located in Tjongspollen. Photo: Signe B. Svensson, 2018.

Except for shared mitochondrial genes further examinations of nuclear DNA content showed that *F. serratus* had a nuclear DNA content of 2.7-3 pg compared to the small *Fucus* morphotype that showed the range 2.5-2.7 pg (unpublished results, K. Sjøtun). This reduced nuclear DNA content in the small morphotype lowers the probability of polyploidyzation as a cause for the diverging morphology, which otherwise is a known possible driver for separation in both terrestrial and marine flora (Coyer et al., 2006c;Wood et al., 2009). The small morphotype is found growing 0.5-2 meters down on the rocky bottom substrate within a landlocked fjord. The small *Fucus* morphotype normally lack serrations along the edge. Although visibility varies, they have a midrib as *F. serratus*.

Adventitious branches are frequently observed on these small morphotypes and these may possibly be able to break off and continue to grow on their own.

The small *Fucus* morphotype is much smaller than *F. serratus* but, within the poll, seem to have taken over the zone normally occupied by *F. serratus.* Some normal *F. serratus* has also been observed in this poll but not in high abundance. The small morphotype has been observed to vary a great deal in morphology inside Tjongspollen and intermediate morphologies between the small morphotype and *F. serratus* could therefore indicate some degree of hybridization between morphotypes.

1.7 Scope of this study

The small morphotype in Tjongspollen displays a distinctly different morphology compared to *F. serratus* but the two share the mitochondrial cox 1 genes (Nøland 2015). The genetic similarity but diverging phenotypes could be a starting process of speciation. The aim of this study was to investigate differences between *Fucus serratus* and the small *Fucus* morphotype (hereafter called *Fucus* x) located in Tjongspollen, Bømlo, Norway. Four different methods were applied to describe these two morphotypes.

The effect of physical factors (combination of salinity and temperature) on growth for the two morphotypes was investigated through a common garden setup. A common garden experiment is a powerful tool and is used for investigating local adaptations to the environment by controlling some physical factors (de Villemereuil et al., 2016). Organisms are held in the experimental environments together, and parameters such as growth are used to measure and evaluate fitness in different environments. This method is often used for both plants and animals (Reusch 2014).
The purpose of the common garden experiment was to show if one of the morphotypes grew better in either of the treatments mimicking inside or outside poll conditions.

To describe their morphologies and be able to compare similarities and dissimilarities a set of morphological traits were used. This type of description of shape and size can be used to describe visual differences in phenotypes (Janson and Sundberg 1983). For example in sexual, dimorphism (Setiawan et al., 2004), the phenotypic results of hybrid forms (Hodge et al., 2010) or to separate species (Roman and Hirschmann 1969). The common garden experiment could also show if individuals of *Fucus* x changed morphology to look more similar to *F. serratus* when experiencing outside poll conditions, where *F. serratus* was collected.

The possibility for the two morphotypes to reproductively cross with each other was tested through crossing in a laboratory experiment. Reciprocal crossing was carried out in two water salinities with matching either inside or outside poll conditions. This was used to evaluate if these two morphotypes could form hybrids and if this was possible for both inside and outside poll water salinities. If they are able to hybridize this could explain observations of intermediate morphologies between morphotypes.

Genetic dissimilarities between morphotypes were investigated with the help of PCR and sequencing of a mitochondrial intergenic spacer (mtIGS), a marker which has been shown to possess some variability in the *F. serratus-F. distichus* lineage, separating these at both the population and species level (Hoarau et al., 2007). The purpose of the genetic study was to show if differences in mitochondrial DNA could be found as a sign of isolation between populations (Neiva et al., 2012b).

This study aims to make a small contribution to the investigation of plasticity and adaptiveness for species within the Fucales in a marine marginal environment.

Based on literature and previous research, the following hypothesis have been formulated and tested:

Hypothesis 1: Difference in the parameters salinity and temperature in a common garden experiment will show that as a response to stress, *F. serratus* will have a reduced growth in inside poll conditions compared to outside poll conditions. The opposite trend will be observed for *Fucus* x.

Hypothesis 2: Morphometric measurements should create distinct separation between these morphotypes in all traits recorded.

Hypothesis 3: Reproductive crossing between these two morphotypes is possible.

Hypothesis 4: Genetic difference is expected to be low in mtIGS, but present.

2 Materials and methods

2.1 Site description

The small morphotype *Fucus* x is located inside the landlocked fjord Tjongspollen (Figure 3) (59°40'07.3"N 5°13'59.3"E). Tjongspollen is a poll/landlocked fjord situated on the island Bømlo 114 kilometres south of Bergen in Hordaland, Norway. Tjongspollen has two small and shallow openings to the sea. The biggest opening is approximately seven meters in width and 3 meters in deep, in the shallowest part. The poll in total is 5.5 kilometres long and the widest part is around 0.7 km. The greatest depth in the poll is 127 meters. The area is almost uninhabited apart from some small cabins and one farm located in the inner part. On the west side there is a protected pine forest area. Restricted water exchange with the outside sea and run off from land generates lower salinity and higher annual temperatures inside the poll (Heggøy 2001). The small *Fucus* x only occur in some places inside the poll along the rocky bottom substrate at depths from 0. 5-1 meter below the surface. *Fucus serratus* (normal morphotype) is common and grow abundantly outside the poll but is only found scattered within the poll.

Figure 3. Overview of study site Tjongspollen. Yellow dot indicate the great inlet (site 3). Green dot show Hakksteinpollen (site 1) and red point Holmen (site 2). Source: Google maps, 2019.

Figure 4. Overview of the inside of Tjongspollen. Red markings indicate where previous inventory has observed *Fucus* x. Blue lines indicate areas where *Fucus* x has not been observed (K. Sjøtun. per.observation). Green arrow indicate sampling site 1 and red arrow sampling site 2.

2.2 Sampling of *Fucus serratus* and *Fucus* x

Sampling took place on the 5th of September 2018 at Tjongspollen, Bømlo, Norway. Sampling site 1, Hakksteinpollen, (coordinates 59.672877, 5.253157) was located inside the poll (Figure 4). Snorkelling was done in order to find and collect *Fucus* x located around 0.5 to 2 meters below the surface. Each selected individual was cut off using a knife. When removed from its substrate (Figure 5-6) as much as possible of the holdfast was included. Care was taken to find individuals with as little epiphytes as possible and in a seemingly healthy condition. Samples were put in zip-lock bags with sea water, marked with the location and then kept in cooling bags with cooling clamps. The same procedure was carried out at sampling site 2 Holmen (Figure 4) (coordinates 59.662684, 5.225803) when collecting *Fucus* x. Sampling site 3 (Figure 3) was located at the biggest inlet to the poll (coordinates 59.698417, 5.245778). *Fucus serratus* was collected in the same manner as *Fucus* x. *F. serratus* individuals where chosen by their coloration and size, and too large individuals were considered unpractical for the experimental set-up. Samples were transported back to the laboratory in

Bergen in cooling bags with open lids and zip-lock bags in order for the algae to be ventilated. Transportation took approximately four hours from sampling to lab.

Figure 5. Densely *Fucus* x growing on the bottom inside Tjongspollen Photo: Kjersti Sjøtun.

At the laboratory samples were gently brushed with toothbrushes to remove as much epiphytes as possible whiteout causing damage. They were quickly rinsed in fresh water to clear of diatoms. Each individual got an id number consisting of a plastic tag that were attached on the main branch. Id-tag for *Fucus* x were attached with a cotton thread. To keep track of from which site they were picked, different colours where used. Red for site 1 and purple for site 2. The *F. serratus* individuals had their id-tags attached whit a plastic strip on stipes.

In order not to shock those individuals that were going to be used in a treatment with values different from their original habitat 15 individuals of *Fucus* x and 15 *F. serratus* individuals were placed in a tank with temperatures and salinities intermediate between those of the running unregulated sea water in the laboratory (14° Celsius and salinity 30 ppm), and the planned experimental values for inside poll conditions. Individuals were kept here for six days before moved to assigned treatment-tank.

Figure 6. *Fucus* x plant (red circle) growing on rock substrate with a substantial amount of epiphytes at site 1. Photo: Signe B. Svensson, 2018.

The rest of the individuals did not need acclimatization before the experiment. The *F. serratus* individuals which were to be used in sea treatment were placed in tanks with salinity and temperature 34 ppm and 12.5°C. *Fucus* x individuals which were to be used in the poll treatment were put in tanks with salinity and temperature 28 ppm and 17 °C. The poll treatment values were regarded to be representative for inside-poll conditions during September, based on earlier measurements (Heggøy 2001; K. Sjøtun unpublished).

2.3 Temperature and salinity measurements

In the field a salinity and temperature measurement sensor (*Cond 3110 WTW*) was used to measure temperature at sites. This was done by simply putting down the sensor just below the surface and read recorded values. Three measurements at each site of both temperature and salinity was recorded. Measurements were done at samplings sites to double check that previous estimations for these parameters where the correct to use in the common garden experiment.
At site 1 and 3 Tiny-tags (Tiny tags aquatic 2 SER-9525) were placed on the bottom, approximately one and a half to two meters below the surface. They were anchored with weights and rocks. Airfield containers where used as floaters. These were left to record long term variation at the sites over winter (September to May).

2.4 The common garden set up

In order to investigate the effect of differences in salinity and temperature on growth rate for and survival for both the *Fucus* morphotypes a common garden experiment was set up. The laboratory used for this was prepared with six tanks (Figure 7). Three tanks were set to "poll-conditions", approximately 17 Celsius and salinity of 28 ppm, and remaining tanks were given "sea-conditions", around 12.5 Celsius and salinity 34 ppm. The poll conditions were based on earlier field measurements during September, and the unregulated sea water represented sea treatment. Salinity for sea treatment was not optimal in relation to the values found outside the Tjongspollen (site 3) but due to limitations in regulation at the laboratory facility unregulated seawater was the easiest to choose to ensure as stable values as possible during the experiment.

Figure 7. Lab facility where the common garden experiment took place. Six tanks used for growing morphotypes in poll and sea treatment. Photo: Signe B. Svensson, 2018.

The two morphotypes were placed together in each of the tanks, and the purpose with the experiment was to see if *Fucus* x from the poll grew better than *F. serratus* in the environment corresponding to the poll conditions, and if *F. serratus* grew better than *Fucus* x in the environment corresponding to the sea conditions. To provide suitable light conditions for the algae each tank had a white plastic box (volume of 47 litres) that were placed on top of another box, to lift each plastic box closer to the lights (there were limited possibilities for adjusting lamps). To these white boxes four holes, around eight mm in diameters, had been drilled to ensure water exchange. Plastic tubes supplying fresh seawater were put inside boxes. Tubes were put in an angel in order to create a small current whit in each box, without causing too much movement on the surface that would disrupt light penetration. Flow velocity were adjusted to two litres per minute using a measuring jug and a stop watch. A light measurement device (*Biospherical instruments inc. model QSL-100 serial number 1214*) was used to measure the light conditions within each box. Light was similar between tanks but varied within each box from 50 to 100 $\mu Em^{-2}s^{-1}$.

In the experimental set up ten individuals were placed in each tank/box, five of each morphotype (Figure 8). A cotton thread was used to tag branches that showed a clear dichotomous splitting. Two branches per individual were chosen in order to ensure that the potential loss of one branch would not mean loss of a total individual. In order to separate the two branches they were marked with different colours, and branches that appeared vegetative were preferred. For *Fucus* x, where reproductive structures were not so easily sorted out with the naked eye, a dissection microscope was used to select vegetative branches. Tagged individuals were anchored with a cotton thread to round metal grids that kept the individuals evenly spread and emerged. Grids also prevented drifting of individuals that could give variation in light availability. 60 individuals were initially included in the common garden experiment.

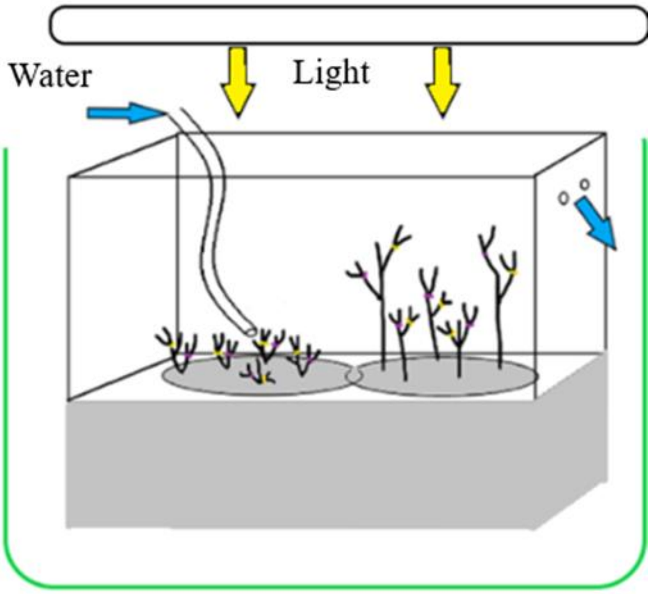

Figure 8. Experimental set-up with both morphotypes in plastic boxes in each tank (green outline). Five individuals of each morphotype anchored to grids. Coloured markings on branches (pink and yellow) show individual markings on branches used for measurements.

Because of a small variation in light conditions between the tanks a rotation schedule was put up. This was in order to reduce the effects of variable conditions between the tanks. Individuals were moved to a new tank with same treatment conditions once a week in a clock wise fashion.

Tanks in the laboratory were automatically monitored with temperature and salinity measurements logged every tenth minutes. Alarm-settings for temperature were to above 19 °C and below 15 °C for “poll-treatment” and above 13 °C and below 9 °C for “sea-treatment”. Control measurements was also done frequently by hand.

2.5 Weekly measurements of length and area

Once a week all individuals were photographed. Each individual was removed from the grid and each marked branch were photographed using a camera attached to a stand, to ensure correct and consistent angle, against a background with laminated millimetre paper. Pictures where later analysed using the program ImageJ (Schindelin et al., 2012). Two types of growth measurements were recorded, branch area and branch tip length. In the program Image J each picture was scaled with the help of millimetre paper in the background. A line was drawn from the cleft in the dichotomous branching to the highest point on the tip (Figure 9). This was done for both sides of the dichotomous cleft and from this an average was calculated. Branch area for *F. serratus* was taken by drawing a line from the bottom of the cleft out to the edge of the branch and then follow the shape of the branch around the edges (Figure 9). For *Fucus* x the area measured was from the "neck" before the dichotomous branching and around the branch edges. The branch area was not taken in the same manner for both morphotypes because the difference in morphology made it difficult to maintain consistency in measurements of *Fucus* x. In total this gave each individual two length and two area measurement's every week. If a branch was damaged or fell off a new branch was marked with a new colour and marked as a new unique branch in data recordings.

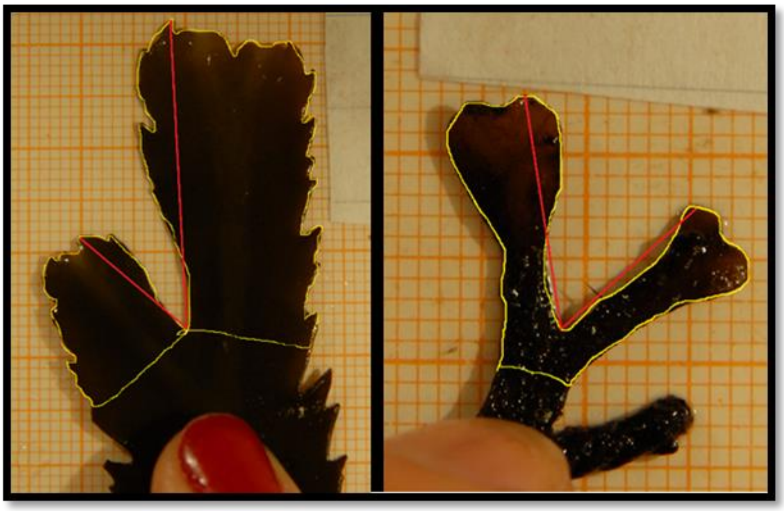

Figure 9. Procedure for defining length and area measurements on *F. serratus* (left) and *Fucus* x (right). Red lines illustrate length measurement and yellow outlining show leaf area. Photo: Signe B. Svensson, 2018.

2.6 Total plant weight and length recordings

Total length and weight were recorded for all individuals in the experimental set up. This was in order to show the relationship between weight and length for both morphotypes. Length was recorded by measuring individuals from the base of the stipe to the tip of the longest branch. A stiff ruler was used and the lengths were noted down to the closest millimetre. The weight (blotted weight) was recorded by taking one individual and gently dry it off with paper before putting it in a small box for weighing. *Fucus* x individuals were often gently cleared from epiphytic algae before weighed. The weight was recorded in grams and noted down with to decimals.

2.7 Morphometry

In order to describe and compare both morphotypes by their morphology a selection of features were recorded. The purpose was to look for consistent differences or similarities within and between morphotypes. Morphological features, given in Table 1, were categorized and recorded for a total of 20 individuals, ten of each *Fucus* morphotype. These morphological features were considered to be suitable because they do not appear to be affected by reproductive stage (Bäck 1993). Morphometry was recorded 57 days after the common garden experiment had started. Individuals were chosen at random from al tanks. Sex of plant individuals were decided if possible. For adventitious branching four categories were created: none, few, common, abundant. "Few" were defined as observed on less than one third of all branches. "Common" was defined as observed on at least half of the branches an "abundant" for those who had adventitious branching on more than half of all branches.
All individuals were also photographed and pressed on herbarium paper to be stored.

2.7.1 Recordings shape and number of reproductive tips

For *Fucus* x there was much variation in shape of reproductive tips. In order to describe this, four different categories were created for reproductive tip shape (Figure 10). These were based on observed variations for the individuals of *Fucus* x in the common garden experiment. At the time for these recordings a very low number of *Fucus* x individuals were present in the experiment. In order to increase the sampling size, dried material from a herbarium made from Kjersti Sjøtun was used. From this seven additional individuals carrying receptacles could be included. These individuals were collected in October during 2014 and 2016, from two different sites inside Tjongspollen. These individuals were soaked for approximately 1 hour and with the help of a dissecting microscope reproductive tips were categorized according to Figure 10. It could sometimes be difficult to decide if a receptacle with two tips was dichotomously divided receptacle, or if two nearby and recently divided branches had become fertile. For this reason reproductive tips were used as a category unit.

2.7.2 Inventory of reproductive tips for all individuals

The 25th of October an inventory of all individuals in the common garden experiment was done. All tips on all individuals were first counted not differentiating between vegetative or reproductive. Then all tips appearing to be reproductive were counted. This was used to get a picture of the relative number of reproductive tips per individual at this time in the common garden experiment independent of treatment.

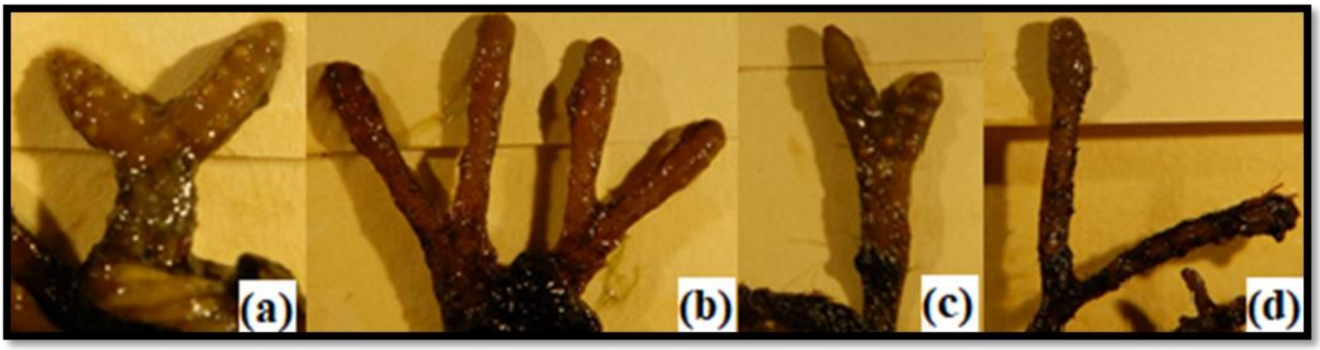

Figure 10. (a-d) Reproductive tips on *Fucus* x as represents for shape categories. (a)= Chubby, (b) = Nail, (c) = Leaf shape/flat, (d) = Club. Photo: Signe B. Svensson, 2018.

Figure 11. Reproductive tips on normal *F. serratus*. Photo: Kjersti Sjøtun, 2009.

Table 1. 10 Morphometric charachters recorded for *Fucus serratus* and *Fucus* x.

Morphometric characters	Type of score
Number of dichotomous splits along the longest branch	Count
Thickness of stipe before the first dichotomous split	(mm)
Serrated leafs	Present: yes/no
Visible mid rib	Present: yes/no
Receptacles	Number and shape according to categories in Figure 10 and 11
Amount of adventitious branches	Categories: none, few, common or abundant.
Width of leaf in between dichotomous splitting, upper part	Average from maximum five separate measurements (mm)
Width of leaf in between dichotomous splitting, lower part	Average from maximum five separate measurements (mm)
Total plant weight	(g)
Total plant length from holdfast to tip of longest branch	(mm)

2.8 Crossing set-up

In order to investigate possible reproductive barriers between the *Fucus* morphotypes crossings were carried out. Procedure described below had three main elements. First selection and collecting of receptacles from individuals in the common garden experiment. Secondly the induction of gamete release from receptacles and finally the combination of prepared receptacles.

Six individuals of *F. serratus* and six individuals of *Fucus* x were selected from the common garden set up, which had been terminated. For each morphotype three females and three males were chosen. An exception was made for females of *F. serratus*, where two receptacles were collected from one large *F. serratus* female, this was because there was too few reproductive females available at this point. In order to decide sexes of individuals a small piece of a receptacle from each individual was taken and examined under a dissection microscope. Individuals were selected on the basis of maturity and number of receptacles. Each individual was tagged in the following manner: Fs-F-1, Fs-M-1, Fx-F-1, Fx-M-1 etc. This corresponds to *Morphotype-Sex-individual*, where Fs stands for *F. serratus*, Fx for *Fucus* x and F or M stands for “Female” or “Male”. The procedure took place in a climate room with temperature of 10 °C and light panels on the wall. The light level on a marked shelf in the room was adjusted to approximately 30 $\mu Em^{-2}s^{-1}$.

A temperature of 10 °C was used because this is close to the temperature inside Tjongspollen when *Fucus* x has been recorded to be fertile, and it was suitable enough for *F. serratus*.
To measure light levels a spherical light sensor (*Biospherical instruments inc. model QSL-100 serial number 1214)* was used. Light in this room was controlled in another part of the building and at some point some lights seem to accidently have been turned off. This likely happened some day after the day of crossing and light intensity was then measured to be approximately 17 $\mu Em^{-2}s^{-1}$.

To stimulate release of gametes a drying method was used. Each individual was placed on a clean surface and the receptacle were cut off using a sterile scalpel, one scalpel per individual. Each receptacle were picked up using a tweezer and dipped for five-six seconds in a bowl of clean freshwater and then for five-six seconds in a bowl of sterile sea water with a salinity of approximately 34 ppm (Figure 12). This was done in order to remove as much diatoms as possible. Water was changed out frequently and at the minimum between each new individual. For *F. serratus* at least four receptacles per individual were cut off and for the small morphotype a minimum of eight receptacles. Extra receptacles were collected from individuals that had more than the required numbers for the crossings to later be used as controls for gamete release.

Figure 12. Preparing of receptacles in climate rom. Photo: Mari Eilertsen, 2018.

Each receptacle was placed on a clean paper towel. The paper towel was gently wrapped around the receptacles and placed in plastic bags. This was repeated for all individuals. Each paper package was marked with the individual number and sex. In total four plastic bags were used to keep the paper packages loosely sorted and not to dry (Figure 13). The bags were then placed in a refrigerator overnight.

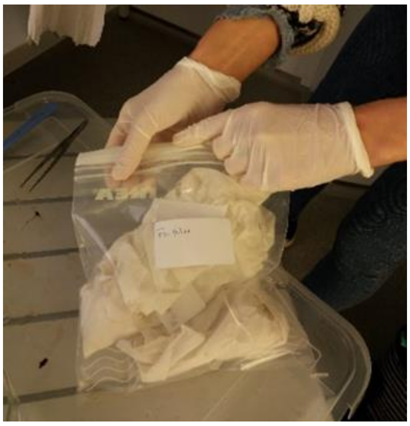

Figure 13. Packing receptacles for storage in refrigerator overnight. Photo: Mari Eilertsen, 2018.

Next day 24 sterelin-dishes (47 mm in diameter) marked, lid and bottom, according to the combination of receptacles and water quality it should contain (see appendix 4). Dishes were filled with sterile sea water (34 ppm) or “poll-water” (27 ppm).

In the climate room plastic bags were opened and with a pincher receptacles were placed in their assigned dishes. To avoid contamination the pincher was cleaned each time a receptacle from a new individual was handled. When all combinations and extra control-receptacles had been placed in the dishes these were placed on the prepared shelf with adjusted light level (Figure 14). Later the same day each dish was gently stirred to prevent gametes from lying on top of receptacles.

Next day control dishes were taken out and examined beneath a dissecting microscope to see if gametes had been released. Based on observations receptacles were given an extra day in dishes to ensure good enough amount of gametes. Dishes were also stirred one more time. The third day the receptacles were taken out from each dish, to avoid bacterial growth, with a pincher that was cleaned between every dish with alcohol and dried of with paper towels. Dishes were stirred and then left for a week in the climate room.

Figure 14. Receptacles combined in steraline dishes in climate rom. Photo: Signe B. Svensson, 2018.

2.8.1 Procedure for counting germlings

After one week in the climate room an inventory of all separate dishes were made to estimate the number of germlings. This was done under a dissection microscope. A four mm^2 square was attached on the bottom of each dish. This was used as a fixed area where all visible germlings were counted. The use of a fixed area was due to the sometimes-difficult task of counting all individual germlings in each dish. To estimate the total number of germlings in each dish (all separate combinations) four categories were created, these were as follows: 0, 1-10 germlings, 10-100 germlings, and 100-1000 germlings.

The same procedure was repeated one week later in order to look for variation in mortality between crossing combinations. A germling was determined to be dead if it appeared colourless and empty.

2.9 DNA extraction, sequencing and analysis

DNA-samples were taken for a total of 30 individuals, 15 *Fucus* x and 15 *F. serratus*. Before cutting, if necessary, the chosen individual was gently brushed with a toothbrush to avoid contamination by epiphytes and diatoms. A vegetative piece of approximately 5x5 mm^2 was cut of using a scalpel and tissue samples were put in tubes with silica gel for drying and storage. Cross-contamination was avoided by working sterile. Plastic tubes were marked with a code that corresponded to number of the individual, the treatment it had been experiencing during the common garden experiment, and morphotype. DNA samples taken were used to sequence the mitochondrial intergenic spacer (mtIGS). This mtIGS was chosen on the basis on a previous study of *F. serratus* that has recorded this as a variable region in their genome (Hoarau et al., 2007).

Samples that had been stored in silica gel tubes were taken out and cut in to appropriate sizes for further DNA-extraction. This was done using disposable scalpels and on a surface that was cleaned with alcohol between each new individual. Samples were extracted using a NucleoMag kit (Machery-Nagel 2017). Extraction method was chosen because it has recently proven to give good and clean DNA samples, which often is difficult to obtain from macroalgae using other kits (Fort et al., 2018). This is a method that uses magnet beads that bind to DNA. Samples are mixed with beads and buffer solution and then placed on a magnet plate. Beads with DNA attaches to the bottom of the plate and supernatant is removed by pipetting. This step is repeated six times. The last step involves buffer and heat treatment that induces beads to let go of the DNA. The fluid now pipetted out from of the wells contain clean DNA that later can be used in PCR-reactions. The protocol for NucleoMag kit was followed with a few moderations. One moderation was made in step eight the plate with samples were placed in oven for 5 minutes at 55 °C. The primers used were; "F 5`CGTTTGGCGAGAACCTTACC-`3; R 5`-TACCACTGAGTTATTGCTCCC-`3" (Coyer et al., 2006b).
For the first PCR-run 10 individual-samples were used, undiluted. For the next run 23 individuals were used and the samples were diluted with a magnitude of 10. The PCR cycling profile was set to 95 C° for five minutes, 95 C° for 30 s, 53 C° for 30 s, 72 C° for 10 minutes and finally 10 C° until samples were collected. Quality of PCR products were assessed using gel electrophoresis and visualised with the help of GeneSnap. Samples were cleansed using ExoSAP. An error in the PCR program was discovered for the second run. The last step had been set to 72 °C for 10 seconds instead of minutes, this was corrected for the second PCR reaction. Successful PCR-runs were sent for sequencing at the sequencing lab at the University of Bergen (Sars centre). Results were analysed and displayed using the software finch TV and Genius 11(Biomatters Ltd).

2. 10 Investigation of suspected bacterial infection

During the common garden set up a suspected bacterial infection systematically attacked *F. serratus* on branches and stipes (Figure 15). No infection for *Fucus x* individuals were observed. In order to investigate this infection, the procedure described below was performed by technicians in the Marine Microbiology research group at the Department of Biological Sciences, University of Bergen. Two *F. serratus* individuals with infected parts were selected; individual number 27 from sea-treatment and individual number 2 from poll-treatment. In the laboratory each infected individual were gently scraped and platted on petri-dishes, containing marine-agar-broth medium. In total six petri-dishes were placed in a warming cabinet set for 16° Celsius with low light.

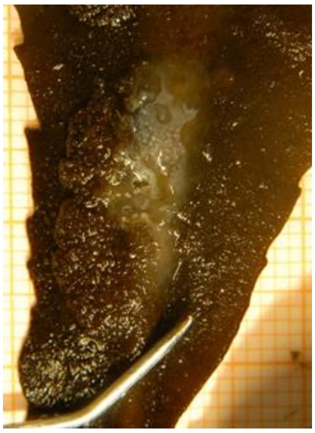

Figure 15. Infected branch on Fucus serratus. White part turning soft and slimy. Photo: Signe B. Svensson, 2018.

After five days in the warming cabinet large enough colonies had appeared to be examined further. With the naked eye three different, judging by coloration, type of colonies could be observed for both individuals. In order to get cleaner cultures that could be sent for sequencing these were plated out once more. Colonies were categorized as yellow, white or grey. New dishes were again put in the warming cabinet with 16° C and low light. When these colonies had grown to become visible, after a few days, they were prepared and sent to be sequenced with the 16S rRNA primer A8f.

2. 11 Statistical analysis

Collected raw data from laboratory measurements were stored in Microsoft Office Excel 2013. Graphs and statistical analyses were performed in Rstudio version 3.5.0 (RStudio Team, 2016). When performing statistical testing significance level was set to $p < 0.05$.

Before analysing data from the common garden experiment control-plotting of data was done for every individual and their branches. This was to check for potential outliers and non-normal patterns in growth.

For the common garden data the first and final day of recorded length and area measurements were analysed with a linear mixed-effects model (Lme). This was done in order to look for significiant differences in growth for corresponding morphotypes between treatments. An lme model was chosen because several branches were measured on the same individuals, and therefore there are not independent data points.

An lme was also used to model the progression of growth, which is the relationship between treatment and growth over time, with data from the common garden experiment. This model was chosen because it deals with repeated measurements on the same individuals over time and with several branches measured per individual. When modelling the progression of growth, for each morphotype in different treatments, a polynomial function was included to illustrate curvature in data. The random effect factor in this model was IDs of individuals and this was structured with the variable branch. The effect of tank was not included since this effect had experimentally been removed by circulating morphotypes between tanks.

A linear model with a polynomial function was used to show the relationship between total plant length and weight

Morphometric measurements were statistically analysed to show differences between morphotypes.

A General linear model (glm) was used for analysing the relationship between the categorical characters; “midrib” and “serrated leaf edge”. All other characters were analysed using Wilcox signed-rank test, which is a nonparametric test.

All plots in this study were drawn with the use of the R package ggplot2 (Wickham, 2016) and Microsoft excel 2013.

3 Results

3.1 Field Measurements

Field measurements of temperature and salinity from sites on the 5th of September 2018 were on average 17.7 °C, 29 ppm on the inside of the poll (Site 1) and 17 °C and 29.5 ppm at the inlet (Site 3).

3.1.1 Tiny-tag Temperature data

Tiny-tags left at site 1 and 3 over winter to record winter and spring temperature is shown in figure 16-17, site 1 and 3 respectively. The temperatures recorded inside the poll display a great deal of fluctuation in temperature compared to temperatures recorded at the inlet (see Figures 16 and 17). Minimum temperatures differs at the two sites. On the inside of the poll (Site 1) the lowest temperature was recorded to be 2.8 °C the 21 of January 2019, and outside of the poll 4.8 °C (Site 3) on 1th February 2019.

Figure 16. Tiny-tag temperature data collected at Hakksteinpollen (Site 1) from 5th of September 2018 to 8th of May in 2019.

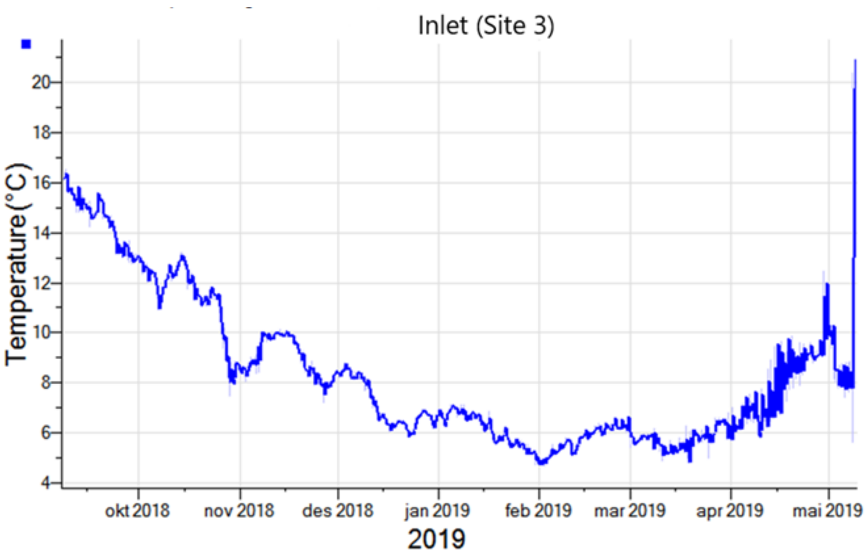

Figure 17. Tiny-tag temperature data collected at the inlet (Site 2) from 5th of September 2018 to 8th of May in 2019.

3.2 Common garden

The common garden experiment was conducted with in total 60 *Fucus* plants, 30 *Fucus serratus* and 30 *Fucus* x individuals for 9 weeks (56 days) where they were kept in two type of treatments (see raw data in appendix 1). Two types of measurements were used to evaluate the effect of salinity and temperature on growth, length increase in apical tips and branch area increase. Some individuals lost one branch during the common garden experiment. These got a new branch tagged with a unique id. Only one total individual, *Fucus* x from poll treatment, had to be excluded the last week.
A linear mixed effects-model was used to test for differences in length and area for corresponding *Fucus* morphotypes between treatments in the beginning and at the end of the experiment (Table 2). Anova outputs from these analysis do not show significant p-values for any growth measurement at the beginning or in the end of the experiment (Table 2). *Fucus serratus* shows lower growth in poll conditions compared to sea conditions, which are closer to being significant than those p-values shown for *Fucus* x (Table 2).

Table 2. Anova-output from linear mixed-effects model. Checking for significant differences in growth measurements for corresponding morphotypes between treatments. Mean values for individuals with two measured branches in treatment groups on the first and final day of the experiment. DF= degrees of freedom.

Morphotype and measurement	***Mean of sea***	***Mean of poll***	***Df***	***F-value***	***p-value***
Fucus serratus					
Start					
Length (mm)	21.0	22.0	28	0.09	0.76
Area (mm^2)	497.0	535.0	28	0.18	0.67
Final					
Length (mm)	42.0	36.0	29	1.75	0.19
Area (mm^2)	1382.0	1120.0	29	2.17	0.15
***Fucus* x**					
Start					
Length (mm)	6.0	6.0	28	0.33	0.57
Area (mm^2)	22.0	25.0	28	1.14	0.29
Final					
Length (mm)	13.0	14.0	27	0.14	0.71
Area (mm^2)	84.0	100.0	27	0.43	0.52

3.3 Progression of growth

Growth curves for both *Fucus* morphotypes show that there are differences in the progression of growth between treatments (Figure 18-21). For both length and area increase in *Fucus serratus* curves get steeper in sea treatment after approximately three weeks (Figure 18). In poll treatment curves for *Fucus serratus* show a more linear relationship for both length and area increase over time (Figure 18). Raw data in figures 18-21 show some variation around lines representing the progression of growth and that this also increase over time.
For *Fucus* x length increase in sea treatment is linear while it in poll treatment show a tendency to flatten out after approximately five weeks (Figure 20). For branch area increase in *Fucus* x, the curve in poll treatment is close to linear (Figure 21). In sea treatment this curve is close to linear but show some increasing steepness after approximately five weeks.

To test if the progression of growth was significantly different between treatments for *F. serratus* and *Fucus* x a linear mixed-effects model was used (Table 3).
Anova outputs show that there is a significant differences for *Fucus* x in the interaction between branch area increase over time between treatments (p-value= 0. 0129) (Table 3). In *F. serratus* the interaction branch length increase over time between treatments was significant (p-value = 0. 0026). The corresponding value for area was close to significant (p-value=0.051) for *F. serratus* between treatments.

Table 3. Results from Linear mixed-effects model (lme). Testing the difference in progression of growth between treatments for length and area increase for *F. serratus* and *Fucus* x over 56 days. Significant p-values ($p < 0.05$) given in bold. DF= degrees of freedom.

Morphotype and interaction	***F-value***	***Df***	***p-value***
Fucus serratus			
Length~poly(Day,2)*Treatment	6.01	462	**0.0026**
Area~poly(Day,2)*Treatment	2.10	458	0.051
Fucus x			
Length~poly(Day,2)*Treatment	1.71	471	0.1828
Area~poly(Day,2)*Treatment	4.39	472	**0.0129**

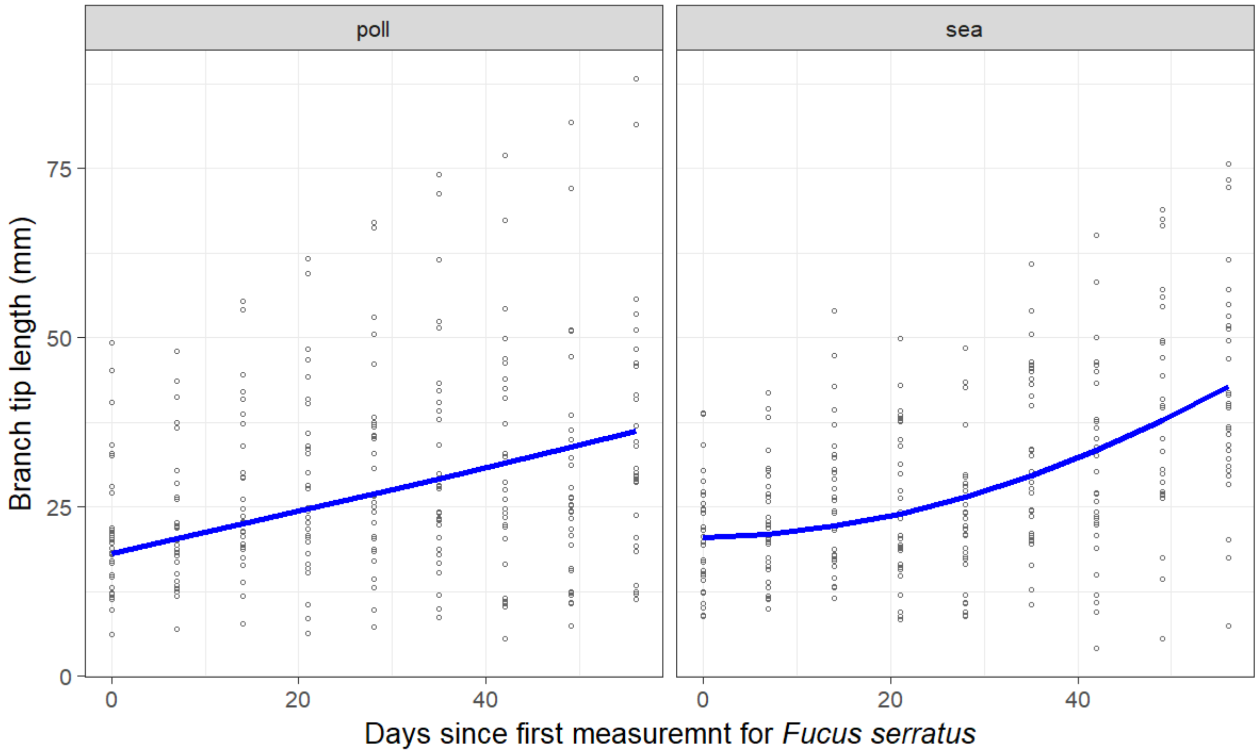

Figure 18. Raw data for branch tip lengths plotted over 9 weeks in both treatments for *F. serratus*. Blue line illustrate linear mixed-effects model with a polynomial function to illustrate progression of growth.

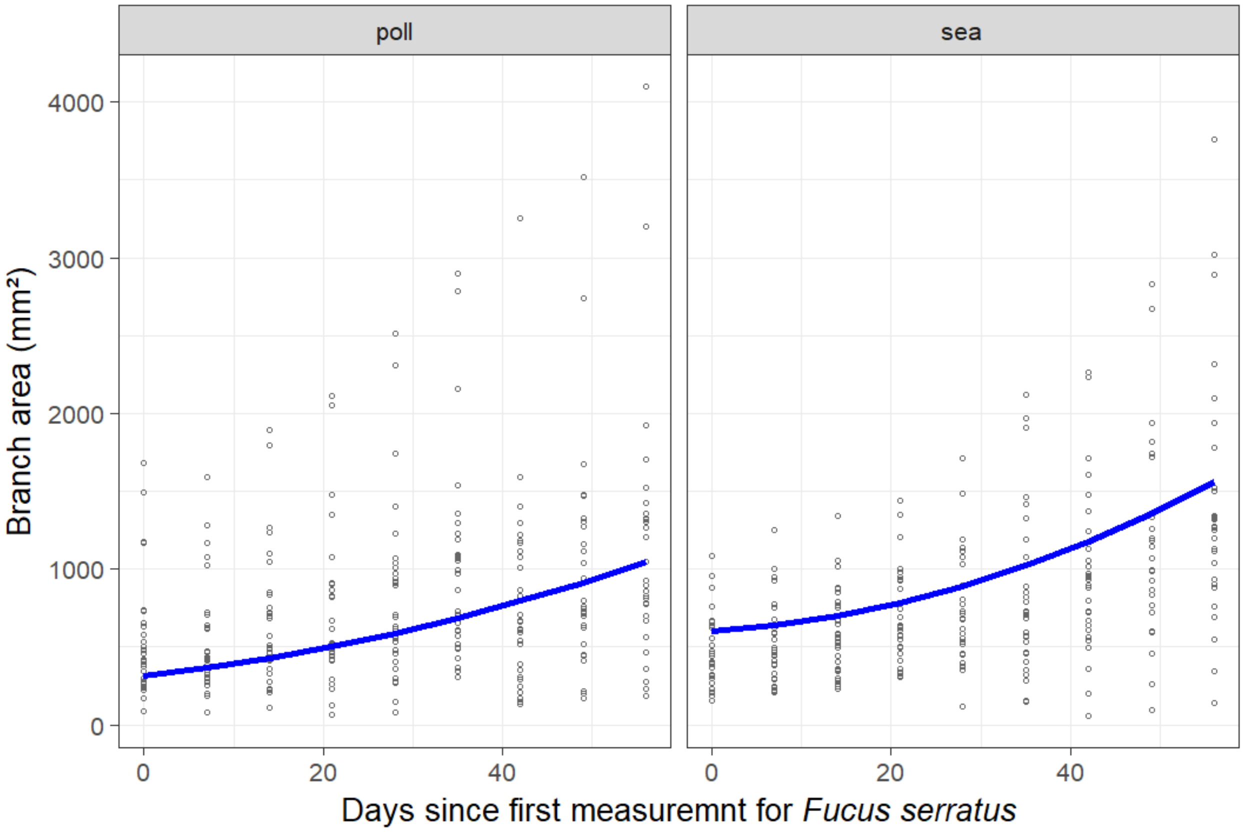

Figure 19. Raw data for branch area lengths plotted over 9 weeks in both treatments for *F. serratus*. Blue line illustrate linear mixed-effects model with a polynomial function to illustrate progression of growth.

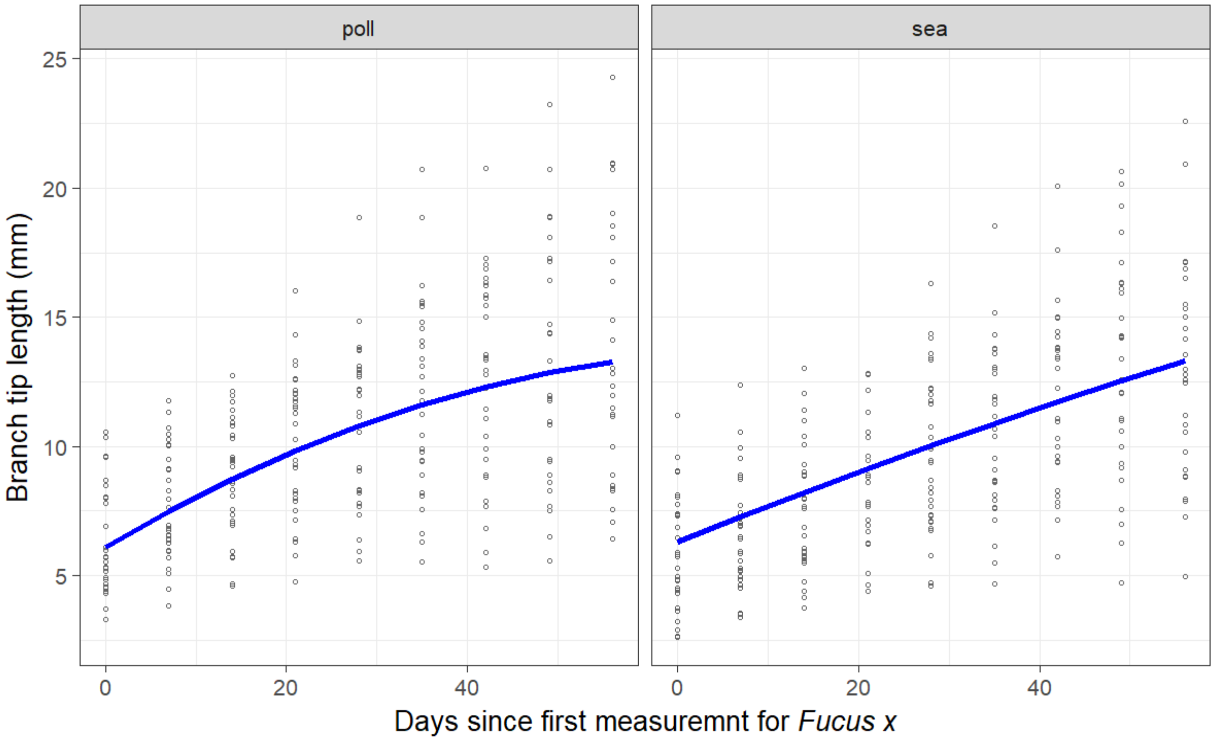

Figure 20. Raw data for branch tip lengths plotted over 9 weeks in both treatments for *Fucus* x. Blue line illustrate linear mixed-effects model with a polynomial function to illustrate progression of growth.

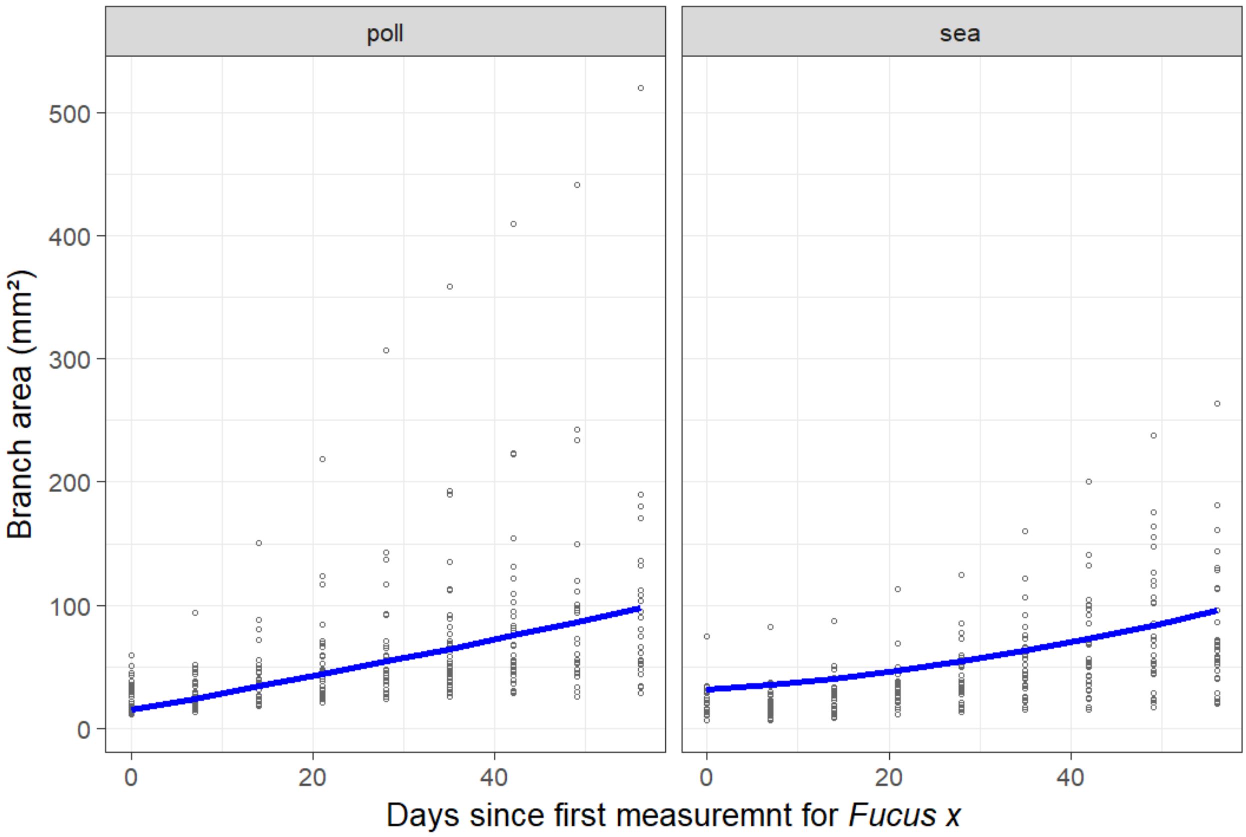

Figure 21. Raw data for branch area plotted over 9 weeks in both treatments for *Fucus* x. Blue line illustrate linear mixed effects-model with a polynomial function to illustrate progression of growth.

3.4 Bacterial infection

Out of 30 *F. serratus* plants eight (~27%) were recorded to suffer from infection in the common garden experiment. Out of the eight infected *F. serratus* individuals six were maintained in poll treatment tanks (Figure 22).

No *Fucus* x individuals showed sign of bacterial infection during the common garden experiment. Samples sent for sequencing, taken from two *F. serratus* (one from each treatment), revealed four different genera of bacteria and 14 possible species (Table 5).

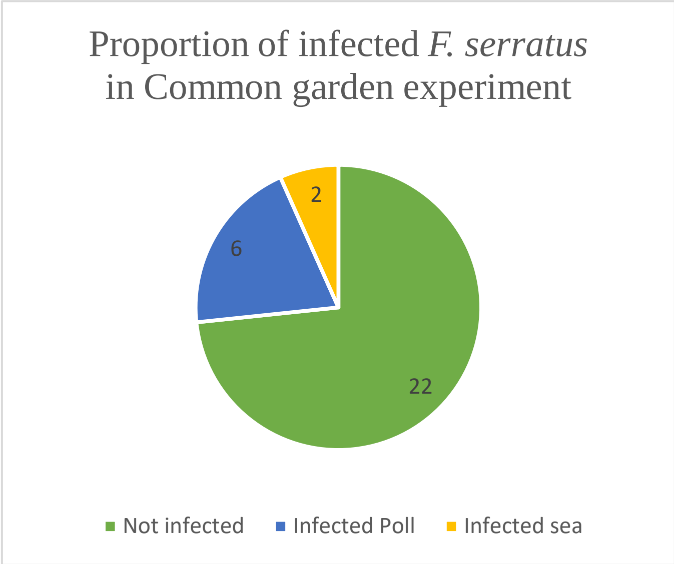

Figure 22. Proportion of infected *F. serratus* in regards to treatment illustrated in a pie chart.

Table 5. Bacterial genera and possible species found when sequencing 16s rRNA in two infected individuals in the common garden set-up. Colour code refer to the categorization that was made with the naked eye in respect to colour to separate different colonies. Blast sequences all had a 93-97% match.

Individual	Colour-code	Bacterial species found through BLAST
#2	Grey	***Vibrio*** - *mexicanus* - *artabrorum* - *toranzoniae* - *gigantis* - *natriegens*
#2	White	***Alteromonas*** - *napthalenivorans* - *addita* - *stellipolaris*
#27	Grey	***Phaeobacter*** - *arcticus* - *leonis* - *porticola*
#2	Yellow/white	***Pseudoalteromonas*** - *citrea* - *aurantia* - *prydzensis*

3.5 Morphometric measurements

Morphometric measurements were conducted on a total of 20 individuals (10 *Fucus serratus* and 10 *Fucus* x individuals) after 57 days in the common garden experiment. In these analysis individuals are not separated in respect to which treatment they had experienced. Results show that these morphotypes are clearly different in overall morphology.

Figure 23 (Graph A- I) show data for all the morphological characthers recorded in both morphotypes. Statistical testing used a Wilcox signed rank test for the characters in graph A, C, E, F, G, H and I. Here graph C "Number of dichotomous splits" was not significantly different between morphotypes (p-value 0. 45). All other characters showed to be highly significantly different between morphotypes. A glm, used to test the characters "visible midrib", graph B and "presence of serrated leaf edge", graph D. These show to be significantly different between morphotypes. The most variable trait for *F. serratus* was "total plant weight", graph I. "Stipe thickness" (Graph A) showed almost no variation in either of the two morphotypes. Adventitious branching was found in 80% of *Fucus* x individuals, and also in a greater amount compared to *F. serratus.* In *F. serratus* only 20 % showed some degree of adventitious branching. Serrated leaf edge was never observed for any *Fucus* x individuals, and only 40 % of *Fucus* x had a visible midrib. Average length for *Fucus* x was 9.2 cm and weight 3.5 g, while for *Fucus serratus* it was 31 cm and 20.6 g.

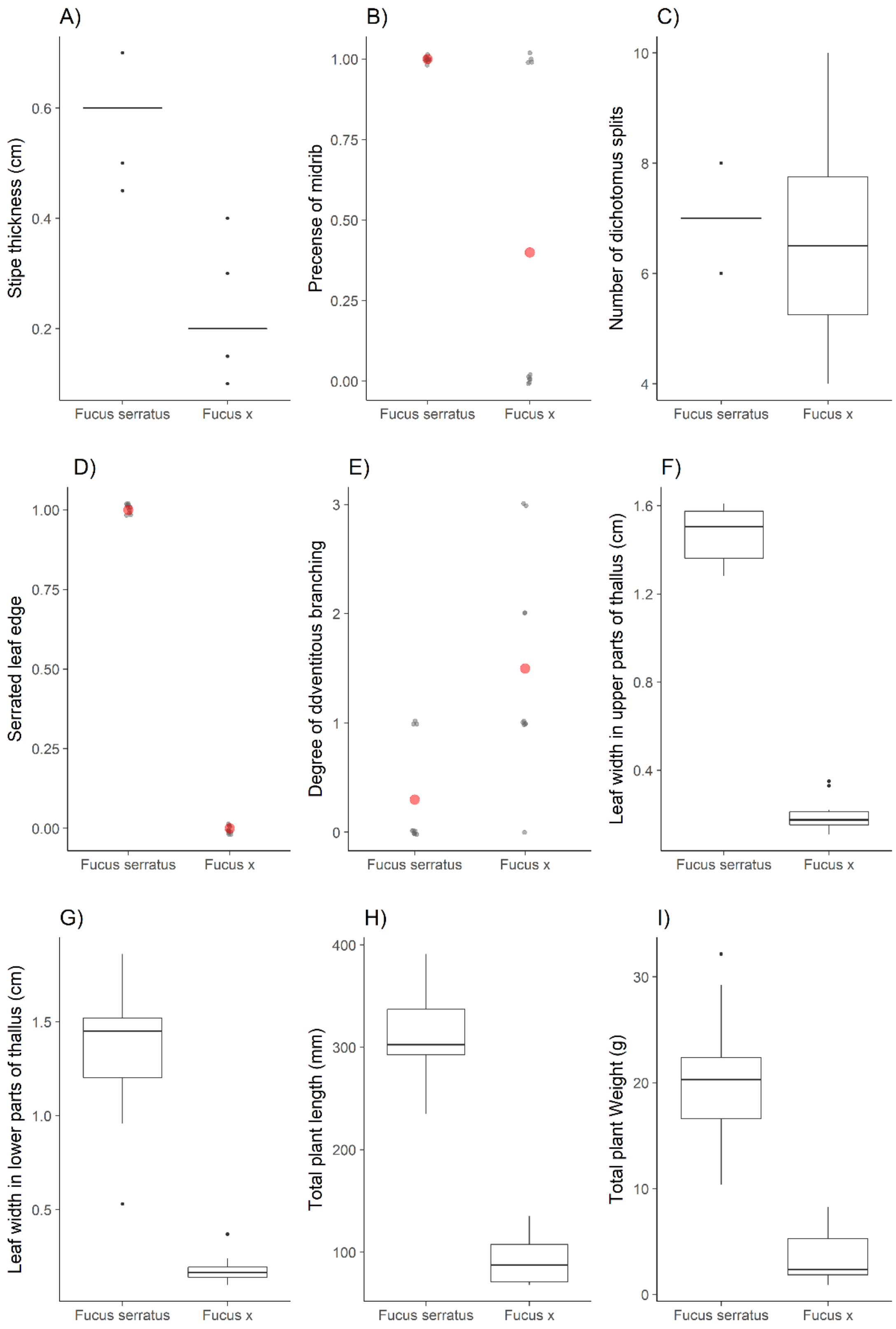

Figure 23. Nine morphometric measurements taken for both morphotypes from the common garden experiment. Each box represent results from one morphotype. Vertical lines extending from boxes show degree of variation. Horizontal lines within boxes represents the median. Dots in graph A, C, F, G, H, I represent outliers. Dots in graph B, D and E mark individual scores for that character and mean values are represented with red circles.

The overall morphology of *Fucus* x individuals varied a great deal (Figure 24). Some *Fucus* x grew in a very "bush like" manner (Figure 24, picture A), while others had a more *F. serratus*-like appearance with flat and blade-like thalli (Figure 24, picture B). Some individuals had "leafs" looking more like stripped branches (Figure 24, picture C). During the course of the common garden experiment none of the *Fucus* x individuals in sea treatment were observed to change their morphology and become more similar to *F. serratus*. Photos of all individuals used for morphometric measurements are found in appendix 3.

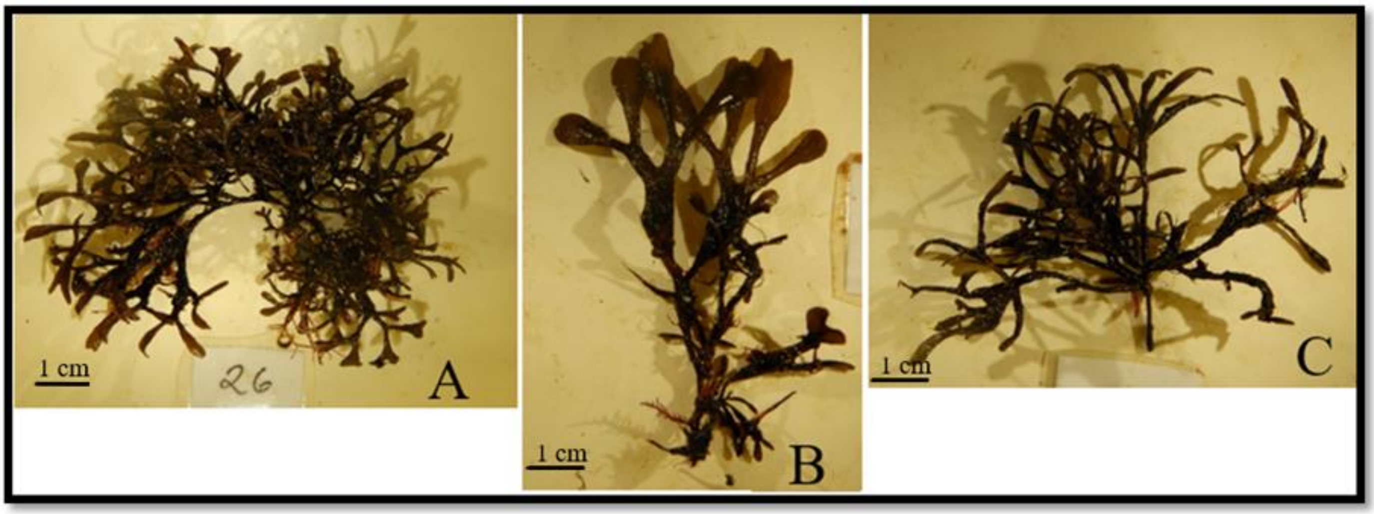

Figure 24. Three different (A-C) *Fucus* x individuals from the common garden experiment that was used for morphometric measurements that illustrates some of the observed within variation in over al morphology. Photo: Signe B. Svensson, 2018.

3.6 Length-weight relationship

The relationship between weight and length relationship for *Fucus* morphotypes can be seen in Figure 25-26. Data were collected from all individuals in the common garden experiment (appendix 2), not separating between treatments. *Fucus* x show a steeper increase in weight when length increases (Figure 25) compared to *F. serratus* (Figure 26). For *F. serratus* the relationship between length and weight is close to linear.

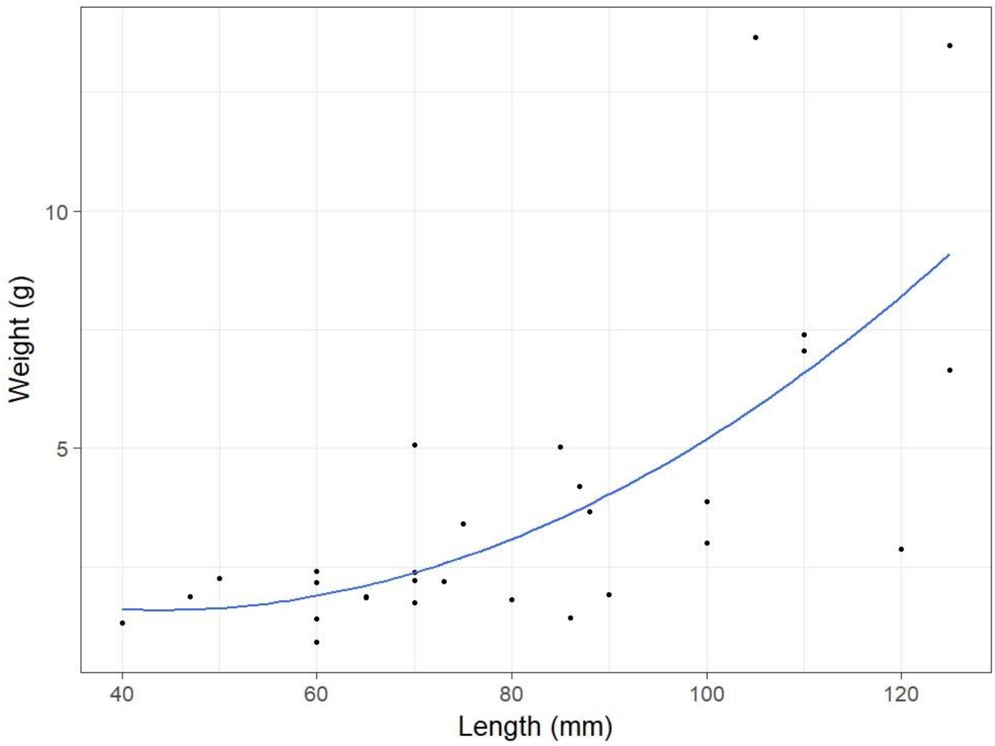

Figure 25. A linear model with a polynomial function to show the relationship between length (mm) and weight (g) for *Fucus* x individuals in the common garden experiment.

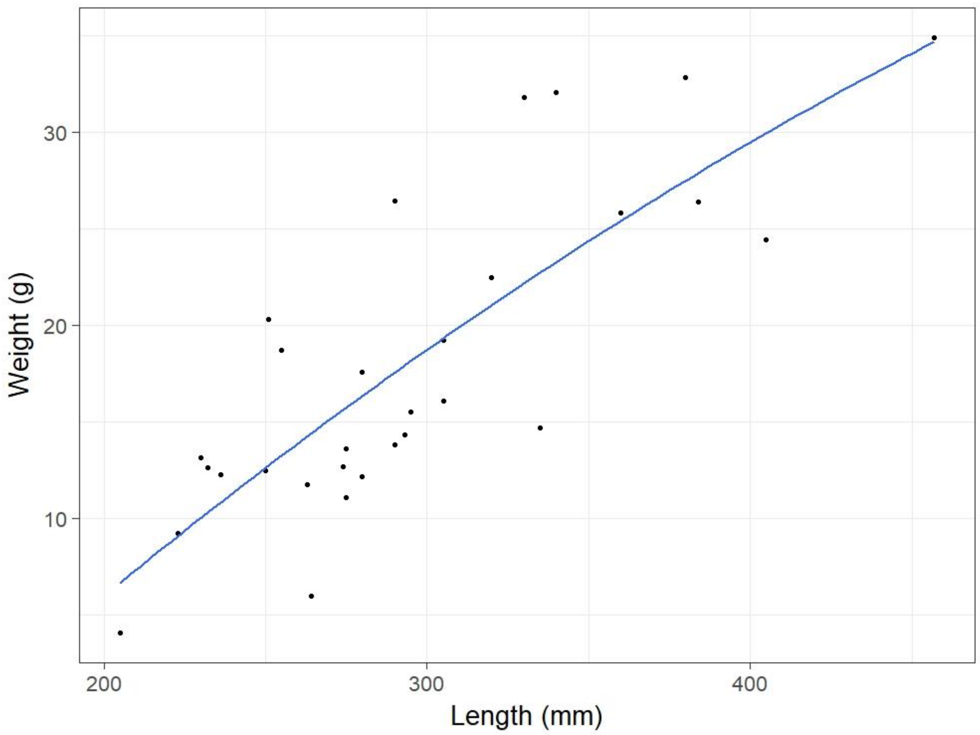

Figure 26. A linear model with a polynomial function to show the relationship between length (mm) and weight (g) for *F. serratus* individuals in the common garden experiment.

3.7 Shape and number of reproductive tips

Frome the stacked bar graph (Figure 27) it is clear that the most frequently observed and most abundant shape of reproductive tips is “nail-shaped”, followed by “leaf shaped”. Individuals often have a combination of several shape categories, two individuals show all four types of shapes. The least common shape is “club-shaped”. Number of reproductive tips per plant varies a great deal between individuals.

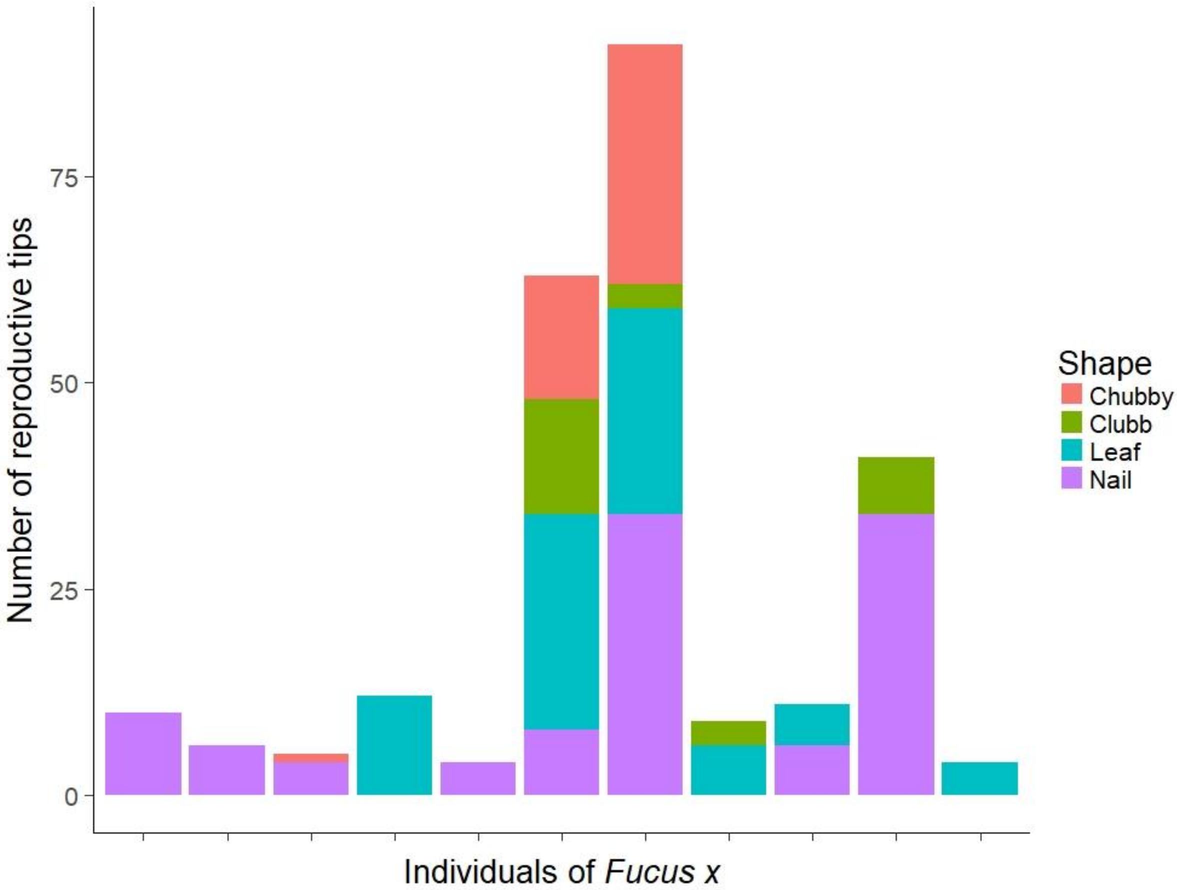

Figure 27. Stalked bar plot illustrate the total number of reproductive tips (y-axis) found for 11 individuals of *Fucus* x collected from the common garden experiment and taken from herbarium collection (x-axis). Each bar represents an individual. Height of each bar show the total number of reproductive tips counted and colours illustrate the proportion of the different shapes for reproductive tips according to categories given.

3.7.1 Inventory of total number of reproductive tips

Inventory conducted seven weeks in to the common garden experiment (25th of October) with all individuals in the common garden experiment showed that of 60 individuals 27 had reproductive tips (appendix 5). 18 of these were *Fucus* x individuals and nine were *F. serratus*. In table six *Fucus* x show a higher total number of branch tips and number of reproductive tips compared to *F. serratus*. *Fucus* x showe a large variation in number of branch tips compared to *F. serratus*.

Table 6. Number of vegetative and reproductive tips on fertile individuals at the time of inventory 25th of October in the common garden experiment

Morphotype	Mean total number of branch tips per individual	SD	Mean number of reproductive tips per individual	SD
Fucus serratus	54	21,6	4.7	3.4
Fucus x	103	104	15.8	13.0

3.8 Crossing of *Fucus serratus* and *Fucus* x

Crossing was conducted with in total 11 *Fucus* plants, five *F. serratus* and six *Fucus* x morphotypes. Results show that it is possible to produce germlings with reciprocal crossings between *F. serratus* and *Fucus* x in both poll and sea-water salinities.

The total amount of germlings estimated after two weeks show that the highest number of germlings is observed in poll-water for the combination of Fs x Fs and the reciprocal crossing with males of *Fucus* x and females of *F. serratus*, both of these categories show between 100-1000 germlings in week two (Figure 28), see appendix 4 for both weeks.
Lowest success is seen in poll-water where the reciprocal crossing between *F. serratus* males and females of *Fucus* x only was successful in one dish (out of three) with an estimated number in each of 10-100 and 0-10 germlings.
In sea-water salinity the reciprocal crossing between males of *Fucus* x and females of *F. serratus* show substantially lower counts of germlings compared to poll-water. Independent of water quality the lowest success is seen in the pure *Fucu*s x crossings, showing no more than 10-100 germlings and only producing germlings in four out of six dishes.

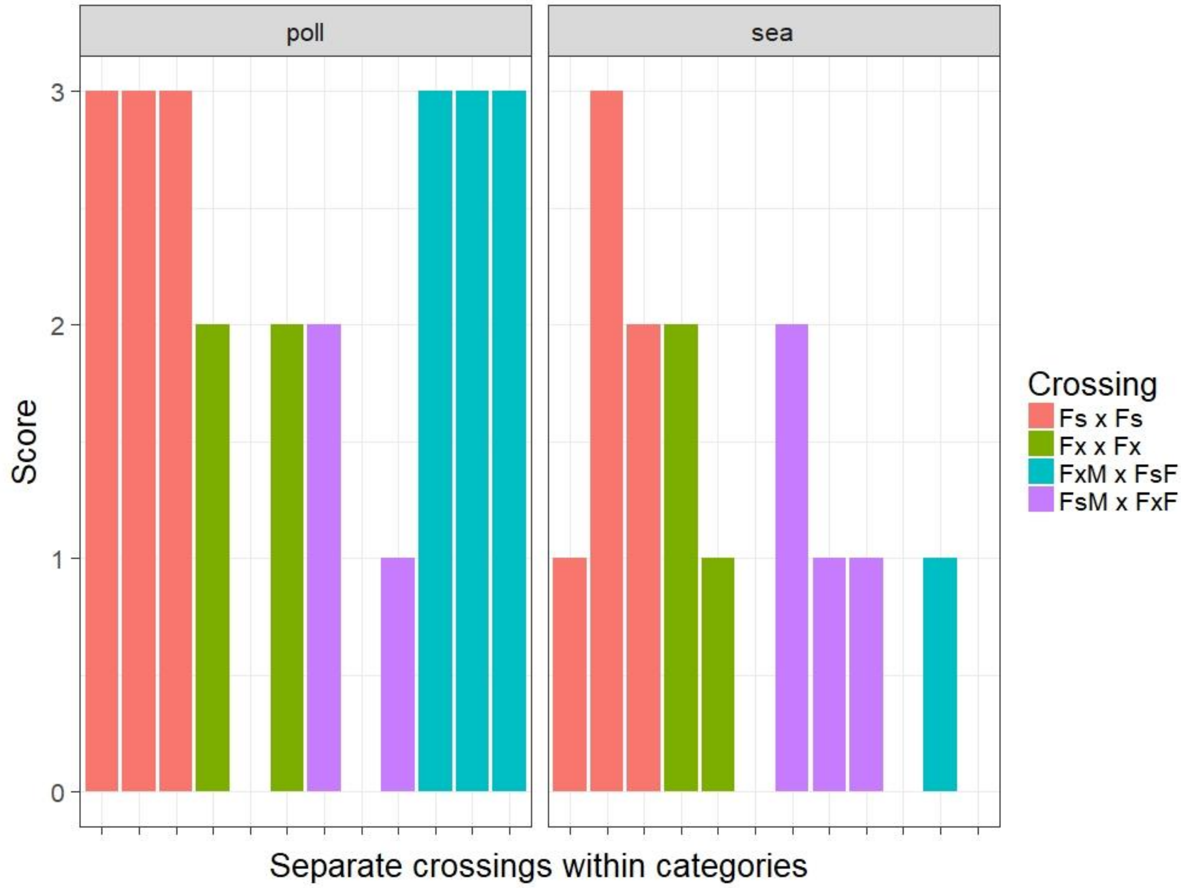

Figure 28. Total estimated amount of germlings in for each individual petri dish for both treatments the second week. Each category of crossing combination is assigned a unique colour and every bar represent an separate dish. Abbreviations: Fs x Fs = *F. serratus* crossing. Fx x Fx = *Fucus* x crossing. FxM x FsF = *Fucus* x male and *F. serratus* female. FsM x FxF= *F. serratus* male and *Fucus* x female. Score: 0=0, 1= 1-10, 2= 10-100, 3= 100-1000.

Summation of all four mm^2 squares for each crossing category show the change in number of germlings between weeks (Figure 28). This graph show the same trends as seen in Figure 29 for which categories being most successful in producing germlings. The highest number of germlings is seen in poll-water for the males of *Fucus* x and females of *F. serratus* (60 germlings). The decrease in in number of germlings between weeks is not substantially different between crosses of the same morphotype compared to the reciprocal crossings, suggesting that mortality is not higher in the reciprocal/hybrid-crossings.

In the crossing with *Fucus* x males and *F. serratus* females in sea-water show zero germlings. From laboratory notes one dish, containing sea water, in this crossing had a great deal of nematodes. Number of germlings in sea water for the Fx x Fx combination was also zero and when examined under a dissection microscope these dishes showed very few released gametes.

For two combinations, containing Fx individuals, week two show a higher number of germlings than week one (Figure 29). This is most likely to the fact that it took some time for some of the *Fucus* x germlings to become visible.

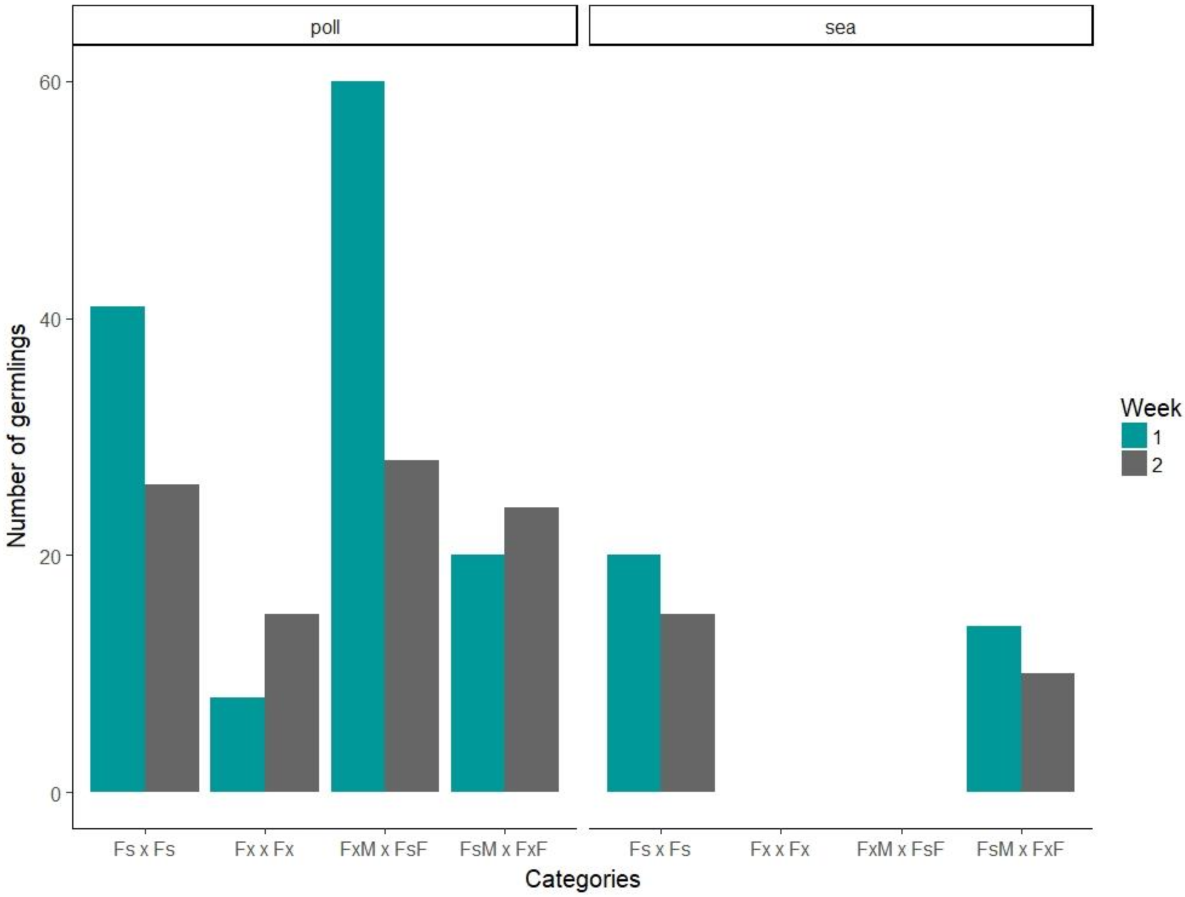

Figure 29. Summation of number of germlings counted on squares (12 mm^2 in total) for the four categories of crossings in each water salinity. First and second week of counting is illustrated to show the mortality within each crossing category, week one in green, week two in grey. Abbreviations: see fig 28.

3.9 Sequencing of mtIGS

In total 30 individuals, 15 *F. serratus* and 15 *Fucus* x individuals, were prepared for sequencing (appendix 6). From these 30 individuals 26 of them (15 *F. serratus* and 11 *Fucus* x) gave high quality PCR-products used for sequencing. Sequences for both *Fucus* morphotypes were blasted and resulted in almost exclusively 99 % match to *F. serratus.* For six individuals of *Fucus* x one type of mutation was found. All *F. serratus* had a C on this same position while the *Fucus* x morphotypes alternated between C or T. Five of the *Fucus* x individuals with an observed mutation were collected at site 1 (Haksteinpollen) and the remaining one was collected at site 2 (Holmen)(see sequences in appendix 7).

Discussion

4.1 Uncertainties of results

With regard to the first week off growth recordings in the common garden experiment, a camera whiteout a stand was used when photographing. This made it difficult to keep a consistent angle when taking photographs. Measurements for the first week are therefore not optimal but after analysing the same pictures several times and control-plotting of data had been done, the first week was included and not thought to disrupt the overall results.

In the common garden experiment there was some variation in temperature and salinity for poll treatment tanks. Alarm settings was used to monitor this and adjust values (see 2.4), temperatures were kept within these limits. This variation is not thought to disrupt the results since the inside of the poll is naturally more variable than the outside conditions, supported by temperature loggers at site 1. When analysing the differences in growth between treatments the variation around curves in figures 18-21 made it unsuitable to use these when concluding about differences in growth between treatments based on these intercepts, therfore the first and last day was analysed seperatly (table 2).

The bacterial infection on *F. serratus* individuals found in the common garden experiment could have been spread when individuals were moved between treatment-tanks, according to the rotations that were done each week. Since the same rotations also were done for *Fucus* x individuals this does not explain the difference in number of infected individuals between the two morphotypes. Also, these bacteria is not uncommon in the marine environment and it is likely that they entered the experiment through the running sea water.

For the morphological study a few modifications could be suggested. In the field individuals were mainly picked on the basis of their size, in order for them to be suitable in the common garden experiment. In order to link morphological characters to size, an allometric scaling could be useful to get a better understanding of how characters might vary with size.
During the analyses the character midrib could better have been defined to degree of visibility, since it was difficult to define it as simply present/not present. This could also have been done for the character serrated leaf edge, since earlier observations has found the tendency of serrated leafs in some individuals of *Fucus* x.
However, this study successfully points at differences in characteristics between morphotypes and also assign some characters to be more or less common for one or the other morphotype.

In the crossing experiment the low number of individuals participating made it difficult to say if results are true patterns or simply random outcomes. It is also likely that receptacles chosen from individuals differed with regard to stage of maturity, which would affect if and how many gametes that were released. In addition the receptacles are much smaller in *Fucus* x compared to *F. serratus*. This will probably cause a bias towards more eggs being released by *F. serratus* females, and therfore show a higher number of germlings in these crossings. Sperm is normally in surplus. Also, nematodes and other small animals (not identified) were observed in dishes which could have disrupted or killed germlings. Even so the data show that these morphotypes can hybridize in both water salinities representing inside and outside poll conditions.

4.2 The Common garden experiment

4.2.1 Evaluation of the experiment

Both *F. serratus* and *Fucus* x grew equally well in both treatments, and no significant differences in mean length and area between treatments were found at the end of the experiment for either morphotype. This is not in line with what was expected in the first hypothesis, where the expected result was to find lower growth as a sign of stress in a less optimal treatment representing either poll or sea habitat around Tjongspollen in Bømlo.

Fucus x and *F. serratus* did show some significant differences in progression of growth between treatments (Table 3). In sea treatment there is a tendency of better growth of *F. serratus* in sea treatment, even if not significant (Table 2), and that the progression of the growth curves get steeper over time. This was significant for length increase (p-value 0.0026). These trends can imply that differences in growth could have been found if the experiment had continued for a longer period of time.

For length increase in *Fucus* x the progression of growth shows a tendency to flatten out in poll treatment compared to sea treatment, this was not significant (p-value 0.18). In branch area the progression of growth was significantly different, with a slightly steeper curve in sea treatment (p-value= 0.00129).

However, there is no clear preference for either treatment supported by difference in the absolute growth at the end of the experiment (Table 2). Therefore I cannot conclude that they have a strong preference for a specific treatment. That being said, the tendency for *F. serratus* to do better in the sea treatment compared to poll conditions can indicate that salinity and temperature, or the fluctuations of these, can be stressful for *F. serratus*. Since no significant differences was found in growth increase in the end of the experiment (Table 2), this raise the suspicion that morphotypes are primarily restricted to their current distribution for other reasons than those salinity and temperature differences used in this common garden experiment.

First I will discuss if the treatment values used in the common garden experiment represent good simulations for the morphotypes in their natural habitats. Secondly, I will discuss to which degree these conditions can limit the growth to *F. serratus*.
Values for salinity and temperature used in this common garden experiment are considered to be representative for the inside poll and outside poll conditions, for late summer/early autumn.
The temperature loggers left at site 1 (inside poll) and 3 (outside poll) show that inside poll temperatures during most of September are around 16 °C (Figure 16). Site 1 show a much greater fluctuation in temperature compared to the outside conditions at site 3. There are no long time recordings of salinity in Tjongspollen, but it is reasonable to believe that salinity will fluctuate in a similar way, since this is found common in estuaries (Kirst 1990). From temperature loggers at site 3 we can see that sea treatment values did not simulate the natural conditions as well as poll treatment. However temperature can differ between years and therefore these can still be argued as being suitable estimates. For example, field measurements done in 1998 and 1999 by Erling Heggøy in September recorded temperatures and salinity at site 1 to be 16 °C and 27 ppm. Conditions on the outside were recorded to be 14 °C and 32 ppm (Heggøy 2001). Based on this the salinity and temperatures values in treatment tanks can be considered representative for early autumn/summer conditions.

A comparison of the growth of *F. serratus* in the laboratory and their natural habitat could be used to show how well the experiment simulated their natural conditions.
A field study was made by Armitage et al. (2017) with *F. serratus* growing in arranged assemblages in shallow waters in two subsequent summers, one unusually warm summer and the next had normal temperatures. Results showed that *F. serratus* length increase was independent of temperature and that *F. serratus* individuals grew around 5 cm from the middle of Mai to the beginning of August during both summers (Armitage et al., 2017). This would mean that *F. serratus* in that study had a mean increase around 0.6 mm per day. From the total length measurements in this study we see that *F. serratus* had an increase around 0.2 mm per day, based on mean lengths for branches in table 2.
This show that growth was relatively low for *F. serratus* in the common garden experiment. In the laboratory there was limited possibilities for adjusting light levels, this can be a possible explanation for the lower growth.

Optimum temperature for growth of *F. serratus* is around 15 °C (Lüning 1990). Both poll and sea treatment temperatures (12.5 °C, 17 °C) are relatively close to these temperatures. This can suggest that they grow equally well in both temperatures, and that temperature is not the primary cause of their restricted distribution inside Tjongspollen. However, inside Tjongspollen it is not unlikely that temperatures can get much higher, compared to the outside, during summer. *Fucus* x could therefore have a better tolerance to higher temperatures compared to *F. serratus.* Studies on thermal stress for *F. serratus* show that resilience strength to increasing temperatures are different between populations

(Jueterbock et al., 2014), indicating the possibility of local adaptation. In addition, *Fucus* x might be better at handling rapid fluctuations in both temperature and salinity compared to *F. serratus*. A study made in Hardangerfjorden (West coast of Norway) examined the distribution of several brown algae, including *F. serratus*, in relation to temperature and salinity changes between years. The results showed that distributions for the members of Fucales were more connected to gradients of salinity than to gradients in temperature (Sjøtun et al., 2015).

Further, Rothäusler et al., (2017) tested possible effects of estimated future conditions in salinity and temperature, as a consequence of climate change, on the susceptibility for *Fucus* species being grazed on. They found that *Fucus* individuals kept in "future conditions" (17.5 °C, 2.6 PSU) in long time exposure (7 months) got softer tissue compared to those in "current conditions" (15 °C, 5.2 PSU). This was independent of which population they were sampled from (Rothäusler et al., 2017). The temperature of the future conditions in this experiment are similar to our poll conditions, further indicating that the time to observe significant differences in growth between treatments might not have been sufficient.

In this study it was observed that individuals of *F. serratus* in the poll treatment in general became more flaccid (softer thallus) compared to the individuals occupying sea treatment (personal observation). This suggest that these individuals experienced stress, caused by high temperature, low salinity or the fluctuations in these during the experiment. Salinity stress is known to have an effect on both the growth rate in *F. serratus* (Knight 1950) and turgor pressure for macroalgae in general (Kirst 1990). Apart from observations of flaccid thalli in poll treatment, the slightly higher length increase in *F. serratus* and a steeper curve in the progression of growth in sea treatment (Figure 18), imply that they possibly have some preference for lower temperatures and higher salinities.
From results of the common garden experiment it cannot be concluded that salinity or temperature is the limiting factors for *F. serratus* distribution inside Tjongspollen or *Fucus* x not being found on the outside, but both parameters are likely to affect their growth in some degree.

4.2.2 Other possible explanations for distribution of morphotypes

Results from the common garden experiment did not show any obvious signs of local adaptations in *Fucus* x regarding temperature and salinity. So why is not *Fucus* x observed outside Tjongspollen? One explanation could be interspecific competition. The most obvious distinction between these morphotypes is the small size of *Fucus* x compared to *F. serratus*. This make it reasonable to believe that *F. serratus* would outcompete *Fucus* x by shading. An example of a similar case is found for the zonation pattern between *Pelvetia* and *Fucus* spp. Many *Fucus* species grow much faster than *Pelvetia* and can therefore outcompete the smaller *Pelvetia* plants by shading (Schonbeck and Norton 1980).

Contradicting to this thought is the fact that *Fucus* x can be found growing beneath the dense canopies of *Ascophyllum nodosum*, and in addition it is often found covered with a great amount of epiphytes. Collectively this would indicate that *Fucus* x would be shade tolerant, and thereby cope shading by *F. serratus* on the outside of its current distribution.

Another aspect that should be considered is grazing. Well known grazers on *Fucus* are *Littorina littorea* and *Idotea* spp. *Littorina littorea* is documented to play a role in the settlement of *Fucus* germlings and in high abundance they can actually eliminate *Fucus* from certain areas (Lubchenco 1983). *Idotea baltica* is also documented to be able to limit the distribution of *Fucus* plants (Engkvist et al., 2000). None of these grazers have been observed inside Tjongspollen (K. Sjøtun pers. com) but, they are often observed in the marine area on the outside. With this in mind a possible reason for not observing the small *Fucus* x on the outside of Tjongspollen could be a spatial escape from grazers.

4.3 Bacterial infection

Several *F. serratus* individuals during the common garden experiment got bacterial infections which dissolved plant tissue on parts of *F. serratus.* Six out of eight infected individuals were found in poll treatment tanks. Infections were observed not only on otherwise intact branches but also on stipes where the ID-tag was placed with a plastic strip. It is possible that this strip damaged the tissue making it an easy target for bacteria.

While marine bacteria are a natural part of the marine environment, they can sometimes be detrimental to algae (Egan et al., 2013). Sequencing results in this study revealed bacteria genera that are known to associate with marine macroalgae (Egan et al., 2013;Ivanova et al., 2002;Rao et al., 2007) and the genera *Pseudoalteromonas* and *Vibrio*, are known to cause the so called "hole-rotten disease" in *Laminaria japonica* (Wang et al., 2008).
The fact that *F. serratus* was more susceptible to infection in poll treatment, than in sea treatment, contribute to the suspicion in that they were stressed. Environmental stress, such as changes in temperature, can alter the chemical defence and lower the resistance against bacterial disease (Case et al., 2011).
A study made on *F. vesicolosus* showed that the peak in antifouling defence was in summer and autumn (Saha and Wahl 2013). Another study also found antifouling defence peaking from May-July for the brown algae, *Ascophyllum nodosum*, *Sargassum muticum* and *Ectocarpus siliculosus* (Hellio et al., 2004). Such seasonal variation can indicate that bacterial and antifouling defence are correlated with environmental factors such as light intensity and temperature.
When individuals of the two morphotypes were moved from their natural habitat to the laboratory they came from summer conditions. For those placed in poll treatment, they continued to experience late

summer conditions for more than two months. *Fucus serratus* collected on the outside would at this time in their natural environment experience a temperature close to 8 °C (Figure 17). If poll summer temperatures and salinities represent a more stressful situation for *F. serratus,* than this prolongation of summer conditions can have reduced their overall fitness.

The seemingly immune *Fucus* x could have adapted to cope with these bacteria or environmental conditions that may trigger bacterial infections, and therefore be more successful inside Tjongspollen. An adaptation to environmental conditions is not supported by the growth data but the main adaptation can be to other aspects than salinity and temperature. With regards to the suspected shade tolerance the carotenoid fucoxanthin has been shown to be interesting. This is a commonly found pigment in many brown algae (Terasaki et al., 2009). This pigment has been found to have antifouling effects of bacterial settlement on *Fucus* species (Saha et al., 2011). If *Fucus* x is shade tolerant it is not unlikely that they differ in their pigment composition. A study on several *Sargassum* species (Fucales) found that their fucoxanthin concentration had a peak in the shift between winter and spring, when light and temperature is at its lowest (Terasaki et al., 2009). This can indicate that *Fucus* x, as a consequence of being shade tolerant, is more resistant towards harmful bacteria. This common garden did not test the effect of light and how that may differ for the different morphotypes, therefore this is just speculations that should further be investigated before drawing any conclusions.

4.4 Morphometric measurements

Fucus serratus and *Fucus* x are distinctly different from each other in their morphology and some characters were more characteristic for *Fucus* x.

The most obvious distinction is the size difference for these morphotypes were *F. serratus* is much larger than *Fucus* x. All size related features (leaf width, stipe thickness, length and weight) clearly separate these two. Statistical testing of characters showed that they are significantly different from each other in all characters except for number of dichotomous splits along the longest branch (p-value = 0.45) (Figure 23, graph C). *Fucus serratus* length increase is larger than in *Fucus* x, so lower growth but equal splitting is most likely the reason for the bushier thalli in *Fucus* x. A bushier thalli can explain the relationship between length and weight for *Fucus* x (Figure 25).

The form of receptacles, or reproductive tips of *Fucus* x, was very different from the receptacle form of *F. serratus*. The shape of reproductive tips were in addition much more variable in *Fucus* x. Too few reproductive tips on *F. serratus* were left to properly analyse their shape but from observations of all *F. serratus* during the common garden, and crossing experiment, there were no variation in shape of their reproductive tips. If the variation of shape has a function or is simply a consequence of their overall variation in morphology is hard to say. Although not analysed in this study it is reasonable to believe that the most common reproductive tip shape "Neal" would be positively correlated with very narrow branches, which was the most common branch shape.

Other characters (midrib and serrated leaf edge) were not related to size. Very few *Fucus* x individuals showed a midrib appearing similar to *F. serratus*. Strictly speaking some, but not all, *Fucus* x showing no visible midrib were individuals only displaying a midrib but without the surrounding blade that make it appear as a midrib. Serrated leaf edge was not observed in any of these *Fucus* x individuals. This is interesting because earlier field observations in Tjongspollen has noted that there are morphological intermediates for these two morphotypes, were for example the tendency to serrated leaf edge has been observed.

The dwarf like morphology to *Fucus* x, in addition to more frequent adventitious branching, is difficult to explain but this miniaturization in thallus size has been found in other *Fucus* species, often when they grow in marginal habitats (Sideman and Mathieson 1983;Coyer et al., 2006c). Studies on several miniaturized *Fucus* showed that many forms harbour great variation in morphological characters (Mathieson et al., 2006) and that reciprocal transplants, lasting over period of years, can induce their morphology to change as a response to environmental factors (Mathieson et al., 2006). On the other hand, stable phenotypic morphotypes has also been found growing side by side with the common morphotype, as has been documented for *F. spiralis* (Scott et al., 2001) and the salt marsh form *F. cottoni* (Sjøtun et al., 2017).

In this common garden experiment I did not observe *Fucus* x to change morphology and become more like *F. serratus.* It can be that time to observe change was not sufficient, or that more than environmental factors are involved in deciding the morphology of *Fucu*s x. This could be genetic components that shape the morphology, as it appears to be for *F. spiralis* and *F. cottoni*.

When inventoring the number of reproductive tips on both morphotypes in the common garden experiment *Fucus* x individuals had a higher mean number of reproductive tips per individual than *F. serratus*. This suggest that *Fucus* x was more reproductive at this time, compared to *F. serratus*. This is interesting for at least two reasons. First, it could affect the vegetative growth recorded in the common garden experiment, if energy is instead allocated to gamete production, less energy will be available for vegetative growth (Bazzaz et al., 1987). This is however not very likely since the cost in production of gametes in *Fucus* has been found to be very low (Vernet and Harper 1980;Knight 1950). Secondly this difference can imply that these two morphotypes do not peak in reproduction at the same time, which could restrict hybridization.

4.5 Crossing of morphotypes

Successful crossings between morphotypes confirmed the hypothesis about the possibility for these morphotypes to form germlings in both water salinities representing inside poll (28 ppm) and outside poll (34 ppm) conditions.

The crossings between morphotypes clearly show that they can produce germling in both water qualities. The difference in success, higher number of germlings, is hard to interpret for several reasons. *Fucus serratus* females contain a much larger amount of eggs per receptacle and therefore egg concentration will be higher in all combinations containing *F. serratus* females. In order to do a proper crossing experiment and evaluate if there is some kind of symmetry in hybrid formation counting of eggs from each receptacle should be carried out, as described by Coyer et al (2002b). Also, in this experiment I did not have a proper control for the success in gamete release. Eggs could be observed with a dissection microscope but sperm were too small. As mentioned, this experiment had very few individuals and trends observed can be random outcomes. This being said there was a tendency of a higher number of germlings in the combination of *Fucus* x males and *F. serratus* females in poll water salinities (28 ppm) compared to sea water salinities (34 ppm). This could be a sign of non-symmetrical hybridization, influenced by salinity. Non-symmetrical hybridization has been found between *F. evanescens* and *F. serratus* (Coyer et al., 2002a). If this is the case for the two morphotypes this can lower the number of opportunities for these to hybridize in higher salinities than inside poll salinity conditions.

A study from the Baltic sea looked at the effect of salinity for the reproduction in *F. vesicolosus* and found that fertilization could be successful in very low salinities, indicating adaptation to brackish environments (Serrão et al., 1996;Serrao et al., 1999b). Comparing only the Fx x Fx crossings between water salinities, results do not clearly show that they do better in either of these salinities. Therefore it is not possible to tell if they show a clear sign of adaption to salinity. The overall lower count of germlings in Fx x Fx crossings is most likely due to the lower numbers of gametes produced by these, compared to *F. serratus*.

Fucus species has been found relatively easy to cross when forced in a laboratory environment (Kim et al., 1997;Coyer et al., 2002a). Even if *F. serratus* and *Fucus* x can produce germlings in the laboratory they may not necessary easily do so in their natural habitats.
In their habitats they may have restricted hybridization due to a restricted transport of gametes. *Fucus* species release their eggs under calm conditions and their negatively buoyant eggs sink close to the parental plant (Jaffe 1968). Further, the calm waters inside Tjongspollen would not aid in spreading gametes, or detached individuals, with the help of currents.
As mentioned, results from the inventory of reproductive tips showed a difference in number of

individuals being reproductive at this time (25th of October). *Fucus* x is observed to be most reproductive in October (which our results can strengthen). For *F. serratus* in southern Norway the time of gamete release is from October to February (Fredriksen 1985). There is a possibility for a skewness in reproduction peak between these two morphotypes that can act as an incomplete reproductive barrier, by not having synchronized gamete release (Monteiro et al., 2012). However, if these two morphotypes have a low frequency of hybridization in Tjongspollen this is most likely to geographical isolation.

4.6 Sequencing mtIGS

Sequences of mtIGS for *Fucus* x showed a 99 % match to *F. serratus*. This high degree of similarity between these two morphotypes strengthens the idea that *Fucus* x is closer related to *F. serratus* than to *F. distichus*.
In six out of eleven *Fucus* x individuals a mutation was found, where C was mutated to a T (see appendix 7 for sequence). The low genetic difference between *Fucus* x and *F. serratus* in these sequences were expected according to the fourth hypothesis.

From an extensive study, mapping mtIGS haplotypes from *F. serratus,* we can compare our sequences with earlier found haplotypes (Hoarau et al., 2007). The study in 2007 sampled 1539 individuals from 33 different locations, covering the entire range for *F. serratus*, and found 28 different mtIGS haplotypes. One haplotype (H1) was the most common one, found in 58 % of all individuals sampled. In Norway five different haplotypes has been found, two of these are found in the area around Bergen (Hoarau et al., 2007).
Results gained in this study show that the mtIGS sequences containing a mutation in *Fucus* x are unique among *F. serratus* haplotypes. Another very interesting discovery is that the sequences obtained from *F. serratus* individuals at the outside of Tjongspollen (site 3) are also different from haplotypes found in *F. serratus*, H1 (see appendix 7). Comparing sequences, between *F. serratus* and the common H1, show that a section at the end in *F. serratus* from site 3 were 5`-TTATTAT-`3 while in the common H1 haplotype this corresponds to 5`-AATTTTA-`3, this was found in all sequenced individuals.
Fucus x individuals, not showing any mutations, are equal to the *F. serratus* haplotype found at site 3. Based on results and the knowledge about that this mtIGS can be used to separate population (Coyer et al., 2006b) the following can be suggested. This haplotype for *F. serratus* is, to the best of our knowledge, unique for the population in this area. Further, *Fucus* x individuals are more similar to this sequence than they are to any other haplotype. This strengthen the idea that *Fucus* x has originated around Tjongspollen from this population of *F. serratus.* The fact that the mutation in the mtIGS for *Fucus* x is not found in all individuals sequenced *Fucus* x can suggest that the mutation happend quite

recently. The estimated arrival of *F. serratus* to southern Norway is 10-15 000 years ago (Hoarau et al., 2007) and therfore one can at least conclude that the mutation in *Fucus* x is less than 10-15 000 years old. Also, since we did not find this mutation in any of *F. serratus* they are most likely restricted in hybridization.

4.7 What is the status of this small morphotype?

Up to this point *Fucus* x has simply been called a morphotype. The categorization “morphotype” is vague and mainly describe it as a *Fucus* morphologically different from any other known *Fucus* species. After investigating several aspects of this morphotype it is relevant to re-evaluate its status. Based on what is known about *Fucus* x a few suggestions for its status can be discussed.

First, it could be that *Fucus* x is best defined as a morphologically different variant to *F. serratus*, without any special adaptations to the conditions in Tjongspollen. If the distinct morphology in *Fucus* x has developed as a response to the conditions inside of Tjongspollen, and the geographical distance between morphotypes are large enough to keep them relatively separated. Then their difference in morphology could possibly be maintained and selected for within the population. If populations at some point grow close enough for gametes to meet then the ability for these to hybridize can possibly maintain an incomplete reproductive barrier, diluting genetic differences. A similar case has been found for *F. distichus* in the arctic (Laughinghouse et al., 2015). Here populations, showing distinct morphologies, used to be categorized as several species. Thorough analysis, mapping haplotypes, found that these populations all belonged to the same species, *F. distichus,* and these had not developed reproductive barriers between each other. This is most likely a result of repeated contact and hybridization opportunities between glacial events (Laughinghouse et al., 2015).

Secondly, *Fucus* x could possibly be an ecotype. An ecotype is described as an species that can hybridize with other closely related ecospecies but, show special adaptions to its habitat and differ genetically from these (Turesson 1922). The common garden experiment did not support special physiological adaptions in *Fucus* x and the genetic differentiation in mtIGS, between morphotypes, was low. However, the degree of resistance to harmful bacteria and their distinct morphology should further be investigated to see if this can be some kind of adaption to the conditions inside Tjongspollen. Tolerance limits for salinity and temperature in regard to survival should also be investigated and compared to *F. serratus* to be able to conclude if this is the case.

Thirdly, *Fucus* x could be in the process of becoming a new species. In the aspect of morphology *Fucus* x is similar to the case described for the Baltic, *F. radians* (Bergström et al., 2005). The upgrading to species status of this morphotype, from *F. vesicolosus,* was based on both morphological and genetic differentiation, rising from sexual reproducing populations with indications of a reproductive barrier (Bergström et al., 2005). Another example of a morphotype gaining species status is *F. guiryi*, earlier described as a morphotype of *F. spiralis*. Investigation of *F. guiryi* did show gene flow with *F. spiralis* in sympatric populations. Even so, they still gained species status because they maintained unique genetic and morphological characters along a stress gradient, therefore acting as independent unit of *F. vesicolosus* (Zardi et al., 2011). Compared to these examples it is clear that additional information about the genetic differentiation between morphotypes is needed to evaluate how close they are of being separated as different species but their morphology is certainly distinct.

However, low genetic differentiation but high phenotypic divergence can be explained by an interesting theory called West-Eberhard's "plasticity-first" model (West-Eberhard 2005). The main idea in this model is that if a population have a high degree of plasticity they can quickly spread in to a new marginal habitat. Here phenotypic divergence, induced by abiotic factors, can separate these from the original population and first after this genetic divergence can follow. This is based on the fact that selection primary target the phenotype and not the underlying genotype (West-Eberhard 2005).
In 2007 De Queiroz argued that a unified species concept would be if we can define species as populations acting as units, evolving separately from each other (De Queiroz 2007). If further studies would find that *Fucus* x and *F. serratus* are not frequently hybridizing, then it can possibly be thought of as a separate species with a recent separation from *F. serratus*

4.8 Suggestions for further studies

The common garden experiment was simulating summer and autumn conditions. Temperature data over winter show that inside conditions had a lower minimum temperature (2.8 °C) than on the outside (4.8 °C). Also, in winter time it is not unusual for the poll to be covered by ice (Heggøy 2001). Adaptions to winter conditions has not been investigated in this study and there is a possibility that *Fucus* x could handle such conditions better than *F. serratus*. In order to assess the effect of different environmental conditions varying over the year and assess adaptions to light, reciprocal transplants are suggested.
For further morphometric studies a greater sample size would be appropriate to account for *Fucus* x great morphological variation and to asses possible intermediate to *F. serratus*.
Reproductive crossing experiments should include a larger number of individuals. Future crossing experiments should also quantify number of eggs used from each receptacle and morphotype. In addition, cultivation of hybrid-germlings would be interesting to assess hybrid fitness.
As a final suggestion the complete genome of *F. serratus* and *Fucus* x should be sequenced to fully understand their genetic make-up and how this is related to their phenotypic plasticity and evolutionary relationship.

4.9 Conclusion

In this study it is difficult to pin point the exact reasons for the separete distributions and success for the morphotypes *Fucus x* and *F. serratus*. Based on results here local adaptations inside and around Tjongspollen is most likely not primarily related to late summer early autumn conditions in salinity and temperature. However, based on differences in progression of growth it is likely that significant differences in growth between treatments would show if the experiment had been runed for a longer period of time.

Their difference in morphology is distinct and did not change when *Fucus* x were keept in marine conditions for 56 days. Indicating that more than abiotic factors determine their morphology.

These morphotypes are able to produce germlings in laboratory crosses. However, the frequency of hybridization in nature is most likely restricted due to some degree of geographical isolation and low gamete-dispersal distance. Also, these morphotypes show a possible sign off non-symmetric hybridization, caused by salinity. The mtIGS sequences show low genetic differentiation between morphotypes. Based on the unique haplotype found in *F. serratus*, *Fucus* x most likely originated around Tjongspollen. From knowledge gained in this study it is clear that more information is needed about tolerance limits and the genetic make-up for *Fucus* x to determine its species status. At this point it is safe to call *Fucus* x a morphotype of *F. serratus*. However, based on knowledge about the evolution in the genus *Fucus* and the West-Eberhard's "plasticity-first" theory it is not unlikely that *Fucus* x is in the process of becoming a separate species from *F. serratus*.

References

Armitage, CS, Husa, V, Petelenz-Kurdziel, EA & Sjøtun, K 2017, 'Growth and competition in a warmer ocean: A field experiment with a non-native and two native habitat-building seaweeds', *Marine Ecology Progress Series,* vol. pp. 573, 85-99.

Arrontes, J, 1993 , 'Nature of the distributional boundary of *Fucus serratus* on the north shore of Spain', *Marine Ecology-Progress Series,* vol. 93, pp. 183-183.

Barrón, C, Marbà, N, Duarte, CM, Pedersen, MF, Lindblad, C, Kersting, K, Moy, F & Bokn, T 2003, 'High organic carbon export precludes eutrophication responses in experimental rocky shore communities', *Ecosystems,* vol. 6, no. 2, pp. 0144-0153.

Bazzaz, FA, Chiariello, NR, Coley, PD & Pitelka, LF 1987, 'Allocating resources to reproduction and defense' *BioScience*, vol. 37, no.2, pp. 58-67.

Bergström, L, Tatarenkov, A, Johannesson, K, Jönsson, RB & Kautsky, L 2005, 'Genetic and morphological identification of *Fucus radicans* sp. Nov.(Fucales, Phaephyceae) in the brackish Baltic Sea 1', *Journal of Phycology,* vol. 41, no. 5, pp. 1025-1038.

Bertness, MD & Leonard, GH 1997, 'The role of positive interactions in communities: lessons from intertidal habitats', *Ecology,* vol.78, no. 7, pp. 1976-1989.

Billard, E, Daguin, C, Pearson, G, Serrão, E, Engel, C & Valero, M 2005, 'Genetic isolation between three closely related taxa: *Fucus vesiculosus, F. spiralis,* and *F. ceranoides* (Phaephycae) 1', *Journal of Phycology*, vol.41, no. 4, pp. 900-905.

Biovitenskap, UIO Institutt for Biovitenskap: Brunalger, 2011. Available from: <https://www.mn.uio.no/ibv/tjenester/kunnskap/plantefys/leksikon/b/brunalg.html>. [05-02-2019].

Bolwell, G, Callow, J, Callow, ME & Evans, L 1977, 'Cross-fertilisation in fucoid seaweeds', *Nature,* vol. 268, no. 5621, pp. 626-627.

Brawley, SH, Coyer, JA, Blakeslee, AM, Hoarau, G, Johnson, LE, Byers, JE, Stam, WT & Olsen, JL 2009, 'Historical invasions of the intertidal zone of Atlantic North America associated with distinctive patterns of trade and emigration', *Proceedings of the National Academy of Sciences,* vol.106, no. 20, 8239-8244.

Bäck, S 1993, 'Morphological variation of northern Baltic *Fucus vesiculosus* along the exposure gradient', *Annales Botanici Fennici*, vol. 30, no. 4, pp. 275-283.

Cairrao, E, Pereira, M, Morgado, F, Nogueira, A, Guilhermino, L & Soares, A 2009, 'Phenotypic variation of *Fucus ceranoides*, *F. spiralis* and *F. vesiculosus* in a temperate coast (NW Portugal)', *Botanical Studies*, vol. 50, no. 2, pp. 205-215.

Cánovas, FG, Mota, CF, Serrão, EA & Pearson, GA 2011, 'Driving south: a multi-gene phylogeny of the brown algal family Fucaceae reveals relationships and recent drivers of a marine radiation' *BMC evolutionary biology,* vol. 11, no.1 pp. 1-14.

Case, RJ, Longford, SR, Campbell, AH, Low, A, Tujula, N, Steinberg, PD & Kjelleberg, S 2011, 'Temperature induced bacterial virulence and bleaching disease in a chemically defended marine macroalga', *Environmental Microbiology,* vol. 13, no. 2, pp. 529-537.

Christie, H, Norderhaug, KM & Fredriksen, S 2009 'Macrophytes as habitat for fauna', *Marine ecology progress series,* vol. 396, pp. 221-233.

Connell, JH, 1972 'Community interactions on marine rocky intertidal shores', *Annual review of ecology and systematics,* vol. 3, no.1, pp. 169-192.

Coyer, J, Hoarau, G, Skage, M, Stam, W & Olsen, J 2006a, 'Origin of *Fucus serratus* (Heterokontophyta; Fucaceae) populations in Iceland and the Faroes: a microsatellite-based assessment', *European Journal of Phycology,* vol. 41, no. 2, pp. 235-246.

Coyer, J, Peters, A, Hoarau, G, Stam, W & Olsen, J 2002a, 'Hybridization of the marine seaweeds, *Fucus serratus* and *Fucus evanescens* (Heterokontophyta: Phaeophyceae) in a 100-year-old zone of secondary contact', *Proceedings of the Royal Society of London. Series B: Biological Sciences,* vol. 269, no.1502, pp. 1829-1834.

Coyer, J, Peters, A, Hoarau, G, Stam, W & Olsen, J 2002b, 'Inheritance patterns of ITS1, chloroplasts and mitochondria in artificial hybrids of the seaweeds *Fucus serratus* and *F. evanescens* (Phaeophyceae)', *European Journal of Phycology,* vol. 37, no. 2, pp. 173-178.

Coyer, J, Peters, A, Stam, W & Olsen, J 2003, 'Post-ice age recolonization and differentiation of *Fucus serratus* L.(Phaeophyceae; Fucaceae) populations in Northern Europe', *Molecular ecology,* vol. 12, no. 7, pp. 1817-1829.

Coyer, JA, Hoarau, G, Oudot-Le Secq, MP, Stam, WT & Olsen, JL 2006b, 'A mtDNA-based phylogeny of the brown algal genus *Fucus* (Heterokontophyta; Phaeophyta)', *Molecular phylogenetics and evolution,* vol. 39, no. 1, pp. 209-222.

Coyer, JA, Hoarau, G, Pearson, GA, Serrao, EA, Stam, WT & Olsen, JL 2006c, 'Convergent adaptation to a marginal habitat by homoploid hybrids and polyploid ecads in the seaweed genus *Fucus*', *Biology letters,* vol. 2, no. 3, pp. 405-408.

Coyer, JA, Hoarau, G, Sjøtun, K & Olsen, JL 2008, 'Being abundant is not enough: a decrease in effective population size over eight generations in a Norwegian population of the seaweed, *Fucus serratus*', *Biology Letters,* vol. 4, no. 6, pp. 755-757.

Craigie, JS 2011 'Seaweed extract stimuli in plant science and agriculture', *Journal of Applied Phycology,* vol. 23, pp. 371-393.

Cruzan, MB, & Arnold, ML 1993, 'Ecological and genetic associations in an Iris hybrid zone', *Evolution,* vol. 47, no. 5, pp. 1432-1445.

D`Avack, EAS 2015, *MarLIN - The Marine Life Information Network - Fucus serratus on moderately exposed lower eulittoral rock,* Available: <https://www.marlin.ac.uk/habitats/detail/103> [02-04-2019].

De Queiroz, K 2005, 'Ernst Mayr and the modern concept of species', *Proceedings of the National Academy of Sciences,* vol. 102**,** 6600-6607.

De Queiroz, K 2007, 'Species concepts and species delimitation', *Systematic biology,* vol. 56, no. 6, pp. 879-886.

De Villemereuil, P, Gaggiotti, OE, Mouterde, M & Till-Bottraud, I 2016, 'Common garden experiments in the genomic era: new perspectives and opportunities' *Heredity,* vol. 116, no. 3, pp. 249.

Egan, S, Harder, T, Burke, C, Steinberg, P, Kjelleberg, S & Thomas, T 2013, 'The seaweed holobiont: understanding seaweed–bacteria interactions', *FEMS Microbiology Reviews,* vol. 37, no. 3, pp. 462-476.

Engkvist, R, Malm, T & Tobiasson, S 2000, 'Density dependent grazing effects of the isopod *Idotea baltica* Pallas on *Fucus vesiculosus* L in the Baltic Sea', *Aquatic Ecology,* vol. 34, no. 3,pp. 253-260.

Fensholt, DE 1955, 'An emendation of the genus Cystophyllum (Fucales)' *American journal of botany,* vol. 42, no.3, pp. 305-322.

Fleurence, J, Gutbier, G, Mabeau, S & Leray, C 1994, 'Fatty acids from 11 marine macroalgae of the French Brittany coast', *Journal of Applied Phycology,* vol. 6, no. 6, pp. 527-532.

Fort, A, Guiry, MD & Sulpice, R 2018, 'Magnetic beads, a particularly effective novel method for extraction of NGS-ready DNA from macroalgae', *Algal research,* vol. 32, pp. 308-313.

Fredriksen, S 1985, *En fenologisk undersøkelse av utvalgte bentiske alger,* Cand.scient.thesis, University of Bergen.

Fredriksen, S, Christie, H & Andre Sæthre, B 2005, 'Species richness in macroalgae and macrofauna assemblages on Fucus serratus L.(Phaeophyceae) and Zostera marina L.(Angiospermae) in Skagerrak, Norway'. *Marine Biology Research,* no. 1, 1, pp. 2-19.

Guiry, MD n.d, *The Seaweed Site: information on marine algae.* Available from: <http://www.seaweed.ie/descriptions/fucus_serratus.php >.[04-18-2019].

Guiry, MD, G, GM 2019, *Algaebase: World wide electronic publication National University of Ireland, Galway*. Available from: < http://www.algaebase.org/pub_taxonomy/?id=4574>. [03-25-2019].

Heggøy, E 2001, *Algevegetasjonen i Tjongspollen, Bømlo, Hordaland,* Cand.scient.thesis, University of Bergen.

Hellio, C, Marechal, JP, Veron, B, Bremer, G, Clare, AS & Le Gal, Y 2004, 'Seasonal variation of antifouling activities of marine algae from the Brittany coast (France)', *Marine Biotechnology,* vol. 6, no.1, pp. 67-82.

Hoarau, G, Coyer, J, Veldsink, J, Stam, W & Olsen, J 2007, 'Glacial refugia and recolonization pathways in the brown seaweed *Fucus serratus*', *Molecular ecology,* vol. 16, no. 17, pp. 3606-3616.

Hodge, FJ, Buchanan, J & Zuccarello, GC 2010, 'Hybridization between the endemic brown algae *Carpophyllum maschalocarpum* and *Carpophyllum angustifolium* (Fucales): Genetic and morphological evidence', *Phycological research,* vol. 58, no. 4, pp. 239-247.

Hurd, CL 2000, 'Water motion, marine macroalgal physiology, and production', *Journal of Phycology,* vol. 36, no. 3, pp. 453-472.

Ivanova, E, Bakunina, IY, Sawabe, T, Hayashi, K, Alexeeva, Y, Zhukova, N, Nicolau, D, Zvaygintseva, T & Mikhailov, V 2002, 'Two species of culturable bacteria associated with degradation of brown algae *Fucus evanescens*', *Microbial ecology,* vol. 43, no.2, pp. 242-249.

Jaffe, LF 1968, 'Advances in morphogenesis' in *Localization in the developing* Fucus *egg and the general role of localizing currents*', eds M Abercrombie, J Brachet & TJ, King, Academic press, New york , pp. 295-328.

Janson, K & Sundberg, P 1983 'Multivariate morphometric analysis of two varieties of Littorina saxatilis from the Swedish west coast', *Marine Biology,* vol. 74, no. 1, pp. 49-53.

Johannesson, K, Johansson, D, Larsson, KH, Huenchuñir, CJ, Perus, J, Forslund, H, Kautsky, L & Pereyra, RT 2011, 'Frequent clonality in fucoids (*Fucus radicans* and *Fucus vesiculosus*; fucales, phaeophyceae) in the baltic sea1, *Journal of Phycology,* vol.47, no. 5, pp. 990-998.

Jueterbock, A, Kollias, S, Smolina, I, Fernandes, JM, Coyer, JA, Olsen, JL & Hoarau, G 2014, 'Thermal stress resistance of the brown alga *Fucus serratus* along the North-Atlantic coast: acclimatization potential to climate change', *Marine Genomics,* vol. 13, pp. 27-36.

Kautsky, L & Kautsky, N 2000, 'The baltic sea, including bothnian sea and bothnian bay' *Seas at the millennium: an environmental evaluation,* vol. 41, pp. 1-14.

Keats, D, Steele, D & South, G 1987, 'The role of fleshy macroalgae in the ecology of juvenile cod (*Gadus morhua* L.) in inshore waters off eastern Newfoundland, *Canadian Journal of Zoology,* vol. 65, no. 1, pp. 49-53.

Kim, KY, O'leary, SJ & Garbary, DJ 1997, 'Artificial hybridization between *Ascophyllum nodosum* and *Fucus vesiculosus* (Phaeophyceae) from Nova Scotia, Canada', *Canadian journal of botany,* vol. 75**,** no. 7, pp. 1133-1136.

Kirst, G 1990, 'Salinity tolerance of eukaryotic marine algae', *Annual review of plant biology,* vol. 41, no. 1, pp. 21-53.

Knight, M, Parke, M 1950, 'A biological study of *Fucus vesicolosus* and *Fucus serratus', The journal of the Marine Biological Association of the United Kingdom,* vol. 29, no. 2. pp. 439-470.

Kucera, H & Saunders, GW 2008 'Assigning morphological variants of *Fucus* (Fucales, Phaeophyceae) in Canadian waters to recognized species using DNA barcoding', *Botany,* vol. 86, no. 9, pp. 1065-1079.

Laughinghouse IV, HD, Müller, KM, Adey, WH, Lara, Y, Young, R & Johnson, G 2015, 'Evolution of the northern rockweed, *Fucus distichus*, in a regime of glacial cycling: implications for benthic algal phylogenetics' *PloS one*, vol. 10, no. 12, pp. 1-17.

Lawson, S, Mcglathery, K & Wiberg, P 2012, 'Enhancement of sediment suspension and nutrient flux by benthic macrophytes at low biomass', *Marine Ecology Progress Series,* vol. 448, pp. 259-270.

Leclerc, MC, Barriel, V, Lecointre, G & De Reviers, B 1998 'Low Divergence in rDNA ITS Sequences Among Five Species of *Fucus* (Phaeophyceae) Suggests a Very Recent Radiation', *Journal of Molecular Evolution*, vol. 46, no. 1, pp. 115-120.

Leitch, A & Leitch, I 2008, 'Genomic plasticity and the diversity of polyploid plants', *Science,* vol. 320, no. 5875, 481-483.

Linnaeus, CV 1753, Species Plantarum, Stockholm.

Lubchenco, J 1980, 'Algal zonation in the New England rocky intertidal community: an experimental analysis', *Ecology,* vol. 61, no. 2, pp. 333-344.

Lubchenco, J 1983, 'Littornia and *Fucus*: Effects of Herbivores, Substratum Heterogeneity, and Plant Escapes During Succession', *Ecology*, vol. 64, no. 5, pp. 1116-1123.

Lüning, K 1990, *Seaweeds: their environment, biogeography, and ecophysiology*, John Wiley & Sons, Hamburg.

Machery-Nagel 2017, *NucleoMag SEP Magnetic separator user manual*. Available: < https://www.takarabio.com/assets/documents/User%20Manual/NucleoMag%20SEP%20Magnetic%20Separator%20User%20Manual_Rev_03.pdf > [10-01-2019].

Maier, I & Muller, D 1986, 'Sexual pheromones in algae', *The Biological Bulletin*, vol. 170, no. 2, pp. 150-175.

Mallet, J 1995, 'A species definition for the modern synthesis', *Trends in Ecology & Evolution*, vol. 10, no. 7, pp. 294-299.

Malm, T, Kautsky, L & Engkvist, R 2001, 'Reproduction, recruitment and geographical distribution of *Fucus serratus* L. in the Baltic Sea', *Botanica Marina*, vol. 44, no. 2, pp. 101-108.

Mathieson, AC, Dawes, CJ, Wallace, AL & Klein, AS 2006, 'Distribution, morphology, and genetic affinities of dwarf embedded *Fucus* populations from the Northwest Atlantic Ocean', *Botanica Marina*, vol. 49, no. 4, pp. 283-303.

Menge, BA 1976, 'Organization of the New England rocky intertidal community: role of predation, competition, and environmental heterogeneity', *Ecological Monographs*, vol. 46, no. 4, pp. 355-393.

Middelboe, A & Binzer, T 2004, 'Importance of canopy structure on photosynthesis in single-and multi-species assemblages of marine macroalgae' *Oikos*, vol. 107, no. 2, pp. 422-432.

Moliac, Y, Arnaud-Haond, S, Perrin, C, Pearson GA, Serrao, EA 2011, 'Traveling in time with networks:Revealing present day hybridization versus ancestral polymorphism between two spcies of brown algae, Fucus vesicolosus and F. spiralis', *BMC evolutionary biology*, vol. 11, no. 1, pp. 1-13.

Monteiro, CA, Serrão, EA & Pearson, GA 2012, 'Prezygotic barriers to hybridization in marine broadcast spawners: reproductive timing and mating system variation', *PLoS One*, vol. 7, no. 4, pp. 1-11.

Murray, SN, Ambrose, R & Dethier, MN 2006, *Monitoring rocky shores*, Univ of California Press, California.

Neiva, J, Hansen, GI, Pearson, GA, Vliet, MS, VD, Maggs, CA & Serrão, EA 2012a, '*Fucus cottonii* (Fucales, Phaeophyceae) is not a single genetic entity but a convergent salt-marsh morphotype with multiple independent origins', *European journal of phycology*, vol. 47, no. 4, pp. 461-468.

Neiva, J, Pearson, GA, Valero, M & Serrao, EA 2012b, 'Drifting fronds and drifting alleles: range dynamics, local dispersal and habitat isolation shape the population structure of the estuarine seaweed *Fucus ceranoides*', *Journal of Biogeography*, vol. 39, no. 6, pp. 1167-1178.

Nøland, H 2015, *Fucus serratus* and *Fucus* x, Can.science project, University of Bergen.

Rai, LC & Gaur, JP 2012, 'Algal adaptation to environmental stresses: physiological, biochemical and molecular mechanisms', Springer Science & Business Media.

Ramus, J, Lemons, F & Zimmerman, C 1977, 'Adaptation of light-harvesting pigments to downwelling light and the consequent photosynthetic performance of the eulittoral rockweeds *Ascophyllum nodosum* and *Fucus vesiculosus*', *Marine Biology*, vol. 42, no. 4, pp. 293-303.

Rao, D, Webb, JS, Holmström, C, Case, R, Low, A, Steinberg, P & Kjelleberg, S 2007, 'Low densities of epiphytic bacteria from the marine alga *Ulva australis* inhibit settlement of fouling organisms', *Appl. Environ. Microbiol*, vol. 73, no. 24, pp. 7844-7852.

Rees, TK, 1932, 'A note on the longevity of certain species of the Fucaceae', *Annals of Botany*, vol. 46, no. 184, pp. 1062-1064.

Reusch, TB 2014, 'Climate change in the oceans: evolutionary versus phenotypically plastic responses of marine animals and plants', *Evolutionary applications*, vol. 7, no. 1, pp. 104-122.

Rice, WR 1987, 'Speciation via habitat specialization: the evolution of reproductive isolation as a correlated character', *Evolutionary Ecology*, vol. 1, no. 4, pp. 301-314.

Rice, WR & Salt, GW 1988, 'Speciation via disruptive selection on habitat preference: experimental evidence', *The American Naturalist*, vol. 131, no. 6, pp. 911-917.

Rieseberg, LH & Willis, JH 2007, 'Plant speciation', *science*, vol. 317, no. 5840, pp. 910-914.

Roman, J & Hirschmann, H 1969, 'Morphology and morphometrics of six species of Pratylenchus' *Journal of Nematology,* vol. 1, no. 4, pp. 363-386.
Rothäusler, E, Haavisto, F & Jormalainen, V 2017, 'Is the future as tasty as the present? Elevated temperature and hyposalinity affect the quality of *Fucus* (Phaeophyceae, Fucales) as food for the isopod *Idotea balthica*, *Marine Biology*, vol. 164, no. 11, pp. 1-15.
RStudioTeam 2016, RStudio: Integrated Development for R. RStudio, Inc, Boston, MA. Available from: < http://www.rstudio.com/ >[31-05-2019]
Saha, M, Rempt, M, Grosser, K, Pohnert, G & Weinberger, F 2011, 'Surface-associated fucoxanthin mediates settlement of bacterial epiphytes on the rockweed *Fucus vesiculosus*', *Biofouling,* vol. 27, no. 4, pp. 423-433.
Saha, M. & Wahl, M 2013, 'Seasonal variation in the antifouling defence of the temperate brown alga *Fucus vesiculosus*', *Biofouling,* vol. 29, no. 6, pp. 661-668.
Schiel, DR & Foster, MS 2006, 'The population biology of large brown seaweeds: ecological consequences of multiphase life histories in dynamic coastal environments', *Annu. Rev. Ecol. Evol. Syst.*, vol 37, pp. 343-372.
Schindelin, J, Arganda-Carreras, I, Frise, E, Kaynig, V, Longair, M, Pietzsch, T, Preibisch, S, Rueden, C, Saalfeld, S & Schmid, B 2012, 'Fiji: an open-source platform for biological-image analysis', *Nature methods,* vol. 9, no. 7, p. 676.
Schonbeck, M. & Norton, TA 1978,'Factors controlling the upper limits of fucoid algae on the shore' *Journal of Experimental Marine Biology and Ecology,* vol. 31, no. 3, pp. 303-313.
Schonbeck, MW & Norton, TA 1980, 'Factors controlling the lower limits of fucoid algae on the shore', *Journal of Experimental Marine Biology and Ecology,* vol. 43, no. 2, pp. 131-150.
Schultze, K, Janke, K, Krüß, A & Weidemann, W 1990, 'The macrofauna and macroflora associated with *Laminaria digitata* and *L. hyperborea* at the island of Helgoland (German Bight, North Sea)', *Helgoländer Meeresuntersuchungen,* vol. 44, no. 1, pp. 39-51.
Scott, GW, Hull, SL, Hornby, SE, Hardy, FG & Owens, NJ 2001, 'Phenotypic variation in *Fucus spiralis* (Phaeophyceae): morphology, chemical phenotype and their relationship to the environment', *European Journal of Phycology,* vol. 36, no. 1, pp. 43-50.
Serrão, EA, Alice, LA & Brawley, SH 1999a, 'Evolution of the Fucaceae (Phaeophyceae) inferred from nrDNA-ITS', *Journal of phycology,* vol. 35, no. 2, pp. 382-394.
Serrão, EA, Brawley, SH, Hedman, J, Kautsky, L & Samuelsson, G 1999b, 'Reproductive success of *Fucus vesiculosus* (Phaeophyceae) in the Baltic Sea', *Journal of Phycology,* vol. 35, no. 2, 254-269.
Serrão, EA, Kautsky, L & Brawley, SH, 1996, 'Distributional success of the marine seaweed *Fucus vesiculosus* L. in the brackish Baltic Sea correlates with osmotic capabilities of Baltic gametes', *Oecologia,* vol. 107, no. 1, pp. 1-12.
Setiawan, AN, Darby, JT & Lambert, DM 2004, 'The use of morphometric measurements to sex yellow-eyed penguins', *Waterbirds,* vol. 27, no. 1, pp. 96-102.
Sideman, EJ & Mathieson, AC 1983, 'Ecological and genecological distinctions of a high intertidal dwarf form of *Fucus distichus* (L.) Powell in New England', *Journal of experimental marine biology and ecology,* vol. 72, no. 2, pp. 171-188.
Sjøtun, K, Heesch, S, Rull Lluch, J, Martín Martín, R, Gómez Garreta, A, Brysting, AK & Coyer, JA 2017, 'Unravelling the complexity of salt marsh '*Fucus cottonii*'forms (Phaeophyceae, Fucales)', *European journal of phycology,* vol. 52, no. 3, pp. 360-370.
Sjøtun, K, Husa, V, Asplin, L & Sandvik, AD 2015, 'Climatic and environmental factors influencing occurrence and distribution of macroalgae a fjord gradient revisited', *Marine Ecology progress series,* vol. 532, pp. 73-88.
Stephenson, T & Stephenson, A 1949 'The universal features of zonation between tide-marks on rocky coasts', *The Journal of Ecology*, vol. 37, no. 2, pp. 289-305.
Terasaki, M, Hirose, A, Narayan, B, Baba, Y, Kawagoe, C, Yasui, H, Saga, N, Hosokawa, M & Miyashita, K 2009, 'Evaluation of recoverable functional lipid components of several brown seaweeds (Phaeophyta) from Japan with speciel reference to fucoxanthin and fucosterol contents 1', *Journal of phycology,* vol. 45, no. 4, pp. 974-980.

Thompson, R, Wilson, B, Tobin, M, Hill, A & Hawkins, S 1996, 'Biologically generated habitat provision and diversity of rocky shore organisms at a hierarchy of spatial scales', *Journal of Experimental Marine Biology and Ecology*, vol. 202, no.1, pp. 73-84.

Turesson, G 1922, 'The species and the variety as ecological units', *Hereditas,* vol. 3, no.1, pp. 100-113.

Ugarte, RA, Craigie, JS & Critchley, AT 2010, Seaweeds and their role in globally changing environments, Springer, Dordrecht.

Valiela, I 2015, *Marine ecological processes,* 3th edn, Springer Science & Business Media, New york.

Wang, G, Shuai, L, Li, Y, Lin, W, Zhao, X & Duan, D 2008, 'Phylogenetic analysis of epiphytic marine bacteria on Hole-Rotten diseased sporophytes of *Laminaria japonica*', *Journal of applied phycology,* vol. 20, no. pp. 403-409.

Vernet, P & Harper, J 1980, 'The costs of sex in seaweeds', *Biological Journal of the Linnean Society*, vol. 13, no. 2, pp. 129-138.

West-Eberhard, MJ 2005, 'Developmental plasticity and the origin of species differences', *Proceedings of the National Academy of Sciences,* vol. 102, no.1 , pp. 6543-6549.

Wickham, H 2009, *ggplot2: elegant graphics for data analysis*, Springer, New york.

Wood, TE, Takebayashi, N, Barker, MS, Mayrose, I, Greenspoon, P. B. & Rieseberg, LH 2009, 'The frequency of polyploid speciation in vascular plants', *Proceedings of the national Academy of sciences,* vol. 106, no. 33, pp. 13875-13879.

Zardi, GI, Nicastro, KR, Canovas, F, Costa, JF, Serrão, EA & Pearson, GA 2011, 'Adaptive traits are maintained on steep selective gradients despite gene flow and hybridization in the intertidal zone', *PloS one*, vol. 6, no. 6, pp. 1-13.

Appendix 1

Common garden experiment: All branch tips and area measured over 9 weeks.

Date	ID	Tank	Branch	Type	Treatment	Site	Length(mm)	Area(mm^2)
2018-09-10 00:00	2	4	B2	serr	poll	outlet	17,04	401,9
2018-09-10 12:00	2	4	B1	serr	poll	outlet	21,061	403,9
2018-09-10 12:00	4	3	B2	serr	sea	outlet	19,739	459,3
2018-09-10 12:00	4	3	B1	serr	sea	outlet	21,525	455,3
2018-09-10 12:00	7	4	B1	morph	poll	Holmen	6,894	35,7
2018-09-10 12:00	7	4	B2	morph	poll	Holmen	9,608	50,8
2018-09-10 12:00	8	1	B2	morph	poll	Hakkstein	5,982	25,9
2018-09-10 12:00	8	1	B1	morph	poll	Hakkstein	8,47	33,5
2018-09-10 12:00	10	4	B2	morph	poll	Hakkstein	4,499	18,6
2018-09-10 12:00	10	4	B1	morph	poll	Hakkstein	10,349	33
2018-09-10 12:00	11	3	B1	serr	sea	outlet	25,485	559,5
2018-09-10 12:00	11	3	B2	serr	sea	outlet	28,727	638,9
2018-09-10 12:00	12	2	B1	serr	sea	outlet	14,803	363,7
2018-09-10 12:00	12	2	B2	serr	sea	outlet	21,531	638
2018-09-10 12:00	14	1	B2	serr	poll	outlet	20,824	457,1
2018-09-10 12:00	14	1	B1	serr	poll	outlet	21,482	480,2
2018-09-10 12:00	15	5	B1	serr	sea	outlet	21,956	460,2
2018-09-10 12:00	15	5	B2	serr	sea	outlet	38,761	959,2
2018-09-10 12:00	16	5	B2	serr	sea	outlet	24,716	620,3
2018-09-10 12:00	16	5	B1	serr	sea	outlet	27,184	664,7
2018-09-10 12:00	17	2	B2	serr	sea	outlet	12,349	297,8
2018-09-10 12:00	17	2	B1	serr	sea	outlet	34,146	878,9
2018-09-10 12:00	18	6	B1	morph	poll	Holmen	8,02	18,7
2018-09-10 12:00	18	6	B2	morph	poll	Holmen	8,059	30,5
2018-09-10 12:00	19	6	B2	serr	poll	outlet	17,982	388,6
2018-09-10 12:00	19	6	B1	serr	poll	outlet	40,466	1 166,8
2018-09-10 12:00	21	3	B1	morph	sea	Holmen	4,811	10,6
2018-09-10 12:00	21	3	B2	morph	sea	Holmen	4,943	10,5
2018-09-10 12:00	22	2	B1	morph	sea	Holmen	2,885	11,1
2018-09-10 12:00	22	2	B2	morph	sea	Holmen	4,324	11
2018-09-10 12:00	23	2	B1	serr	sea	outlet	14,203	319,2
2018-09-10 12:00	23	2	B2	serr	sea	outlet	15,043	315,4
2018-09-10 12:00	24	1	B2	serr	poll	outlet	9,743	173,8
2018-09-10 12:00	24	1	B1	serr	poll	outlet	20,518	416,5
2018-09-10 12:00	25	6	B2	serr	poll	outlet	18,13	408,7
2018-09-10 12:00	25	6	B1	serr	poll	outlet	32,829	729,4
2018-09-10 12:00	26	1	B2	morph	poll	Hakkstein	4,941	12,8
2018-09-10 12:00	26	1	B1	morph	poll	Hakkstein	5,541	13,4
2018-09-10 12:00	27	3	B2	serr	sea	outlet	8,838	155,3
2018-09-10 12:00	27	3	B1	serr	sea	outlet	17,119	391,2
2018-09-10 12:00	28	5	B2	serr	sea	outlet	19,328	395
2018-09-10 12:00	28	5	B1	serr	sea	outlet	24,517	508,4
2018-09-10 12:00	29	5	B2	morph	sea	Hakkstein	5,796	33,1
2018-09-10 12:00	29	5	B1	morph	sea	Hakkstein	7,355	25,2
2018-09-10 12:00	31	5	B2	morph	sea	Holmen	5,296	20,3
2018-09-10 12:00	36	1	B2	morph	poll	NA	5,296	20,3
2018-09-10 12:00	31	5	B1	morph	sea	Holmen	9,58	30,4
2018-09-10 12:00	36	1	B1	morph	poll	NA	9,58	30,4
2018-09-10 12:00	32	5	B1	serr	sea	outlet	24,048	670,6
2018-09-10 12:00	32	5	B2	serr	sea	outlet	38,855	1 084,2
2018-09-10 12:00	33	2	B1	morph	sea	Hakkstein	3,239	15,7
2018-09-10 12:00	33	2	B2	morph	sea	Hakkstein	3,626	11,7
2018-09-10 12:00	34	2	B1	morph	sea	Holmen	4,841	16,429
2018-09-10 12:00	34	2	B2	morph	sea	Holmen	6,459	23,2
2018-09-10 12:00	38	3	B2	morph	sea	Hakkstein	2,603	10,8
2018-09-10 12:00	38	3	B1	morph	sea	Hakkstein	9,02	24,6
2018-09-10 12:00	40	5	B2	morph	sea	Holmen	7,323	21,5
2018-09-10 12:00	40	5	B1	morph	sea	Holmen	9,073	28,5
2018-09-10 12:00	41	4	B1	serr	poll	outlet	27,99	630
2018-09-10 12:00	41	4	B2	serr	poll	outlet	32,61	737,3
2018-09-10 12:00	42	5	B2	morph	sea	Hakkstein	6,853	20,7
2018-09-10 12:00	42	5	B1	morph	sea	Hakkstein	7,396	20,789
2018-09-10 12:00	43	4	B2	serr	poll	outlet	20,165	536,1
2018-09-10 12:00	43	4	B1	serr	poll	outlet	21,931	499,9
2018-09-10 12:00	46	4	B2	morph	poll	Hakkstein	4,841	13,8
2018-09-10 12:00	46	4	B1	morph	poll	Hakkstein	6,084	16,7
2018-09-10 12:00	49	4	B1	morph	poll	Hakkstein	5,149	22
2018-09-10 12:00	49	4	B2	morph	poll	Hakkstein	8,675	59,3

2018-09-10 12:00	50	6	B2	morph	poll	Hakkstein	4,672	15
2018-09-10 12:00	50	6	B1	morph	poll	Hakkstein	10,572	43
2018-09-10 12:00	52	3	B2	serr	sea	outlet	10,086	186,3
2018-09-10 12:00	52	3	B1	serr	sea	outlet	30,332	877,3
2018-09-10 12:00	54	6	B1	serr	poll	outlet	12,045	238,7
2018-09-10 12:00	54	6	B2	serr	poll	outlet	16,639	376,3
2018-09-10 12:00	59	4	B1	serr	poll	outlet	6,138	85,8
2018-09-10 12:00	59	4	B2	serr	poll	outlet	19,662	575,2
2018-09-10 12:00	60	1	B1	serr	poll	outlet	34,093	1 173,7
2018-09-10 12:00	60	1	B2	serr	poll	outlet	45,088	1 493,9
2018-09-10 12:00	64	6	B1	morph	poll	Hakkstein	4,305	14,1
2018-09-10 12:00	64	6	B2	morph	poll	Hakkstein	5,963	29,6
2018-09-10 12:00	65	3	B2	morph	sea	Hakkstein	5,712	24,9
2018-09-10 12:00	65	3	B1	morph	sea	Hakkstein	11,202	74,9
2018-09-10 12:00	66	6	B1	morph	poll	Hakkstein	4,558	11,3
2018-09-10 12:00	66	6	B2	morph	poll	Hakkstein	5,307	17,5
2018-09-10 12:00	69	1	B2	morph	poll	NA	4,537	17,5
2018-09-10 12:00	69	1	B1	morph	poll	NA	7,792	21,8
2018-09-10 12:00	70	2	B2	serr	sea	outlet	15,516	272,3
2018-09-10 12:00	70	2	B1	serr	sea	outlet	26,67	759,8
2018-09-10 12:00	71	6	B2	serr	poll	outlet	12,281	246,2
2018-09-10 12:00	71	6	B1	serr	poll	outlet	18,298	420,7
2018-09-10 12:00	72	6	B1	morph	poll	Hakkstein	3,304	12,2
2018-09-10 12:00	72	6	B2	morph	poll	Hakkstein	3,69	15,4
2018-09-10 12:00	73	3	B1	morph	sea	Holmen	2,655	6,5
2018-09-10 12:00	73	3	B2	morph	sea	Holmen	3,758	10,7
2018-09-10 12:00	77	4	B1	morph	poll	Hakkstein	4,413	16,8
2018-09-10 12:00	77	4	B2	morph	poll	Hakkstein	7,986	38,5
2018-09-10 12:00	78	3	B2	morph	sea	Holmen	7,752	20,3
2018-09-10 12:00	78	3	B1	morph	sea	Holmen	8,044	29,8
2018-09-10 12:00	79	2	B2	morph	sea	Hakkstein	4,515	15,4
2018-09-10 12:00	79	2	B1	morph	sea	Hakkstein	5,748	21
2018-09-10 12:00	81	1	B1	morph	poll	Hakkstein	5,711	44,7
2018-09-10 12:00	81	1	B2	morph	poll	Hakkstein	5,751	27,9
2018-09-10 12:00	82	2	B2	morph	sea	Hakkstein	7,321	23,1
2018-09-10 12:00	82	2	B1	morph	sea	Hakkstein	8,111	34,5
2018-09-10 12:00	85	5	B1	serr	sea	outlet	12,266	227,5
2018-09-10 12:00	85	5	B2	serr	sea	outlet	19,348	445,5
2018-09-10 12:00	88	2	B1	serr	sea	outlet	10,62	209,9
2018-09-10 12:00	88	2	B2	serr	sea	outlet	20,617	472,8
2018-09-10 12:00	90	1	B1	serr	poll	outlet	14,946	271,5
2018-09-10 12:00	90	1	B2	serr	poll	outlet	18,894	272,6
2018-09-10 12:00	91	5	B1	morph	sea	Holmen	4,433	13,1
2018-09-10 12:00	91	5	B2	morph	sea	Holmen	5,903	25
2018-09-10 12:00	92	4	B1	serr	poll	outlet	14,59	301,7
2018-09-10 12:00	92	4	B2	serr	poll	outlet	49,2	1 682,1
2018-09-10 12:00	94	3	B1	serr	sea	outlet	8,963	211,5
2018-09-10 12:00	94	3	B2	serr	sea	outlet	16,778	401,6
2018-09-10 12:00	97	1	B1	serr	poll	outlet	13,074	344,9
2018-09-10 12:00	97	1	B2	serr	poll	outlet	27,056	657,6
2018-09-10 12:00	100	6	B2	serr	poll	outlet	11,282	222,7
2018-09-10 12:00	100	6	B1	serr	poll	outlet	11,66	259,4
2018-09-17 12:00	2	4	B2	serr	poll	outlet	19,368	435,3
2018-09-17 12:00	2	4	B1	serr	poll	outlet	26,374	620,8
2018-09-17 12:00	4	3	B2	serr	sea	outlet	20,343	492,7
2018-09-17 12:00	4	3	B1	serr	sea	outlet	22,744	461,7
2018-09-17 12:00	7	4	B1	morph	poll	Holmen	8,693	34,7
2018-09-17 12:00	7	4	B2	morph	poll	Holmen	10,714	44,5
2018-09-17 12:00	8	1	B2	morph	poll	Hakkstein	6,809	29,3
2018-09-17 12:00	8	1	B1	morph	poll	Hakkstein	10,039	38,2
2018-09-17 12:00	10	4	B2	morph	poll	Hakkstein	5,255	18,7
2018-09-17 12:00	10	4	B1	morph	poll	Hakkstein	11,328	36,9
2018-09-17 12:00	11	3	B1	serr	sea	outlet	25,813	586,5
2018-09-17 12:00	11	3	B2	serr	sea	outlet	30,378	677,4
2018-09-17 12:00	12	2	B1	serr	sea	outlet	16,2	383,1
2018-09-17 12:00	12	2	B2	serr	sea	outlet	23,457	586,3
2018-09-17 12:00	14	1	B2	serr	poll	outlet	21,81	465,2
2018-09-17 12:00	14	1	B1	serr	poll	outlet	22,244	475,4
2018-09-17 12:00	15	5	B1	serr	sea	outlet	21,787	447,4
2018-09-17 12:00	15	5	B2	serr	sea	outlet	39,439	951,5
2018-09-17 12:00	16	5	B2	serr	sea	outlet	26,372	626,5
2018-09-17 12:00	16	5	B1	serr	sea	outlet	30,645	755,9
2018-09-17 12:00	17	2	B2	serr	sea	outlet	11,502	225,7
2018-09-17 12:00	17	2	B1	serr	sea	outlet	38,229	922,5
2018-09-17 12:00	18	6	B1	morph	poll	Holmen	9,497	21,6
2018-09-17 12:00	18	6	B2	morph	poll	Holmen	10,257	36,6

2018-09-17 12:00	19	6	B2	serr	poll	outlet	18,236	382,4
2018-09-17 12:00	19	6	B1	serr	poll	outlet	43,598	1 280,9
2018-09-17 12:00	21	3	B1	morph	sea	Holmen	5,196	11,404
2018-09-17 12:00	21	3	B2	morph	sea	Holmen	5,844	11,5
2018-09-17 12:00	22	2	B1	morph	sea	Holmen	3,544	12,9
2018-09-17 12:00	22	2	B2	morph	sea	Holmen	5,145	12,3
2018-09-17 12:00	23	2	B1	serr	sea	outlet	13,837	292,3
2018-09-17 12:00	23	2	B2	serr	sea	outlet	15,728	330,6
2018-09-17 12:00	24	1	B2	serr	poll	outlet	11,807	181,8
2018-09-17 12:00	24	1	B1	serr	poll	outlet	22,089	469,3
2018-09-17 12:00	25	6	B2	serr	poll	outlet	18,705	385,4
2018-09-17 12:00	25	6	B1	serr	poll	outlet	41,238	1026,101
2018-09-17 12:00	25	6	B3	serr	poll	outlet	NA	NA
2018-09-17 12:00	26	1	B2	morph	poll	Hakkstein	6,376	15,9
2018-09-17 12:00	26	1	B1	morph	poll	Hakkstein	6,931	15,5
2018-09-17 12:00	27	3	B2	serr	sea	outlet	11,365	223,9
2018-09-17 12:00	27	3	B1	serr	sea	outlet	19,438	445,8
2018-09-17 12:00	28	5	B2	serr	sea	outlet	19,792	391
2018-09-17 12:00	28	5	B1	serr	sea	outlet	29,567	596,3
2018-09-17 12:00	29	5	B2	morph	sea	Hakkstein	6,482	34,1
2018-09-17 12:00	29	5	B1	morph	sea	Hakkstein	8,886	30,2
2018-09-17 12:00	31	5	B2	morph	sea	Holmen	4,841	8,456
2018-09-17 12:00	31	5	B1	morph	sea	Holmen	5,3	7,626
2018-09-17 12:00	36	1	B2	morph	poll	NA	6,602	24,491
2018-09-17 12:00	36	1	B1	morph	poll	NA	10,49	29,189
2018-09-17 12:00	32	5	B1	serr	sea	outlet	26,9	773,3
2018-09-17 12:00	32	5	B2	serr	sea	outlet	41,901	1 248,6
2018-09-17 12:00	33	2	B1	morph	sea	Hakkstein	3,49	14,6
2018-09-17 12:00	33	2	B2	morph	sea	Hakkstein	4,657	12,9
2018-09-17 12:00	34	2	B1	morph	sea	Holmen	6,423	21
2018-09-17 12:00	34	2	B2	morph	sea	Holmen	7,25	27,1
2018-09-17 12:00	38	3	B2	morph	sea	Hakkstein	3,68	14,8
2018-09-17 12:00	38	3	B1	morph	sea	Hakkstein	9,939	23,3
2018-09-17 12:00	40	5	B2	morph	sea	Holmen	8,901	20,8
2018-09-17 12:00	40	5	B1	morph	sea	Holmen	10,561	27,2
2018-09-17 12:00	41	4	B2	serr	poll	outlet	28,418	640,1
2018-09-17 12:00	41	4	B1	serr	poll	outlet	30,285	709,6
2018-09-17 12:00	42	5	B2	morph	sea	Hakkstein	7,041	18,7
2018-09-17 12:00	42	5	B1	morph	sea	Hakkstein	7,44	22,3
2018-09-17 12:00	43	4	B2	serr	poll	outlet	22,596	637,8
2018-09-17 12:00	43	4	B1	serr	poll	outlet	26,179	619,1
2018-09-17 12:00	46	4	B2	morph	poll	Hakkstein	6,525	20,8
2018-09-17 12:00	46	4	B1	morph	poll	Hakkstein	7,947	22,2
2018-09-17 12:00	49	4	B1	morph	poll	Hakkstein	6,264	29
2018-09-17 12:00	49	4	B2	morph	poll	Hakkstein	11,784	93,8
2018-09-17 12:00	49	4	B3	morph	poll	Hakkstein	NA	NA
2018-09-17 12:00	50	6	B2	morph	poll	Hakkstein	5,972	22,3
2018-09-17 12:00	50	6	B1	morph	poll	Hakkstein	10,07	45,6
2018-09-17 12:00	52	3	B2	serr	sea	outlet	11,367	211,1
2018-09-17 12:00	52	3	B1	serr	sea	outlet	33,294	1 000,3
2018-09-17 12:00	54	6	B1	serr	poll	outlet	13,996	279,8
2018-09-17 12:00	54	6	B2	serr	poll	outlet	16,765	338,8
2018-09-17 12:00	59	4	B1	serr	poll	outlet	6,906	83,4
2018-09-17 12:00	59	4	B2	serr	poll	outlet	17,719	409,2
2018-09-17 12:00	60	1	B1	serr	poll	outlet	36,577	1 165,1
2018-09-17 12:00	60	1	B2	serr	poll	outlet	47,892	1 590,3
2018-09-17 12:00	64	6	B1	morph	poll	Hakkstein	5,072	17,5
2018-09-17 12:00	64	6	B2	morph	poll	Hakkstein	6,581	37,3
2018-09-17 12:00	65	3	B2	morph	sea	Hakkstein	6,939	37,198
2018-09-17 12:00	65	3	B1	morph	sea	Hakkstein	12,365	82,239
2018-09-17 12:00	66	6	B1	morph	poll	Hakkstein	5,69	15,7
2018-09-17 12:00	66	6	B2	morph	poll	Hakkstein	7,649	27,5
2018-09-17 12:00	69	1	B2	morph	poll	NA	5,928	19,5
2018-09-17 12:00	69	1	B1	morph	poll	NA	9,126	23,8
2018-09-17 12:00	70	2	B2	serr	sea	outlet	16,787	296,8
2018-09-17 12:00	70	2	B1	serr	sea	outlet	27,929	753,6
2018-09-17 12:00	71	6	B2	serr	poll	outlet	13,417	253,6
2018-09-17 12:00	71	6	B1	serr	poll	outlet	19,93	421,4
2018-09-17 12:00	72	6	B1	morph	poll	Hakkstein	3,84	13,9
2018-09-17 12:00	72	6	B2	morph	poll	Hakkstein	4,461	17,7
2018-09-17 12:00	73	3	B1	morph	sea	Holmen	3,389	7,014
2018-09-17 12:00	73	3	B2	morph	sea	Holmen	4,535	13,338
2018-09-17 12:00	77	4	B1	morph	poll	Hakkstein	6,414	25,7
2018-09-17 12:00	77	4	B2	morph	poll	Hakkstein	9,086	46
2018-09-17 12:00	78	3	B1	morph	sea	Holmen	8,749	27,5
2018-09-17 12:00	78	3	B2	morph	sea	Holmen	8,8	20,04

2018-09-17 12:00	78	3	B3	morph	sea	Holmen	NA	NA
2018-09-17 12:00	79	2	B2	morph	sea	Hakkstein	4,974	14,9
2018-09-17 12:00	79	2	B1	morph	sea	Hakkstein	6,902	27,5
2018-09-17 12:00	81	1	B1	morph	poll	Hakkstein	6,759	52,1
2018-09-17 12:00	81	1	B2	morph	poll	Hakkstein	8,27	49
2018-09-17 12:00	82	2	B2	morph	sea	Hakkstein	7,704	23,05
2018-09-17 12:00	82	2	B1	morph	sea	Hakkstein	9,532	36,7
2018-09-17 12:00	85	5	B1	serr	sea	outlet	13,014	235,1
2018-09-17 12:00	85	5	B2	serr	sea	outlet	20,11	479,3
2018-09-17 12:00	88	2	B1	serr	sea	outlet	11,757	245,9
2018-09-17 12:00	88	2	B2	serr	sea	outlet	22,274	546,2
2018-09-17 12:00	90	1	B1	serr	poll	outlet	12,431	188,8
2018-09-17 12:00	90	1	B2	serr	poll	outlet	20,017	319,1
2018-09-17 12:00	91	5	B2	morph	sea	Holmen	5,583	21,8
2018-09-17 12:00	91	5	B1	morph	sea	Holmen	5,952	12
2018-09-17 12:00	92	4	B2	serr	poll	outlet	12,852	297,7
2018-09-17 12:00	92	4	B1	serr	poll	outlet	20,16	438,3
2018-09-17 12:00	94	3	B1	serr	sea	outlet	9,969	212,7
2018-09-17 12:00	94	3	B2	serr	sea	outlet	17,45	410,3
2018-09-17 12:00	97	1	B1	serr	poll	outlet	15,075	424
2018-09-17 12:00	97	1	B2	serr	poll	outlet	28,448	722,6
2018-09-17 12:00	100	6	B1	serr	poll	outlet	11,766	204,3
2018-09-17 12:00	100	6	B2	serr	poll	outlet	37,422	1075,308
2018-09-24 12:00	2	6	B2	serr	poll	outlet	23,618	571,421
2018-09-24 12:00	2	6	B1	serr	poll	outlet	29,433	718,206
2018-09-24 12:00	4	5	B2	serr	sea	outlet	21,909	575,544
2018-09-24 12:00	4	5	B1	serr	sea	outlet	24,32	512,922
2018-09-24 12:00	7	6	B1	morph	poll	Holmen	10,815	51,696
2018-09-24 12:00	7	6	B2	morph	poll	Holmen	11,111	55,197
2018-09-24 12:00	8	4	B2	morph	poll	Hakkstein	7,573	31,767
2018-09-24 12:00	8	4	B1	morph	poll	Hakkstein	11,748	48,853
2018-09-24 12:00	10	6	B2	morph	poll	Hakkstein	5,733	21,633
2018-09-24 12:00	10	6	B1	morph	poll	Hakkstein	12,127	44,841
2018-09-24 12:00	11	5	B1	serr	sea	outlet	26,482	586,117
2018-09-24 12:00	11	5	B2	serr	sea	outlet	33,97	766,171
2018-09-24 12:00	12	3	B1	serr	sea	outlet	17,728	444,799
2018-09-24 12:00	12	3	B2	serr	sea	outlet	25,892	646,067
2018-09-24 12:00	14	4	B2	serr	poll	outlet	22,72	488,4
2018-09-24 12:00	14	4	B1	serr	poll	outlet	24,759	512,129
2018-09-24 12:00	15	2	B1	serr	sea	outlet	27,652	530,716
2018-09-24 12:00	15	2	B2	serr	sea	outlet	39,265	873,599
2018-09-24 12:00	16	2	B2	serr	sea	outlet	30,463	755,88
2018-09-24 12:00	16	2	B1	serr	sea	outlet	32,292	793,058
2018-09-24 12:00	17	3	B2	serr	sea	outlet	13,062	286,942
2018-09-24 12:00	17	3	B1	serr	sea	outlet	53,905	854,165
2018-09-24 12:00	18	1	B2	morph	poll	Holmen	7,571	20,23
2018-09-24 12:00	18	1	B1	morph	poll	Holmen	10,321	23,984
2018-09-24 12:00	19	1	B2	serr	poll	outlet	19,017	412,061
2018-09-24 12:00	19	1	B1	serr	poll	outlet	44,442	1235,135
2018-09-24 12:00	21	3	B1	morph	sea	Holmen	5,756	11,969
2018-09-24 12:00	21	3	B2	morph	sea	Holmen	6,525	12,198
2018-09-24 12:00	22	2	B1	morph	sea	Holmen	4,779	51,233
2018-09-24 12:00	22	2	B2	morph	sea	Holmen	5,739	12,64
2018-09-24 12:00	23	3	B1	serr	sea	outlet	16,134	353,02
2018-09-24 12:00	23	3	B2	serr	sea	outlet	17,373	357,759
2018-09-24 12:00	24	4	B2	serr	poll	outlet	13,896	226,762
2018-09-24 12:00	24	4	B1	serr	poll	outlet	22,792	437,263
2018-09-24 12:00	25	1	B2	serr	poll	outlet	19,44	1099,761
2018-09-24 12:00	25	1	B1	serr	poll	outlet	41,999	852,319
2018-09-24 12:00	26	4	B1	morph	poll	Hakkstein	8,309	19,079
2018-09-24 12:00	26	4	B2	morph	poll	Hakkstein	8,588	24,224
2018-09-24 12:00	27	5	B2	serr	sea	outlet	16,988	342,431
2018-09-24 12:00	27	5	B1	serr	sea	outlet	21,538	499,06
2018-09-24 12:00	28	2	B1	serr	sea	outlet	29,055	558,268
2018-09-24 12:00	28	2	B2	serr	sea	outlet	42,769	669,916
2018-09-24 12:00	29	5	B2	morph	sea	Hakkstein	6,886	40,562
2018-09-24 12:00	29	5	B1	morph	sea	Hakkstein	10,39	41,63
2018-09-24 12:00	31	5	B2	morph	sea	Holmen	5,688	9,53
2018-09-24 12:00	31	5	B1	morph	sea	Holmen	6,07	8,689
2018-09-24 12:00	36	4	B2	morph	poll	NA	9,441	39,413
2018-09-24 12:00	36	4	B1	morph	poll	NA	11,967	34,769
2018-09-24 12:00	32	2	B1	serr	sea	outlet	32,655	1014,562
2018-09-24 12:00	32	2	B2	serr	sea	outlet	47,347	1 343,16
2018-09-24 12:00	33	2	B1	morph	sea	Hakkstein	4,143	19,646
2018-09-24 12:00	33	2	B2	morph	sea	Hakkstein	4,407	13,963
2018-09-24 12:00	34	2	B1	morph	sea	Holmen	7,611	30,423

2018-09-24 12:00	34	2	B2	morph	sea	Holmen	8,219	29,627
2018-09-24 12:00	38	3	B2	morph	sea	Hakkstein	5,882	28,501
2018-09-24 12:00	38	3	B1	morph	sea	Hakkstein	11,397	30,57
2018-09-24 12:00	40	5	B2	morph	sea	Holmen	9,277	33,831
2018-09-24 12:00	40	5	B1	morph	sea	Holmen	12,069	27,055
2018-09-24 12:00	41	6	B1	serr	poll	outlet	34,008	751,161
2018-09-24 12:00	41	6	B2	serr	poll	outlet	37,252	832,469
2018-09-24 12:00	42	5	B2	morph	sea	Hakkstein	7,674	23,485
2018-09-24 12:00	42	5	B1	morph	sea	Hakkstein	7,967	25,353
2018-09-24 12:00	43	6	B2	serr	poll	outlet	26,15	701,883
2018-09-24 12:00	43	6	B1	serr	poll	outlet	29,178	682,091
2018-09-24 12:00	46	6	B2	morph	poll	Hakkstein	8,101	23,082
2018-09-24 12:00	46	6	B1	morph	poll	Hakkstein	9,392	26,55
2018-09-24 12:00	49	6	B1	morph	poll	Hakkstein	7,117	37,048
2018-09-24 12:00	49	6	B2	morph	poll	Hakkstein	12,731	150,264
2018-09-24 12:00	50	1	B2	morph	poll	Hakkstein	5,934	20,572
2018-09-24 12:00	50	1	B1	morph	poll	Hakkstein	11,4	46,273
2018-09-24 12:00	52	5	B2	serr	sea	outlet	13,119	248,501
2018-09-24 12:00	52	5	B1	serr	sea	outlet	37,077	1057,829
2018-09-24 12:00	54	1	B1	serr	poll	outlet	16,36	326,885
2018-09-24 12:00	54	1	B2	serr	poll	outlet	17,443	356,243
2018-09-24 12:00	59	6	B1	serr	poll	outlet	7,767	112,45
2018-09-24 12:00	59	6	B2	serr	poll	outlet	18,708	419,263
2018-09-24 12:00	60	4	B1	serr	poll	outlet	40,932	1267,566
2018-09-24 12:00	60	4	B2	serr	poll	outlet	54,058	1794,334
2018-09-24 12:00	64	1	B1	morph	poll	Hakkstein	5,683	20,436
2018-09-24 12:00	64	1	B2	morph	poll	Hakkstein	7,334	40,589
2018-09-24 12:00	65	3	B2	morph	sea	Hakkstein	8,878	50,824
2018-09-24 12:00	65	3	B1	morph	sea	Hakkstein	13,035	87,012
2018-09-24 12:00	66	1	B1	morph	poll	Hakkstein	6,939	18,588
2018-09-24 12:00	66	1	B2	morph	poll	Hakkstein	9,567	35,683
2018-09-24 12:00	69	4	B2	morph	poll	NA	7,046	27,15
2018-09-24 12:00	69	4	B1	morph	poll	NA	9,504	25,636
2018-09-24 12:00	70	3	B2	serr	sea	outlet	17,97	296,863
2018-09-24 12:00	70	3	B1	serr	sea	outlet	30,002	883,841
2018-09-24 12:00	72	1	B1	morph	poll	Hakkstein	4,605	19,71
2018-09-24 12:00	72	1	B2	morph	poll	Hakkstein	4,689	26,788
2018-09-24 12:00	73	3	B1	morph	sea	Holmen	3,763	8,9
2018-09-24 12:00	73	3	B2	morph	sea	Holmen	5,58	16,663
2018-09-24 12:00	77	6	B1	morph	poll	Hakkstein	9,209	45,401
2018-09-24 12:00	77	6	B2	morph	poll	Hakkstein	10,921	72,003
2018-09-24 12:00	78	3	B1	morph	sea	Holmen	9,033	32,21
2018-09-24 12:00	78	3	B2	morph	sea	Holmen	10,054	23,211
2018-09-24 12:00	79	2	B2	morph	sea	Hakkstein	5,479	18,498
2018-09-24 12:00	79	2	B1	morph	sea	Hakkstein	8,018	27,461
2018-09-24 12:00	81	4	B1	morph	poll	Hakkstein	8,653	87,787
2018-09-24 12:00	81	4	B2	morph	poll	Hakkstein	10,422	80,335
2018-09-24 12:00	82	2	B2	morph	sea	Hakkstein	8,863	28,766
2018-09-24 12:00	82	2	B1	morph	sea	Hakkstein	10,99	47,897
2018-09-24 12:00	85	2	B1	serr	sea	outlet	14,487	257,957
2018-09-24 12:00	85	2	B2	serr	sea	outlet	22,198	513,086
2018-09-24 12:00	88	3	B1	serr	sea	outlet	13,169	264,637
2018-09-24 12:00	88	3	B2	serr	sea	outlet	23,984	564,918
2018-09-24 12:00	90	4	B2	serr	poll	outlet	13,811	329,818
2018-09-24 12:00	90	4	B1	serr	poll	outlet	21,291	204,481
2018-09-24 12:00	91	5	B2	morph	sea	Holmen	5,932	27,441
2018-09-24 12:00	91	5	B1	morph	sea	Holmen	6,454	14,83
2018-09-24 12:00	92	6	B1	serr	poll	outlet	20,657	464,502
2018-09-24 12:00	92	6	B2	serr	poll	outlet	55,297	1895,625
2018-09-24 12:00	94	5	B1	serr	sea	outlet	11,477	234,453
2018-09-24 12:00	94	5	B2	serr	sea	outlet	18,739	404,947
2018-09-24 12:00	97	4	B1	serr	poll	outlet	17,487	498,69
2018-09-24 12:00	97	4	B2	serr	poll	outlet	30,002	722,465
2018-09-24 12:00	100	1	B1	serr	poll	outlet	11,767	229,527
2018-09-24 12:00	100	1	B2	serr	poll	outlet	38,688	1044,071
2018-09-24 12:00	17A	1	B1	serr	poll	outlet	13,798	454,644
2018-09-24 12:00	17A	1	B2	serr	poll	outlet	21,344	276,151
2018-09-24 12:00	17A	1	B3	serr	poll	outlet	NA	NA
2018-10-01 12:00	2	1	B2	serr	poll	outlet	27,756	669,341
2018-10-01 12:00	2	1	B1	serr	poll	outlet	34,036	861,986
2018-10-01 12:00	4	2	B1	serr	sea	outlet	8,882	496,148
2018-10-01 12:00	4	2	B2	serr	sea	outlet	20,708	642,029
2018-10-01 12:00	7	1	B2	morph	poll	Holmen	12,01	71,195
2018-10-01 12:00	7	1	B1	morph	poll	Holmen	12,186	68,935
2018-10-01 12:00	8	6	B2	morph	poll	Hakkstein	8,175	39,956
2018-10-01 12:00	8	6	B1	morph	poll	Hakkstein	14,318	59,209

2018-10-01 12:00	10	1	B2	morph	poll	Hakkstein	7,154	27,007
2018-10-01 12:00	10	1	B1	morph	poll	Hakkstein	12,637	45,425
2018-10-01 12:00	11	2	B1	serr	sea	outlet	8,293	607,248
2018-10-01 12:00	11	2	B2	serr	sea	outlet	11,98	872,434
2018-10-01 12:00	12	5	B1	serr	sea	outlet	20,356	546,528
2018-10-01 12:00	12	5	B2	serr	sea	outlet	27,3	689,951
2018-10-01 12:00	12	5	B3	serr	sea	outlet	NA	NA
2018-10-01 12:00	14	6	B2	serr	poll	outlet	24,436	526,425
2018-10-01 12:00	14	6	B1	serr	poll	outlet	28,074	613,185
2018-10-01 12:00	14	6	B3	serr	poll	outlet	NA	NA
2018-10-01 12:00	15	3	B1	serr	sea	outlet	29,938	574,456
2018-10-01 12:00	15	3	B2	serr	sea	outlet	39,13	932,896
2018-10-01 12:00	16	3	B2	serr	sea	outlet	34,845	924,249
2018-10-01 12:00	16	3	B1	serr	sea	outlet	37,516	981,299
2018-10-01 12:00	17	5	B2	serr	sea	outlet	16,069	360,424
2018-10-01 12:00	17	5	B1	serr	sea	outlet	38,518	946,25
2018-10-01 12:00	18	4	B1	morph	poll	Holmen	11,476	30,888
2018-10-01 12:00	18	4	B2	morph	poll	Holmen	12,069	46,975
2018-10-01 12:00	19	4	B2	serr	poll	outlet	19,796	418,517
2018-10-01 12:00	19	4	B1	serr	poll	outlet	48,301	1350,909
2018-10-01 12:00	21	5	B1	morph	sea	Holmen	6,537	15,737
2018-10-01 12:00	21	5	B2	morph	sea	Holmen	7,153	17,573
2018-10-01 12:00	22	3	B1	morph	sea	Holmen	6,273	25,434
2018-10-01 12:00	22	3	B2	morph	sea	Holmen	9,111	21,393
2018-10-01 12:00	23	5	B1	serr	sea	outlet	18,619	454,365
2018-10-01 12:00	23	5	B2	serr	sea	outlet	19,344	453,814
2018-10-01 12:00	24	6	B2	serr	poll	outlet	16,506	290,273
2018-10-01 12:00	24	6	B1	serr	poll	outlet	24,821	468,046
2018-10-01 12:00	25	4	B2	serr	poll	outlet	20,746	420,926
2018-10-01 12:00	25	4	B1	serr	poll	outlet	44,247	911,558
2018-10-01 12:00	26	6	B1	morph	poll	Hakkstein	9,457	25,651
2018-10-01 12:00	26	6	B2	morph	poll	Hakkstein	11,285	34,827
2018-10-01 12:00	27	2	B1	serr	sea	outlet	11,98	608,135
2018-10-01 12:00	27	2	B2	serr	sea	outlet	23,23	413,179
2018-10-01 12:00	28	3	B1	serr	sea	outlet	31,278	622,495
2018-10-01 12:00	28	3	B2	serr	sea	outlet	38	747,533
2018-10-01 12:00	29	2	B2	morph	sea	Hakkstein	7,659	43,807
2018-10-01 12:00	29	2	B1	morph	sea	Hakkstein	12,162	49,919
2018-10-01 12:00	31	2	B2	morph	sea	Holmen	6,69	11,885
2018-10-01 12:00	31	2	B1	morph	sea	Holmen	6,958	11,475
2018-10-01 12:00	36	6	B2	morph	poll	NA	11,709	58,721
2018-10-01 12:00	36	6	B1	morph	poll	NA	13,316	38,034
2018-10-01 12:00	32	3	B1	serr	sea	outlet	37,702	1 203,98
2018-10-01 12:00	32	3	B2	serr	sea	outlet	49,807	1442,387
2018-10-01 12:00	33	3	B1	morph	sea	Hakkstein	4,619	21,998
2018-10-01 12:00	33	3	B2	morph	sea	Hakkstein	5,085	15,108
2018-10-01 12:00	34	3	B2	morph	sea	Holmen	8,596	33,511
2018-10-01 12:00	34	3	B1	morph	sea	Holmen	9,441	37,078
2018-10-01 12:00	38	5	B1	morph	sea	Hakkstein	7,819	36,562
2018-10-01 12:00	38	5	B2	morph	sea	Hakkstein	12,782	38,202
2018-10-01 12:00	40	2	B2	morph	sea	Holmen	10,533	31,185
2018-10-01 12:00	40	2	B1	morph	sea	Holmen	NA	NA
2018-10-01 12:00	40	2	B3	morph	sea	Holmen	NA	NA
2018-10-01 12:00	41	1	B1	serr	poll	outlet	35,799	818,599
2018-10-01 12:00	41	1	B2	serr	poll	outlet	40,891	902,38
2018-10-01 12:00	42	2	B1	morph	sea	Hakkstein	8,875	29,346
2018-10-01 12:00	42	2	B2	morph	sea	Hakkstein	8,809	26,432
2018-10-01 12:00	43	1	B2	serr	poll	outlet	30,072	862,636
2018-10-01 12:00	43	1	B1	serr	poll	outlet	32,892	825,443
2018-10-01 12:00	46	1	B2	morph	poll	Hakkstein	9,177	30,64
2018-10-01 12:00	46	1	B1	morph	poll	Hakkstein	10,895	31,788
2018-10-01 12:00	49	1	B1	morph	poll	Hakkstein	7,863	46,08
2018-10-01 12:00	49	1	B2	morph	poll	Hakkstein	16,031	218,725
2018-10-01 12:00	50	4	B2	morph	poll	Hakkstein	6,296	21,335
2018-10-01 12:00	50	4	B1	morph	poll	Hakkstein	11,555	52,64
2018-10-01 12:00	52	2	B2	serr	sea	outlet	15,68	360,175
2018-10-01 12:00	52	2	B1	serr	sea	outlet	42,994	1 351,52
2018-10-01 12:00	54	4	B1	serr	poll	outlet	18,113	410,309
2018-10-01 12:00	54	4	B2	serr	poll	outlet	20,438	443,523
2018-10-01 12:00	59	1	B1	serr	poll	outlet	8,499	128,822
2018-10-01 12:00	59	1	B2	serr	poll	outlet	21,633	487,039
2018-10-01 12:00	60	6	B1	serr	poll	outlet	46,689	1478,337
2018-10-01 12:00	60	6	B2	serr	poll	outlet	59,405	2050,095
2018-10-01 12:00	64	4	B1	morph	poll	Hakkstein	6,418	29,007
2018-10-01 12:00	64	4	B2	morph	poll	Hakkstein	8,298	47,683
2018-10-01 12:00	65	5	B2	morph	sea	Hakkstein	10,355	69,158

2018-10-01 12:00	65	5	B1	morph	sea	Hakkstein	NA	112,817
2018-10-01 12:00	66	4	B1	morph	poll	Hakkstein	7,981	24,156
2018-10-01 12:00	66	4	B2	morph	poll	Hakkstein	11,834	48,071
2018-10-01 12:00	66	4	B3	morph	poll	Hakkstein	NA	NA
2018-10-01 12:00	69	6	B2	morph	poll	NA	7,518	31,279
2018-10-01 12:00	69	6	B1	morph	poll	NA	10,278	40,087
2018-10-01 12:00	70	5	B2	serr	sea	outlet	18,973	337,984
2018-10-01 12:00	70	5	B1	serr	sea	outlet	33,9	1003,087
2018-10-01 12:00	71	4	B2	serr	poll	outlet	15,915	507,795
2018-10-01 12:00	71	4	B1	serr	poll	outlet	23,433	NA
2018-10-01 12:00	72	4	B1	morph	poll	Hakkstein	4,779	25,205
2018-10-01 12:00	72	4	B2	morph	poll	Hakkstein	5,76	26,442
2018-10-01 12:00	73	5	B1	morph	sea	Holmen	4,404	11,187
2018-10-01 12:00	73	5	B2	morph	sea	Holmen	6,708	23,268
2018-10-01 12:00	77	1	B1	morph	poll	Hakkstein	11,489	65,884
2018-10-01 12:00	77	1	B2	morph	poll	Hakkstein	13,137	84,666
2018-10-01 12:00	78	5	B1	morph	sea	Holmen	7,758	26,532
2018-10-01 12:00	78	5	B2	morph	sea	Holmen	11,33	30,159
2018-10-01 12:00	79	3	B2	morph	sea	Hakkstein	6,218	23,05
2018-10-01 12:00	79	3	B1	morph	sea	Hakkstein	9,603	38,355
2018-10-01 12:00	81	6	B1	morph	poll	Hakkstein	9,287	117,262
2018-10-01 12:00	81	6	B2	morph	poll	Hakkstein	12,593	123,681
2018-10-01 12:00	82	3	B2	morph	sea	Hakkstein	10,346	32,55
2018-10-01 12:00	82	3	B1	morph	sea	Hakkstein	12,805	35,026
2018-10-01 12:00	85	3	B1	serr	sea	outlet	16,438	306,271
2018-10-01 12:00	85	3	B2	serr	sea	outlet	24,242	578,069
2018-10-01 12:00	88	5	B1	serr	sea	outlet	14,714	314,163
2018-10-01 12:00	88	5	B2	serr	sea	outlet	26,243	631,043
2018-10-01 12:00	90	6	B3	serr	poll	outlet	6,242	65,363
2018-10-01 12:00	90	6	B1	serr	poll	outlet	15,277	261,912
2018-10-01 12:00	91	2	B2	morph	sea	Holmen	6,952	28,732
2018-10-01 12:00	91	2	B1	morph	sea	Holmen	7,935	17,462
2018-10-01 12:00	92	1	B1	serr	poll	outlet	22,681	516,424
2018-10-01 12:00	92	1	B2	serr	poll	outlet	61,725	2110,037
2018-10-01 12:00	94	2	B1	serr	sea	outlet	9,41	326,31
2018-10-01 12:00	94	2	B2	serr	sea	outlet	18,861	506,419
2018-10-01 12:00	97	6	B2	serr	poll	outlet	33,421	823,095
2018-10-01 12:00	100	4	B1	serr	poll	outlet	10,604	231,128
2018-10-01 12:00	100	4	B2	serr	poll	outlet	40,248	1 076,53
2018-10-01 12:00	100	4	B3	serr	poll	outlet	NA	NA
2018-10-08 12:00	2	4	B2	serr	poll	outlet	32,918	909,215
2018-10-08 12:00	2	4	B1	serr	poll	outlet	38,231	1006,023
2018-10-08 12:00	4	3	B3	serr	sea	outlet	10,759	NA
2018-10-08 12:00	4	3	B1	serr	sea	outlet	25,285	615,517
2018-10-08 12:00	4	3	B2	serr	sea	outlet	28,037	806,829
2018-10-08 12:00	7	4	B1	morph	poll	Holmen	13,7	92,004
2018-10-08 12:00	7	4	B2	morph	poll	Holmen	13,742	70,693
2018-10-08 12:00	8	1	B2	morph	poll	Hakkstein	8,185	38,454
2018-10-08 12:00	8	1	B1	morph	poll	Hakkstein	12,204	59,894
2018-10-08 12:00	10	4	B2	morph	poll	Hakkstein	7,796	41,464
2018-10-08 12:00	10	4	B1	morph	poll	Hakkstein	12,771	48,141
2018-10-08 12:00	11	3	B1	serr	sea	outlet	29,658	682,431
2018-10-08 12:00	11	3	B2	serr	sea	outlet	42,621	1077,144
2018-10-08 12:00	12	2	B2	serr	sea	outlet	24,119	680,051
2018-10-08 12:00	12	2	B1	serr	sea	outlet	28,499	895,492
2018-10-08 12:00	14	1	B1	serr	poll	outlet	25,014	554,953
2018-10-08 12:00	14	1	B2	serr	poll	outlet	30,644	709,914
2018-10-08 12:00	15	5	B1	serr	sea	outlet	11,98	772,724
2018-10-08 12:00	15	5	B2	serr	sea	outlet	23,23	1030,406
2018-10-08 12:00	16	5	B1	serr	sea	outlet	8,882	1137,741
2018-10-08 12:00	16	5	B2	serr	sea	outlet	20,708	1116,829
2018-10-08 12:00	17	2	B2	serr	sea	outlet	18,182	448,317
2018-10-08 12:00	17	2	B1	serr	sea	outlet	43,379	1033,057
2018-10-08 12:00	18	6	B2	morph	poll	Holmen	12,707	45,103
2018-10-08 12:00	18	6	B1	morph	poll	Holmen	12,984	35,955
2018-10-08 12:00	19	6	B2	serr	poll	outlet	20,668	454,794
2018-10-08 12:00	19	6	B1	serr	poll	outlet	50,56	1399,944
2018-10-08 12:00	21	2	B1	morph	sea	Holmen	7,127	17,043
2018-10-08 12:00	21	2	B2	morph	sea	Holmen	7,924	16,379
2018-10-08 12:00	22	5	B2	morph	sea	Holmen	6,738	17,497
2018-10-08 12:00	22	5	B1	morph	sea	Holmen	7,352	31,595
2018-10-08 12:00	22	5	B3	morph	sea	Holmen	13,598	50,099
2018-10-08 12:00	23	2	B1	serr	sea	outlet	16,486	372,871
2018-10-08 12:00	23	2	B2	serr	sea	outlet	21,681	536,048
2018-10-08 12:00	24	1	B2	serr	poll	outlet	18,434	356,474
2018-10-08 12:00	24	1	B1	serr	poll	outlet	26,754	536,774

2018-10-08 12:00	25	6	B2	serr	poll	outlet	26,827	631,45
2018-10-08 12:00	25	6	B1	serr	poll	outlet	46,027	1039,339
2018-10-08 12:00	26	1	B1	morph	poll	Hakkstein	9,07	28,685
2018-10-08 12:00	26	1	B2	morph	poll	Hakkstein	12,157	47,08
2018-10-08 12:00	27	3	B3	serr	sea	outlet	9,035	119,428
2018-10-08 12:00	27	3	B2	serr	sea	outlet	21,704	1077,144
2018-10-08 12:00	27	3	B1	serr	sea	outlet	27,298	716,637
2018-10-08 12:00	28	5	B1	serr	sea	outlet	10,855	585,353
2018-10-08 12:00	28	5	B2	serr	sea	outlet	20,754	803,236
2018-10-08 12:00	29	3	B2	morph	sea	Hakkstein	8,195	43,191
2018-10-08 12:00	29	3	B1	morph	sea	Hakkstein	13,432	57,397
2018-10-08 12:00	31	3	B1	morph	sea	Holmen	7,306	13,224
2018-10-08 12:00	31	3	B2	morph	sea	Holmen	11,75	30,985
2018-10-08 12:00	36	1	B2	morph	poll	NA	12,882	65,029
2018-10-08 12:00	36	1	B1	morph	poll	NA	13,099	41,678
2018-10-08 12:00	32	5	B1	serr	sea	outlet	9,41	NA
2018-10-08 12:00	32	5	B2	serr	sea	outlet	18,861	1485,402
2018-10-08 12:00	33	5	B1	morph	sea	Hakkstein	4,719	21,442
2018-10-08 12:00	33	5	B2	morph	sea	Hakkstein	5,765	16,87
2018-10-08 12:00	34	5	B2	morph	sea	Holmen	8,409	36,557
2018-10-08 12:00	34	5	B1	morph	sea	Holmen	10,368	59,405
2018-10-08 12:00	38	2	B2	morph	sea	Hakkstein	9,475	49,968
2018-10-08 12:00	38	2	B1	morph	sea	Hakkstein	14,19	52,042
2018-10-08 12:00	40	3	B2	morph	sea	Holmen	12,207	32,91
2018-10-08 12:00	40	3	B1	morph	sea	Holmen	14,378	54,506
2018-10-08 12:00	41	4	B2	serr	poll	outlet	36,774	895,794
2018-10-08 12:00	41	4	B1	serr	poll	outlet	37,454	970,747
2018-10-08 12:00	42	3	B1	morph	sea	Hakkstein	9,891	33,478
2018-10-08 12:00	42	3	B2	morph	sea	Hakkstein	9,983	35,6
2018-10-08 12:00	43	4	B1	serr	poll	outlet	35,052	920,392
2018-10-08 12:00	43	4	B2	serr	poll	outlet	35,533	1073,195
2018-10-08 12:00	46	4	B1	morph	poll	Hakkstein	8,293	38,327
2018-10-08 12:00	46	4	B2	morph	poll	Hakkstein	11,98	41,72
2018-10-08 12:00	49	4	B1	morph	poll	Hakkstein	8,293	59,94
2018-10-08 12:00	49	4	B2	morph	poll	Hakkstein	18,861	306,94
2018-10-08 12:00	50	6	B2	morph	poll	Hakkstein	6,366	24,232
2018-10-08 12:00	50	6	B1	morph	poll	Hakkstein	11,329	58,357
2018-10-08 12:00	52	3	B2	serr	sea	outlet	18,172	552,841
2018-10-08 12:00	52	3	B1	serr	sea	outlet	48,514	1713,865
2018-10-08 12:00	54	6	B2	serr	poll	outlet	20,315	481,386
2018-10-08 12:00	54	6	B1	serr	poll	outlet	22,571	553,876
2018-10-08 12:00	59	4	B1	serr	poll	outlet	9,702	144,855
2018-10-08 12:00	59	4	B2	serr	poll	outlet	24,163	569,025
2018-10-08 12:00	60	1	B1	serr	poll	outlet	52,925	1 742,3
2018-10-08 12:00	60	1	B2	serr	poll	outlet	66,175	2305,103
2018-10-08 12:00	64	6	B1	morph	poll	Hakkstein	7,356	39,589
2018-10-08 12:00	64	6	B2	morph	poll	Hakkstein	8,321	54,415
2018-10-08 12:00	65	2	B2	morph	sea	Hakkstein	12,015	85,7
2018-10-08 12:00	65	2	B1	morph	sea	Hakkstein	16,296	125,034
2018-10-08 12:00	66	6	B1	morph	poll	Hakkstein	9,162	27,41
2018-10-08 12:00	66	6	B2	morph	poll	Hakkstein	13,774	67,508
2018-10-08 12:00	69	1	B2	morph	poll	NA	7,657	31,985
2018-10-08 12:00	69	1	B1	morph	poll	NA	11,148	43,378
2018-10-08 12:00	70	2	B2	serr	sea	outlet	20,865	394,946
2018-10-08 12:00	70	2	B1	serr	sea	outlet	37,169	1193,629
2018-10-08 12:00	71	6	B2	serr	poll	outlet	18,763	404,071
2018-10-08 12:00	71	6	B1	serr	poll	outlet	25,704	618,432
2018-10-08 12:00	72	6	B1	morph	poll	Hakkstein	5,574	27,933
2018-10-08 12:00	72	6	B2	morph	poll	Hakkstein	5,946	26,025
2018-10-08 12:00	73	2	B1	morph	sea	Holmen	4,596	15,795
2018-10-08 12:00	73	2	B2	morph	sea	Holmen	7,661	28,105
2018-10-08 12:00	77	4	B1	morph	poll	Hakkstein	13,848	93,058
2018-10-08 12:00	77	4	B2	morph	poll	Hakkstein	14,857	116,804
2018-10-08 12:00	78	2	B1	morph	sea	Holmen	9,386	37,698
2018-10-08 12:00	78	2	B2	morph	sea	Holmen	12,256	39,078
2018-10-08 12:00	79	5	B2	morph	sea	Hakkstein	6,82	29,868
2018-10-08 12:00	79	5	B1	morph	sea	Hakkstein	10,755	50,608
2018-10-08 12:00	81	1	B1	morph	poll	Hakkstein	10,541	137,427
2018-10-08 12:00	81	1	B2	morph	poll	Hakkstein	13,707	142,758
2018-10-08 12:00	82	5	B2	morph	sea	Hakkstein	11,631	77,869
2018-10-08 12:00	82	5	B1	morph	sea	Hakkstein	13,365	73,147
2018-10-08 12:00	85	5	B1	serr	sea	outlet	17,666	353,194
2018-10-08 12:00	85	5	B2	serr	sea	outlet	24,284	678,428
2018-10-08 12:00	88	2	B1	serr	sea	outlet	16,528	372,317
2018-10-08 12:00	88	2	B2	serr	sea	outlet	29,482	727,45
2018-10-08 12:00	90	1	B3	serr	poll	outlet	7,225	278,941

2018-10-08 12:00	90	1	B1	serr	poll	outlet	16,944	79,296
2018-10-08 12:00	91	3	B2	morph	sea	Holmen	7,061	31,585
2018-10-08 12:00	91	3	B1	morph	sea	Holmen	8,671	18,951
2018-10-08 12:00	92	4	B1	serr	poll	outlet	26,631	692,379
2018-10-08 12:00	92	4	B2	serr	poll	outlet	67,057	2510,141
2018-10-08 12:00	94	3	B1	serr	sea	outlet	17,268	457,081
2018-10-08 12:00	94	3	B2	serr	sea	outlet	22,132	521,723
2018-10-08 12:00	97	1	B1	serr	poll	outlet	13,05	267,825
2018-10-08 12:00	97	1	B2	serr	poll	outlet	37,051	939,662
2018-10-08 12:00	100	6	B1	serr	poll	outlet	14,35	301,823
2018-10-08 12:00	100	6	B2	serr	poll	outlet	35,343	1229,152
2018-10-15 12:00	2	6	B1	serr	poll	outlet	11,98	1187,237
2018-10-15 12:00	2	6	B2	serr	poll	outlet	23,23	1085,311
2018-10-15 12:00	4	5	B3	serr	sea	outlet	12,739	280,327
2018-10-15 12:00	4	5	B1	serr	sea	outlet	27,647	705,065
2018-10-15 12:00	7	6	B1	morph	poll	Holmen	9,41	112,257
2018-10-15 12:00	7	6	B2	morph	poll	Holmen	18,861	91,832
2018-10-15 12:00	8	4	B2	morph	poll	Hakkstein	8,067	44,538
2018-10-15 12:00	8	4	B1	morph	poll	Hakkstein	16,245	71,199
2018-10-15 12:00	10	6	B2	morph	poll	Hakkstein	9,767	54,706
2018-10-15 12:00	10	6	B1	morph	poll	Hakkstein	12,719	46,421
2018-10-15 12:00	11	5	B1	serr	sea	outlet	32,615	848,245
2018-10-15 12:00	11	5	B2	serr	sea	outlet	45,993	1191,713
2018-10-15 12:00	12	3	B1	serr	sea	outlet	24,523	790,286
2018-10-15 12:00	12	3	B2	serr	sea	outlet	27,001	787,465
2018-10-15 12:00	14	4	B1	serr	poll	outlet	27,638	608,525
2018-10-15 12:00	14	4	B2	serr	poll	outlet	34,048	866,987
2018-10-15 12:00	15	2	B1	serr	sea	outlet	39,967	851,276
2018-10-15 12:00	15	2	B2	serr	sea	outlet	45,393	1073,937
2018-10-15 12:00	16	2	B2	serr	sea	outlet	44,915	1 330,14
2018-10-15 12:00	16	2	B1	serr	sea	outlet	46,379	1416,066
2018-10-15 12:00	17	3	B2	serr	sea	outlet	20,755	564,651
2018-10-15 12:00	17	3	B1	serr	sea	outlet	43,944	1077,119
2018-10-15 12:00	18	1	B2	morph	poll	Holmen	13,384	52,617
2018-10-15 12:00	18	1	B1	morph	poll	Holmen	13,879	48,701
2018-10-15 12:00	19	1	B2	serr	poll	outlet	22,357	493,451
2018-10-15 12:00	19	1	B1	serr	poll	outlet	52,313	1067,096
2018-10-15 12:00	21	3	B1	morph	sea	Holmen	7,604	32,157
2018-10-15 12:00	21	3	B2	morph	sea	Holmen	8,692	21,841
2018-10-15 12:00	22	2	B1	morph	sea	Holmen	8,665	41,64
2018-10-15 12:00	22	2	B3	morph	sea	Holmen	14,319	59,862
2018-10-15 12:00	23	3	B1	serr	sea	outlet	16,364	354,265
2018-10-15 12:00	23	3	B2	serr	sea	outlet	24,4	682,657
2018-10-15 12:00	24	4	B2	serr	poll	outlet	18,002	369,845
2018-10-15 12:00	24	4	B1	serr	poll	outlet	29,889	652,053
2018-10-15 12:00	25	1	B2	serr	poll	outlet	28,164	1358,253
2018-10-15 12:00	25	1	B1	serr	poll	outlet	51,389	1073,732
2018-10-15 12:00	26	4	B1	morph	poll	Hakkstein	9,446	35,248
2018-10-15 12:00	26	4	B2	morph	poll	Hakkstein	14,812	68,555
2018-10-15 12:00	27	5	B3	serr	sea	outlet	10,522	154,312
2018-10-15 12:00	27	5	B1	serr	sea	outlet	30,218	823,028
2018-10-15 12:00	27	5	B2	serr	sea	outlet	NA	150,711
2018-10-15 12:00	28	2	B1	serr	sea	outlet	33,462	720,82
2018-10-15 12:00	28	2	B2	serr	sea	outlet	43,146	889,595
2018-10-15 12:00	29	5	B2	morph	sea	Hakkstein	8,119	56,221
2018-10-15 12:00	29	5	B1	morph	sea	Hakkstein	13,793	65,751
2018-10-15 12:00	31	5	B1	morph	sea	Holmen	7,617	15,228
2018-10-15 12:00	31	5	B2	morph	sea	Holmen	12,819	42,702
2018-10-15 12:00	36	4	B1	morph	poll	NA	13,099	47,4
2018-10-15 12:00	36	4	B2	morph	poll	NA	14,089	89,292
2018-10-15 12:00	32	2	B2	serr	sea	outlet	50,411	1910,016
2018-10-15 12:00	32	2	B1	serr	sea	outlet	60,83	2119,486
2018-10-15 12:00	33	2	B1	morph	sea	Hakkstein	4,675	24,651
2018-10-15 12:00	33	2	B2	morph	sea	Hakkstein	6,148	22,637
2018-10-15 12:00	34	2	B2	morph	sea	Holmen	9,087	35,735
2018-10-15 12:00	34	2	B1	morph	sea	Holmen	11,817	75,748
2018-10-15 12:00	38	3	B2	morph	sea	Hakkstein	10,374	61,968
2018-10-15 12:00	38	3	B1	morph	sea	Hakkstein	15,184	73,18
2018-10-15 12:00	40	5	B2	morph	sea	Holmen	13,047	46,546
2018-10-15 12:00	40	5	B1	morph	sea	Holmen	16,047	82,733
2018-10-15 12:00	41	6	B2	serr	poll	outlet	37,894	1056,674
2018-10-15 12:00	41	6	B1	serr	poll	outlet	39,226	996,814
2018-10-15 12:00	42	5	B2	morph	sea	Hakkstein	11,145	51,417
2018-10-15 12:00	42	5	B1	morph	sea	Hakkstein	11,65	51,962
2018-10-15 12:00	43	6	B2	serr	poll	outlet	40,341	1536,377
2018-10-15 12:00	43	6	B1	serr	poll	outlet	43,279	1230,489

2018-10-15 12:00	46	6	B1	morph	poll	Hakkstein	8,882	41,562
2018-10-15 12:00	46	6	B2	morph	poll	Hakkstein	20,708	49,44
2018-10-15 12:00	49	6	B1	morph	poll	Hakkstein	9,41	76,664
2018-10-15 12:00	49	6	B2	morph	poll	Hakkstein	20,708	358,84
2018-10-15 12:00	50	1	B2	morph	poll	Hakkstein	6,606	25,84
2018-10-15 12:00	50	1	B1	morph	poll	Hakkstein	11,753	58,434
2018-10-15 12:00	52	5	B2	serr	sea	outlet	21,094	567,645
2018-10-15 12:00	52	5	B1	serr	sea	outlet	53,893	1968,751
2018-10-15 12:00	54	1	B2	serr	poll	outlet	22,973	573,515
2018-10-15 12:00	54	1	B1	serr	poll	outlet	24,117	604,813
2018-10-15 12:00	59	6	B1	serr	poll	outlet	9,972	515,804
2018-10-15 12:00	59	6	B2	serr	poll	outlet	24,284	729,611
2018-10-15 12:00	60	4	B1	serr	poll	outlet	61,514	2158,268
2018-10-15 12:00	60	4	B2	serr	poll	outlet	71,271	2787,535
2018-10-15 12:00	64	1	B1	morph	poll	Hakkstein	8,221	49,323
2018-10-15 12:00	64	1	B2	morph	poll	Hakkstein	9,888	68,787
2018-10-15 12:00	65	3	B2	morph	sea	Hakkstein	13,756	121,68
2018-10-15 12:00	65	3	B1	morph	sea	Hakkstein	18,549	160,121
2018-10-15 12:00	66	1	B1	morph	poll	Hakkstein	10,434	38,345
2018-10-15 12:00	66	1	B2	morph	poll	Hakkstein	15,418	82,439
2018-10-15 12:00	69	4	B2	morph	poll	NA	7,535	33,129
2018-10-15 12:00	69	4	B1	morph	poll	NA	12,14	62,495
2018-10-15 12:00	70	3	B2	serr	sea	outlet	23,55	458,262
2018-10-15 12:00	70	3	B1	serr	sea	outlet	41,423	1465,305
2018-10-15 12:00	71	1	B2	serr	poll	outlet	20,518	490,993
2018-10-15 12:00	71	1	B1	serr	poll	outlet	27,946	705,462
2018-10-15 12:00	72	1	B1	morph	poll	Hakkstein	5,516	31,236
2018-10-15 12:00	72	1	B2	morph	poll	Hakkstein	6,315	28,317
2018-10-15 12:00	73	3	B1	morph	sea	Holmen	5,493	17,346
2018-10-15 12:00	73	3	B2	morph	sea	Holmen	8,609	35,731
2018-10-15 12:00	77	6	B2	morph	poll	Hakkstein	15,549	135,356
2018-10-15 12:00	77	6	B1	morph	poll	Hakkstein	15,636	113,627
2018-10-15 12:00	78	3	B1	morph	sea	Holmen	10,666	82,531
2018-10-15 12:00	78	3	B2	morph	sea	Holmen	13,606	43,917
2018-10-15 12:00	79	2	B2	morph	sea	Hakkstein	7,933	40,569
2018-10-15 12:00	79	2	B1	morph	sea	Hakkstein	11,93	65,146
2018-10-15 12:00	81	4	B1	morph	poll	Hakkstein	11,24	192,379
2018-10-15 12:00	81	4	B2	morph	poll	Hakkstein	14,575	189,481
2018-10-15 12:00	82	2	B2	morph	sea	Hakkstein	13,003	106,147
2018-10-15 12:00	82	2	B1	morph	sea	Hakkstein	13,813	91,639
2018-10-15 12:00	85	2	B1	serr	sea	outlet	19,961	403,55
2018-10-15 12:00	85	2	B2	serr	sea	outlet	28,545	732,301
2018-10-15 12:00	88	3	B1	serr	sea	outlet	19,491	465,109
2018-10-15 12:00	88	3	B2	serr	sea	outlet	33,344	323,09
2018-10-15 12:00	90	4	B3	serr	poll	outlet	8,714	340,56
2018-10-15 12:00	90	4	B1	serr	poll	outlet	18,64	424,596
2018-10-15 12:00	91	5	B2	morph	sea	Holmen	7,143	34,596
2018-10-15 12:00	91	5	B1	morph	sea	Holmen	9,555	25,429
2018-10-15 12:00	92	6	B1	serr	poll	outlet	23,056	654,442
2018-10-15 12:00	92	6	B2	serr	poll	outlet	74,073	2896,492
2018-10-15 12:00	94	5	B1	serr	sea	outlet	20,39	534,046
2018-10-15 12:00	94	5	B2	serr	sea	outlet	24,595	592,735
2018-10-15 12:00	97	4	B1	serr	poll	outlet	16,629	1092,843
2018-10-15 12:00	97	4	B2	serr	poll	outlet	42,172	974,44
2018-10-15 12:00	100	1	B1	serr	poll	outlet	15,218	308,174
2018-10-15 12:00	100	1	B2	serr	poll	outlet	40,383	1294,175
2018-10-22 12:00	2	1	B2	serr	poll	outlet	42,458	1222,669
2018-10-22 12:00	2	1	B1	serr	poll	outlet	46,901	1405,776
2018-10-22 12:00	4	2	B1	serr	sea	outlet	10,855	882,638
2018-10-22 12:00	4	2	B3	serr	sea	outlet	15,008	358,254
2018-10-22 12:00	4	2	B2	serr	sea	outlet	20,754	NA
2018-10-22 12:00	7	1	B2	morph	poll	Holmen	13,341	102,501
2018-10-22 12:00	7	1	B1	morph	poll	Holmen	16,229	121,448
2018-10-22 12:00	8	6	B2	morph	poll	Hakkstein	8,82	47,582
2018-10-22 12:00	8	6	B1	morph	poll	Hakkstein	16,503	81,813
2018-10-22 12:00	10	1	B2	morph	poll	Hakkstein	10,378	94,748
2018-10-22 12:00	10	1	B1	morph	poll	Hakkstein	15,744	53,925
2018-10-22 12:00	11	2	B2	serr	sea	outlet	24,284	1368,881
2018-10-22 12:00	11	2	B1	serr	sea	outlet	35,001	930,056
2018-10-22 12:00	12	5	B2	serr	sea	outlet	30,219	724,702
2018-10-22 12:00	12	5	B1	serr	sea	outlet	37,641	1017,506
2018-10-22 12:00	14	6	B1	serr	poll	outlet	28,67	665,027
2018-10-22 12:00	14	6	B2	serr	poll	outlet	37,206	1009,667
2018-10-22 12:00	15	3	B1	serr	sea	outlet	45,003	956,512
2018-10-22 12:00	15	3	B2	serr	sea	outlet	46,441	1243,065
2018-10-22 12:00	16	3	B1	serr	sea	outlet	43,301	1475,976

2018-10-22 12:00	16	3	B2	serr	sea	outlet	50,053	1606,171
2018-10-22 12:00	17	5	B2	serr	sea	outlet	23,585	720,502
2018-10-22 12:00	17	5	B1	serr	sea	outlet	33,78	1 127,98
2018-10-22 12:00	18	4	B2	morph	poll	Holmen	12,769	53,887
2018-10-22 12:00	18	4	B1	morph	poll	Holmen	14,998	54,642
2018-10-22 12:00	19	4	B1	serr	poll	outlet	54,195	1588,851
2018-10-22 12:00	19	4	B2	serr	poll	outlet	NA	NA
2018-10-22 12:00	19	4	B3	serr	poll	outlet	NA	NA
2018-10-22 12:00	21	5	B1	morph	sea	Holmen	7,682	31,673
2018-10-22 12:00	21	5	B2	morph	sea	Holmen	9,613	31,139
2018-10-22 12:00	22	3	B1	morph	sea	Holmen	9,994	49,637
2018-10-22 12:00	22	3	B3	morph	sea	Holmen	14,443	68,277
2018-10-22 12:00	23	5	B3	serr	sea	outlet	4,054	55,421
2018-10-22 12:00	23	5	B2	serr	sea	outlet	27,092	799,203
2018-10-22 12:00	24	6	B2	serr	poll	outlet	22,388	514,397
2018-10-22 12:00	24	6	B1	serr	poll	outlet	32,442	705,752
2018-10-22 12:00	25	4	B2	serr	poll	outlet	27,542	609,49
2018-10-22 12:00	25	4	B1	serr	poll	outlet	49,872	1168,492
2018-10-22 12:00	26	6	B1	morph	poll	Hakkstein	9,923	30,623
2018-10-22 12:00	26	6	B2	morph	poll	Hakkstein	16,334	79,86
2018-10-22 12:00	27	2	B1	serr	sea	outlet	9,41	949,726
2018-10-22 12:00	27	2	B3	serr	sea	outlet	11,915	199,668
2018-10-22 12:00	27	2	B2	serr	sea	outlet	18,861	NA
2018-10-22 12:00	28	3	B1	serr	sea	outlet	37,929	606,742
2018-10-22 12:00	28	3	B2	serr	sea	outlet	44,933	968,167
2018-10-22 12:00	29	2	B2	morph	sea	Hakkstein	7,838	51,652
2018-10-22 12:00	29	2	B1	morph	sea	Hakkstein	13,374	68,735
2018-10-22 12:00	31	2	B1	morph	sea	Holmen	8,068	15,74
2018-10-22 12:00	31	2	B2	morph	sea	Holmen	13,018	42,088
2018-10-22 12:00	36	6	B1	morph	poll	NA	13,541	51,262
2018-10-22 12:00	36	6	B2	morph	poll	NA	15,441	102,918
2018-10-22 12:00	32	3	B2	serr	sea	outlet	58,182	2236,548
2018-10-22 12:00	32	3	B1	serr	sea	outlet	65,161	2266,438
2018-10-22 12:00	33	3	B1	morph	sea	Hakkstein	4,486	24,737
2018-10-22 12:00	33	3	B2	morph	sea	Hakkstein	6,545	23,657
2018-10-22 12:00	34	3	B2	morph	sea	Holmen	9,39	42,561
2018-10-22 12:00	34	3	B1	morph	sea	Holmen	13,399	101,112
2018-10-22 12:00	35	1	B1	serr	poll	outlet	11,015	310,066
2018-10-22 12:00	35	1	B2	serr	poll	outlet	11,405	288,361
2018-10-22 12:00	38	5	B2	morph	sea	Hakkstein	10,314	68,462
2018-10-22 12:00	38	5	B1	morph	sea	Hakkstein	15,64	85,154
2018-10-22 12:00	40	2	B2	morph	sea	Holmen	13,809	56,624
2018-10-22 12:00	40	2	B1	morph	sea	Holmen	17,589	100,078
2018-10-22 12:00	41	1	B1	serr	poll	outlet	41,024	1073,959
2018-10-22 12:00	41	1	B2	serr	poll	outlet	41,102	1118,587
2018-10-22 12:00	42	2	B1	morph	sea	Hakkstein	10,959	53,716
2018-10-22 12:00	42	2	B2	morph	sea	Hakkstein	12,27	70,029
2018-10-22 12:00	46	1	B1	morph	poll	Hakkstein	12,95	46,199
2018-10-22 12:00	46	1	B2	morph	poll	Hakkstein	12,951	59,18
2018-10-22 12:00	49	1	B1	morph	poll	Hakkstein	8,882	83,231
2018-10-22 12:00	49	1	B2	morph	poll	Hakkstein	20,754	409,263
2018-10-22 12:00	50	4	B2	morph	poll	Hakkstein	5,881	29,579
2018-10-22 12:00	50	4	B1	morph	poll	Hakkstein	11,449	55,708
2018-10-22 12:00	52	2	B2	serr	sea	outlet	24,159	728,949
2018-10-22 12:00	54	4	B2	serr	poll	outlet	24,082	672,121
2018-10-22 12:00	54	4	B1	serr	poll	outlet	24,725	612,814
2018-10-22 12:00	59	1	B1	serr	poll	outlet	10,927	173,998
2018-10-22 12:00	59	1	B2	serr	poll	outlet	26,164	824,34
2018-10-22 12:00	60	6	B1	serr	poll	outlet	67,232	249,034
2018-10-22 12:00	60	6	B2	serr	poll	outlet	76,948	3252,181
2018-10-22 12:00	64	4	B1	morph	poll	Hakkstein	7,872	68,245
2018-10-22 12:00	64	4	B2	morph	poll	Hakkstein	9,52	90,811
2018-10-22 12:00	65	5	B2	morph	sea	Hakkstein	14,986	141,396
2018-10-22 12:00	65	5	B1	morph	sea	Hakkstein	20,066	200,658
2018-10-22 12:00	66	4	B1	morph	poll	Hakkstein	11,06	43,236
2018-10-22 12:00	66	4	B2	morph	poll	Hakkstein	16,868	108,952
2018-10-22 12:00	69	6	B2	morph	poll	NA	7,667	28,641
2018-10-22 12:00	69	6	B1	morph	poll	NA	13,44	66,683
2018-10-22 12:00	70	5	B2	serr	sea	outlet	25,801	542,848
2018-10-22 12:00	70	5	B1	serr	sea	outlet	45,874	1713,428
2018-10-22 12:00	71	4	B2	serr	poll	outlet	23,499	592,574
2018-10-22 12:00	71	4	B1	serr	poll	outlet	32,848	868,209
2018-10-22 12:00	72	4	B1	morph	poll	Hakkstein	5,331	39,039
2018-10-22 12:00	72	4	B2	morph	poll	Hakkstein	6,815	36,488
2018-10-22 12:00	73	5	B1	morph	sea	Holmen	5,749	17,471
2018-10-22 12:00	73	5	B2	morph	sea	Holmen	9,407	43,045

2018-10-22 12:00	74	1	B1	serr	poll	outlet	5,467	209,972
2018-10-22 12:00	74	1	B2	serr	poll	outlet	10,71	132,522
2018-10-22 12:00	77	1	B1	morph	poll	Hakkstein	17,025	131,839
2018-10-22 12:00	77	1	B2	morph	poll	Hakkstein	17,282	154,412
2018-10-22 12:00	78	5	B1	morph	sea	Holmen	13,717	97,116
2018-10-22 12:00	78	5	B2	morph	sea	Holmen	13,85	49,745
2018-10-22 12:00	79	3	B2	morph	sea	Hakkstein	8,296	50,769
2018-10-22 12:00	79	3	B1	morph	sea	Hakkstein	13,474	91,749
2018-10-22 12:00	81	6	B1	morph	poll	Hakkstein	12,256	222,892
2018-10-22 12:00	81	6	B2	morph	poll	Hakkstein	15,85	223,177
2018-10-22 12:00	82	3	B2	morph	sea	Hakkstein	14,251	132,725
2018-10-22 12:00	82	3	B1	morph	sea	Hakkstein	15,011	104,235
2018-10-22 12:00	85	3	B1	serr	sea	outlet	22,592	492,051
2018-10-22 12:00	85	3	B2	serr	sea	outlet	32,625	897,829
2018-10-22 12:00	88	5	B1	serr	sea	outlet	22,397	562,966
2018-10-22 12:00	88	5	B2	serr	sea	outlet	36,615	1052,434
2018-10-22 12:00	90	6	B3	serr	poll	outlet	10,247	352,162
2018-10-22 12:00	90	6	B1	serr	poll	outlet	20,308	144,235
2018-10-22 12:00	91	2	B2	morph	sea	Holmen	7,163	38,766
2018-10-22 12:00	91	2	B1	morph	sea	Holmen	11,099	35,425
2018-10-22 12:00	94	2	B1	serr	sea	outlet	23,301	638,638
2018-10-22 12:00	94	2	B2	serr	sea	outlet	26,841	667,713
2018-10-22 12:00	97	6	B1	serr	poll	outlet	22	540,811
2018-10-22 12:00	97	6	B2	serr	poll	outlet	46,173	1 295,79
2018-10-22 12:00	100	4	B1	serr	poll	outlet	16,441	392,828
2018-10-22 12:00	100	4	B2	serr	poll	outlet	43,898	1 186,24
2018-10-29 12:00	2	4	B1	serr	poll	outlet	11,98	1671,792
2018-10-29 12:00	2	4	B2	serr	poll	outlet	23,23	1305,795
2018-10-29 12:00	4	3	B3	serr	sea	outlet	17,385	455,213
2018-10-29 12:00	4	3	B1	serr	sea	outlet	NA	NA
2018-10-29 12:00	4	3	B2	serr	sea	outlet	NA	NA
2018-10-29 12:00	7	4	B1	morph	poll	Holmen	9,41	149,18
2018-10-29 12:00	7	4	B2	morph	poll	Holmen	18,861	100,683
2018-10-29 12:00	8	1	B2	morph	poll	Hakkstein	8,602	48,017
2018-10-29 12:00	8	1	B1	morph	poll	Hakkstein	16,436	86,506
2018-10-29 12:00	10	4	B1	morph	poll	Hakkstein	8,293	59,947
2018-10-29 12:00	10	4	B2	morph	poll	Hakkstein	11,98	111,208
2018-10-29 12:00	11	3	B1	serr	sea	outlet	39,685	1072,412
2018-10-29 12:00	11	3	B2	serr	sea	outlet	56,007	1739,419
2018-10-29 12:00	12	2	B2	serr	sea	outlet	33,234	1186,046
2018-10-29 12:00	12	2	B1	serr	sea	outlet	37,706	983,719
2018-10-29 12:00	14	1	B1	serr	poll	outlet	31,131	718,391
2018-10-29 12:00	14	1	B2	serr	poll	outlet	38,592	1112,179
2018-10-29 12:00	15	5	B1	serr	sea	outlet	44,27	1146,109
2018-10-29 12:00	15	5	B2	serr	sea	outlet	49,492	1332,896
2018-10-29 12:00	16	5	B2	serr	sea	outlet	54,631	1817,326
2018-10-29 12:00	16	5	B1	serr	sea	outlet	57,14	1720,841
2018-10-29 12:00	17	2	B2	serr	sea	outlet	26,852	924,691
2018-10-29 12:00	17	2	B1	serr	sea	outlet	47	1199,117
2018-10-29 12:00	18	6	B2	morph	poll	Holmen	13,292	53,214
2018-10-29 12:00	18	6	B1	morph	poll	Holmen	16,345	52,492
2018-10-29 12:00	19	6	B2	serr	poll	outlet	24,416	624,255
2018-10-29 12:00	19	6	B1	serr	poll	outlet	NA	NA
2018-10-29 12:00	19	6	B3	serr	poll	outlet	NA	NA
2018-10-29 12:00	21	2	B1	morph	sea	Holmen	7,908	29,124
2018-10-29 12:00	21	2	B2	morph	sea	Holmen	10,577	28,334
2018-10-29 12:00	22	5	B1	morph	sea	Holmen	10,98	59,104
2018-10-29 12:00	22	5	B3	morph	sea	Holmen	16,104	74,757
2018-10-29 12:00	23	2	B3	serr	sea	outlet	5,579	98,554
2018-10-29 12:00	23	2	B2	serr	sea	outlet	30,558	987,849
2018-10-29 12:00	24	1	B2	serr	poll	outlet	25,202	639,045
2018-10-29 12:00	24	1	B1	serr	poll	outlet	34,967	793,826
2018-10-29 12:00	25	6	B2	serr	poll	outlet	32,204	756,275
2018-10-29 12:00	25	6	B1	serr	poll	outlet	51,009	1328,216
2018-10-29 12:00	26	1	B1	morph	poll	Hakkstein	10,956	33,338
2018-10-29 12:00	26	1	B2	morph	poll	Hakkstein	18,086	95,638
2018-10-29 12:00	27	3	B3	serr	sea	outlet	14,235	264,077
2018-10-29 12:00	28	5	B1	serr	sea	outlet	39,869	862,314
2018-10-29 12:00	28	5	B2	serr	sea	outlet	49,299	1148,433
2018-10-29 12:00	29	3	B2	morph	sea	Hakkstein	9,351	51,329
2018-10-29 12:00	29	3	B1	morph	sea	Hakkstein	13,37	67,237
2018-10-29 12:00	31	3	B1	morph	sea	Holmen	8,679	16,855
2018-10-29 12:00	31	3	B2	morph	sea	Holmen	14,275	47,336
2018-10-29 12:00	36	1	B1	morph	poll	NA	14,382	48,008
2018-10-29 12:00	36	1	B2	morph	poll	NA	17,285	120,004
2018-10-29 12:00	32	5	B2	serr	sea	outlet	67,441	2830,761

2018-10-29 12:00	32	5	B1	serr	sea	outlet	68,91	2670,633
2018-10-29 12:00	33	5	B1	morph	sea	Hakkstein	4,722	23,563
2018-10-29 12:00	33	5	B2	morph	sea	Hakkstein	6,997	23,35
2018-10-29 12:00	34	5	B2	morph	sea	Holmen	9,053	44,729
2018-10-29 12:00	34	5	B1	morph	sea	Holmen	13,913	116,468
2018-10-29 12:00	35	4	B2	serr	poll	outlet	15,55	452,132
2018-10-29 12:00	35	4	B1	serr	poll	outlet	15,856	520,542
2018-10-29 12:00	38	2	B2	morph	sea	Hakkstein	11,073	71,634
2018-10-29 12:00	38	2	B1	morph	sea	Hakkstein	17,1	101,438
2018-10-29 12:00	40	3	B2	morph	sea	Holmen	16,331	71,824
2018-10-29 12:00	40	3	B1	morph	sea	Holmen	20,159	126,594
2018-10-29 12:00	41	4	B1	serr	poll	outlet	10,855	1157,416
2018-10-29 12:00	41	4	B2	serr	poll	outlet	20,754	1276,842
2018-10-29 12:00	42	3	B1	morph	sea	Hakkstein	12,038	52,683
2018-10-29 12:00	42	3	B2	morph	sea	Hakkstein	12,103	85,407
2018-10-29 12:00	46	4	B1	morph	poll	Hakkstein	8,882	55,938
2018-10-29 12:00	46	4	B2	morph	poll	Hakkstein	20,708	69,301
2018-10-29 12:00	49	4	B1	morph	poll	Hakkstein	10,855	97,627
2018-10-29 12:00	49	4	B2	morph	poll	Hakkstein	23,23	441,398
2018-10-29 12:00	50	6	B2	morph	poll	Hakkstein	6,49	54,186
2018-10-29 12:00	50	6	B1	morph	poll	Hakkstein	11,753	25,656
2018-10-29 12:00	52	3	B2	serr	sea	outlet	26,732	833,176
2018-10-29 12:00	52	3	B1	serr	sea	outlet	66,525	2 669,34
2018-10-29 12:00	54	6	B2	serr	poll	outlet	26,289	756,114
2018-10-29 12:00	54	6	B1	serr	poll	outlet	27,821	711,493
2018-10-29 12:00	59	4	B1	serr	poll	outlet	12,422	213,962
2018-10-29 12:00	59	4	B2	serr	poll	outlet	24,284	942,552
2018-10-29 12:00	60	1	B1	serr	poll	outlet	71,984	2740,277
2018-10-29 12:00	60	1	B2	serr	poll	outlet	81,764	3514,585
2018-10-29 12:00	64	6	B1	morph	poll	Hakkstein	9,515	73,131
2018-10-29 12:00	64	6	B2	morph	poll	Hakkstein	10,854	94,405
2018-10-29 12:00	65	2	B2	morph	sea	Hakkstein	15,933	163,818
2018-10-29 12:00	65	2	B1	morph	sea	Hakkstein	20,63	238,249
2018-10-29 12:00	66	6	B1	morph	poll	Hakkstein	11,84	44,655
2018-10-29 12:00	66	6	B2	morph	poll	Hakkstein	18,902	120,048
2018-10-29 12:00	69	1	B2	morph	poll	NA	7,689	29,636
2018-10-29 12:00	69	1	B1	morph	poll	NA	14,723	60,657
2018-10-29 12:00	70	2	B2	serr	sea	outlet	28,639	599,536
2018-10-29 12:00	70	2	B1	serr	sea	outlet	49,52	1940,921
2018-10-29 12:00	71	6	B2	serr	poll	outlet	26,49	1041,218
2018-10-29 12:00	71	6	B1	serr	poll	outlet	36,282	741,267
2018-10-29 12:00	72	6	B1	morph	poll	Hakkstein	5,585	42,254
2018-10-29 12:00	72	6	B2	morph	poll	Hakkstein	7,5	45,373
2018-10-29 12:00	73	2	B1	morph	sea	Holmen	6,272	20,839
2018-10-29 12:00	73	2	B2	morph	sea	Holmen	10,005	44,537
2018-10-29 12:00	74	4	B1	serr	poll	outlet	7,371	197,355
2018-10-29 12:00	74	4	B2	serr	poll	outlet	10,72	213,124
2018-10-29 12:00	77	4	B2	morph	sea	Hakkstein	18,312	175,583
2018-10-29 12:00	77	4	B1	morph	sea	Hakkstein	19,296	155,494
2018-10-29 12:00	77	4	B3	morph	sea	Hakkstein	NA	NA
2018-10-29 12:00	78	2	B2	morph	sea	Holmen	14,208	54,378
2018-10-29 12:00	78	2	B1	morph	sea	Holmen	16,091	106,143
2018-10-29 12:00	79	5	B2	morph	sea	Hakkstein	9,182	54,979
2018-10-29 12:00	79	5	B1	morph	sea	Hakkstein	14,238	102,876
2018-10-29 12:00	81	1	B1	morph	poll	Hakkstein	14,391	233,817
2018-10-29 12:00	81	1	B2	morph	poll	Hakkstein	17,154	242,7
2018-10-29 12:00	82	5	B2	morph	sea	Hakkstein	14,951	147,392
2018-10-29 12:00	82	5	B1	morph	sea	Hakkstein	16,292	119,419
2018-10-29 12:00	85	5	B1	serr	sea	outlet	26,224	591,034
2018-10-29 12:00	85	5	B2	serr	sea	outlet	35,142	994,756
2018-10-29 12:00	88	2	B1	serr	sea	outlet	27,244	718,822
2018-10-29 12:00	88	2	B2	serr	sea	outlet	40,811	1257,419
2018-10-29 12:00	90	1	B1	serr	poll	outlet	12,334	167,554
2018-10-29 12:00	90	1	B3	serr	poll	outlet	21,745	408,813
2018-10-29 12:00	91	3	B2	morph	sea	Holmen	7,567	47,225
2018-10-29 12:00	91	3	B1	morph	sea	Holmen	12,579	46,877
2018-10-29 12:00	94	3	B1	serr	sea	outlet	27,23	835,476
2018-10-29 12:00	94	3	B2	serr	sea	outlet	29,901	769,068
2018-10-29 12:00	97	1	B1	serr	poll	outlet	25,367	696,877
2018-10-29 12:00	97	1	B2	serr	poll	outlet	51,061	1475,718
2018-10-29 12:00	100	6	B1	serr	poll	outlet	19,398	440,827
2018-10-29 12:00	100	6	B2	serr	poll	outlet	47,19	1471,439
2018-11-05 12:00	2	6	B2	serr	poll	outlet	46,211	1427,564
2018-11-05 12:00	2	6	B1	serr	poll	outlet	53,483	1925,357
2018-11-05 12:00	4	5	B3	serr	sea	outlet	20,196	548,511
2018-11-05 12:00	4	5	B1	serr	sea	outlet	39,602	1113,938

2018-11-05 12:00	7	6	B1	morph	poll	Holmen	8,293	170,599
2018-11-05 12:00	7	6	B2	morph	poll	Holmen	11,98	112,159
2018-11-05 12:00	8	4	B2	morph	poll	Hakkstein	8,473	47,929
2018-11-05 12:00	8	4	B1	morph	poll	Hakkstein	16,39	90,054
2018-11-05 12:00	10	6	B2	morph	poll	Hakkstein	11,499	94,656
2018-11-05 12:00	10	6	B1	morph	poll	Hakkstein	12,341	56,031
2018-11-05 12:00	10	6	B3	morph	poll	Hakkstein	NA	NA
2018-11-05 12:00	11	5	B1	serr	sea	outlet	41,822	1253,294
2018-11-05 12:00	11	5	B2	serr	sea	outlet	61,431	1779,214
2018-11-05 12:00	12	3	B2	serr	sea	outlet	36,8	1322,536
2018-11-05 12:00	12	3	B1	serr	sea	outlet	41,534	1333,874
2018-11-05 12:00	14	4	B1	serr	poll	outlet	33,901	809,911
2018-11-05 12:00	14	4	B2	serr	poll	outlet	40,905	1 300,97
2018-11-05 12:00	15	2	B1	serr	sea	outlet	49,52	1274,545
2018-11-05 12:00	15	2	B2	serr	sea	outlet	51,328	1496,856
2018-11-05 12:00	16	2	B1	serr	sea	outlet	53,102	2093,708
2018-11-05 12:00	16	2	B2	serr	sea	outlet	57,137	1938,872
2018-11-05 12:00	17	3	B2	serr	sea	outlet	31,056	1129,365
2018-11-05 12:00	17	3	B1	serr	sea	outlet	35,75	1338,156
2018-11-05 12:00	18	1	B2	morph	poll	Holmen	12,821	55,094
2018-11-05 12:00	18	1	B1	morph	poll	Holmen	17,148	51,658
2018-11-05 12:00	19	1	B2	serr	poll	outlet	29,635	699,32
2018-11-05 12:00	21	3	B1	morph	sea	Holmen	7,864	22,336
2018-11-05 12:00	21	3	B2	morph	sea	Holmen	10,56	40,164
2018-11-05 12:00	22	2	B1	morph	sea	Holmen	12,459	68,081
2018-11-05 12:00	22	2	B3	morph	sea	Holmen	17,122	72,078
2018-11-05 12:00	23	3	B3	serr	sea	outlet	7,318	138,057
2018-11-05 12:00	23	3	B2	serr	sea	outlet	34,099	1197,561
2018-11-05 12:00	24	4	B2	serr	poll	outlet	29,031	771,741
2018-11-05 12:00	24	4	B1	serr	poll	outlet	36,999	922,801
2018-11-05 12:00	25	5	B2	serr	sea	outlet	29,515	933,221
2018-11-05 12:00	25	5	B1	serr	sea	outlet	72,234	2894,271
2018-11-05 12:00	25	5	B3	serr	sea	outlet	NA	NA
2018-11-05 12:00	25	1	B2	serr	poll	outlet	30,721	894,312
2018-11-05 12:00	25	1	B1	serr	poll	outlet	51,181	1520,875
2018-11-05 12:00	26	4	B1	morph	poll	Hakkstein	11,179	33,682
2018-11-05 12:00	26	4	B2	morph	poll	Hakkstein	18,555	108,566
2018-11-05 12:00	27	5	B3	serr	sea	outlet	17,446	341,582
2018-11-05 12:00	27	5	B1	serr	sea	outlet	39,868	1265,879
2018-11-05 12:00	28	2	B1	serr	sea	outlet	40,186	930,904
2018-11-05 12:00	28	2	B2	serr	sea	outlet	51,793	1 322,97
2018-11-05 12:00	29	5	B2	morph	sea	Hakkstein	8,869	57,884
2018-11-05 12:00	29	5	B1	morph	sea	Hakkstein	13,558	70,064
2018-11-05 12:00	31	5	B1	morph	sea	Holmen	8,807	19,884
2018-11-05 12:00	36	4	B1	morph	poll	NA	14,107	51,338
2018-11-05 12:00	31	5	B2	morph	sea	Holmen	15	52,093
2018-11-05 12:00	36	4	B2	morph	poll	NA	18,078	132,679
2018-11-05 12:00	32	2	B2	serr	sea	outlet	73,318	3759,785
2018-11-05 12:00	32	2	B1	serr	sea	outlet	75,59	3022,048
2018-11-05 12:00	33	2	B1	morph	sea	Hakkstein	4,953	24,54
2018-11-05 12:00	33	2	B2	morph	sea	Hakkstein	7,262	28,397
2018-11-05 12:00	34	2	B2	morph	sea	Holmen	9,114	41,654
2018-11-05 12:00	34	2	B1	morph	sea	Holmen	15,505	130,151
2018-11-05 12:00	34	2	B3	morph	sea	Holmen	NA	NA
2018-11-05 12:00	35	6	B2	serr	poll	outlet	18,367	563,14
2018-11-05 12:00	35	6	B1	serr	poll	outlet	20,461	666,948
2018-11-05 12:00	38	3	B2	morph	sea	Hakkstein	11,188	71,144
2018-11-05 12:00	38	3	B1	morph	sea	Hakkstein	18,068	114,034
2018-11-05 12:00	40	5	B2	morph	sea	Holmen	17,153	85,954
2018-11-05 12:00	40	5	B1	morph	sea	Holmen	20,917	161,42
2018-11-05 12:00	41	6	B2	serr	poll	outlet	45,829	1323,614
2018-11-05 12:00	41	6	B1	serr	poll	outlet	48,239	1319,654
2018-11-05 12:00	42	5	B1	morph	sea	Hakkstein	12,569	63,08
2018-11-05 12:00	42	5	B2	morph	sea	Hakkstein	14,14	96,103
2018-11-05 12:00	42	5	B3	morph	sea	Hakkstein	NA	NA
2018-11-05 12:00	46	6	B1	morph	poll	Hakkstein	8,882	55,46
2018-11-05 12:00	46	6	B2	morph	poll	Hakkstein	20,708	75,189
2018-11-05 12:00	49	6	B1	morph	poll	Hakkstein	11,98	108,088
2018-11-05 12:00	49	6	B2	morph	poll	Hakkstein	24,284	519,752
2018-11-05 12:00	50	1	B2	morph	poll	Hakkstein	6,438	29,103
2018-11-05 12:00	50	1	B1	morph	poll	Hakkstein	11,485	61,123
2018-11-05 12:00	54	1	B2	serr	poll	outlet	28,756	854,93
2018-11-05 12:00	54	1	B1	serr	poll	outlet	29,395	786,147
2018-11-05 12:00	59	6	B1	serr	poll	outlet	13,302	233,185
2018-11-05 12:00	59	6	B2	serr	poll	outlet	34,537	1043,442
2018-11-05 12:00	60	4	B1	serr	poll	outlet	81,437	3197,821

2018-11-05 12:00	60	4	B2	serr	poll	outlet	88,208	4098,691
2018-11-05 12:00	64	1	B1	morph	poll	Hakkstein	9,979	80,929
2018-11-05 12:00	64	1	B2	morph	poll	Hakkstein	11,224	103,138
2018-11-05 12:00	65	3	B2	morph	sea	Hakkstein	16,493	181,08
2018-11-05 12:00	65	3	B1	morph	sea	Hakkstein	22,582	263,384
2018-11-05 12:00	66	1	B1	morph	poll	Hakkstein	13,022	53,122
2018-11-05 12:00	66	1	B2	morph	poll	Hakkstein	20,953	136,174
2018-11-05 12:00	69	4	B2	morph	poll	NA	7,555	34,103
2018-11-05 12:00	69	4	B1	morph	poll	NA	14,873	66,313
2018-11-05 12:00	70	3	B2	serr	sea	outlet	32,109	761,915
2018-11-05 12:00	70	3	B1	serr	sea	outlet	54,919	2315,099
2018-11-05 12:00	71	1	B2	serr	poll	outlet	28,692	826,338
2018-11-05 12:00	71	1	B1	serr	poll	outlet	41,511	1202,682
2018-11-05 12:00	72	1	B1	morph	poll	Hakkstein	7,071	43,923
2018-11-05 12:00	72	1	B2	morph	poll	Hakkstein	8,375	54,441
2018-11-05 12:00	73	3	B1	morph	sea	Holmen	7,283	20,892
2018-11-05 12:00	73	3	B2	morph	sea	Holmen	10,856	47,218
2018-11-05 12:00	74	6	B2	serr	poll	outlet	12,161	275,058
2018-11-05 12:00	74	6	B1	serr	poll	outlet	12,409	359,486
2018-11-05 12:00	77	6	B2	morph	poll	Hakkstein	19,009	189,824
2018-11-05 12:00	77	6	B1	morph	poll	Hakkstein	20,944	180,644
2018-11-05 12:00	78	3	B1	morph	sea	Holmen	14,574	128,864
2018-11-05 12:00	78	3	B2	morph	sea	Holmen	16,869	66,097
2018-11-05 12:00	79	2	B2	morph	sea	Hakkstein	9,767	58,185
2018-11-05 12:00	79	2	B1	morph	sea	Hakkstein	15,317	113,106
2018-11-05 12:00	79	2	B3	morph	sea	Hakkstein	NA	NA
2018-11-05 12:00	81	4	B1	morph	poll	Hakkstein	NA	NA
2018-11-05 12:00	81	4	B2	morph	poll	Hakkstein	NA	NA
2018-11-05 12:00	81	4	B3	morph	poll	Hakkstein	NA	NA
2018-11-05 12:00	82	2	B2	morph	sea	Hakkstein	12,778	181,078
2018-11-05 12:00	82	2	B1	morph	sea	Hakkstein	16,855	143,958
2018-11-05 12:00	85	2	B1	serr	sea	outlet	28,261	691,235
2018-11-05 12:00	85	2	B2	serr	sea	outlet	36,504	1040,085
2018-11-05 12:00	88	3	B2	serr	sea	outlet	41,796	1 522,67
2018-11-05 12:00	88	3	B1	serr	sea	outlet	46,903	901,437
2018-11-05 12:00	90	4	B1	serr	poll	outlet	11,387	182,304
2018-11-05 12:00	90	4	B3	serr	poll	outlet	23,735	467,151
2018-11-05 12:00	91	5	B2	morph	sea	Holmen	7,942	57,023
2018-11-05 12:00	91	5	B1	morph	sea	Holmen	12,971	53,289
2018-11-05 12:00	94	5	B1	serr	sea	outlet	30,341	903,525
2018-11-05 12:00	94	5	B2	serr	sea	outlet	33,338	880,854
2018-11-05 12:00	97	4	B1	serr	poll	outlet	30,089	1354,523
2018-11-05 12:00	97	4	B2	serr	poll	outlet	55,662	1705,871
2018-11-05 12:00	100	1	B1	serr	poll	outlet	19,183	468,461
2018-11-05 12:00	100	1	B2	serr	poll	outlet	46,28	1264,627

Appendix 2

Total weight and lengths of all individuals in common garden taken every other week

Date	ID	Type	Treatment	Tot.length	Weight
2018-09-24	100	serr	poll	290	26,42
2018-09-24	54	serr	poll	230	13,16
2018-09-24	25	serr	poll	274	12,69
2018-09-24	71	serr	poll	457	34,9
2018-09-24	19	serr	poll	236	12,26
2018-09-24	18	morph	poll	65	1,88
2018-09-24	72	morph	poll	65	1,88
2018-09-24	64	morph	poll	47	1,88
2018-09-24	50	morph	poll	110	7,05
2018-09-24	66	morph	poll	88	3,67
2018-09-24	15	serr	sea	264	6,02
2018-09-24	85	serr	sea	295	15,53
2018-09-24	28	serr	sea	293	14,34
2018-09-24	16	serr	sea	340	32,03
2018-09-24	32	serr	sea	335	14,68
2018-09-24	33	morph	sea	65	1,85
2018-09-24	82	morph	sea	90	1,92
2018-09-24	34	morph	sea	85	5,03

2018-09-24	22	morph	sea	125	6,65
2018-09-24	79	morph	sea	60	1,41
2018-09-24	88	serr	sea	251	20,32
2018-09-24	12	serr	sea	232	12,63
2018-09-24	70	serr	sea	263	11,74
2018-09-24	17	serr	sea	255	18,72
2018-09-24	23	serr	sea	320	22,45
2018-09-24	38	morph	sea	120	2,88
2018-09-24	65	morph	sea	86	1,44
2018-09-24	73	morph	sea	80	1,82
2018-09-24	21	morph	sea	70	2,23
2018-09-24	78	morph	sea	125	13,49
2018-09-24	14	serr	poll	280	12,19
2018-09-24	90	serr	poll	380	32,82
2018-09-24	24	serr	poll	205	4,09
2018-09-24	60	serr	poll	384	26,39
2018-09-24	97	serr	poll	275	13,63
2018-09-24	31	morph	poll	105	13,66
2018-09-24	81	morph	poll	50	2,27
2018-09-24	8	morph	poll	60	0,92
2018-09-24	26	morph	poll	70	5,08
2018-09-24	69	morph	poll	75	3,41
2018-09-24	11	serr	sea	330	31,82
2018-09-24	52	serr	sea	405	24,45
2018-09-24	27	serr	sea	280	17,56
2018-09-24	4	serr	sea	305	19,25
2018-09-24	94	serr	sea	290	13,82
2018-09-24	91	morph	sea	60	2,18
2018-09-24	42	morph	sea	40	1,32
2018-09-24	31	morph	sea	110	7,4
2018-09-24	40	morph	sea	100	3,89
2018-09-24	29	morph	sea	70	1,76
2018-09-24	2	serr	poll	360	25,84
2018-09-24	43	serr	poll	275	11,09
2018-09-24	92	serr	poll	250	12,48
2018-09-24	41	serr	poll	305	16,08
2018-09-24	59	serr	poll	223	9,23
2018-09-24	10	morph	poll	100	3,01
2018-09-24	46	morph	poll	73	2,2
2018-09-24	7	morph	poll	87	4,2
2018-09-24	77	morph	poll	70	2,4
2018-09-24	49	morph	poll	60	2,42

Appendix 3

All individuals included in morphometric measurements: First 10 pictures *F. serratus* and next 10 show 10 *Fucus* x individuals. Individual lengths (cm) and weights (g) included for each individual on photographs.


22
Length: 13.5 cm
Weight: 6.14 g


38
Length: 10 cm
Weight: 2.73 g


31
Length: 11.5 cm
Weight: 8.24 g


26
Length: 7.5 cm
Weight: 6.93 g


Length: 7.5 cm
Weight: 2.01 g


55
Length: 6.8 cm
Weight: 0.91 g


10
Length: 11 cm
Weight: 2.76 g


18
Length: 6.9 cm
Weight: 1.83 g


7
Length: 10 cm
Weight: 1.94 g


73
Length: 7 cm
Weight: 1.74 g

Appendix 4

Crossing of morphotypes	Water-salinity	Week	Estimation of total number of Germlings
Fs-HAN-1 x Fs-HUN-1	sea	1	10-100
		2	1-10
	poll	1	100-1000
		2	100-1000
Fs-HAN-2 x Fs-HUN-2	sea	1	100-1000
		2	100-1000
	poll	1	100-1000
		2	100-1000
Fs-HAN-3 x Fs-HUN-2	sea	1	10-100
		2	10-100
	poll	1	100-1000
		2	100-1000
Fx-HAN-1 x Fx-HUN-1	sea	1	0
		2	10-100
	poll	1	10-100
		2	10-100
Fx-HAN-2 x Fx-HUN-2	sea	1	10-100
		2	1-10
	poll	1	1-10
		2	0
Fx-HAN-3 x Fx-HUN-3	sea	1	0
		2	0
	poll	1	10-100
		2	10-100
Fs-HAN-1 x Fx-HUN-1	sea	1	10-100
		2	10-100
	poll	1	100-1000
		2	10-100
Fs-HAN-2 x Fx-HUN-2	sea	1	1-10
		2	1-10
	poll	1	0
		2	0
Fs-HAN-3 x Fx-HUN-3	sea	1	0
		2	1-10
	poll	1	0
		2	1-10
Fx-HAN-1 x Fs-HUN-1	sea	1	0
		2	0
	poll	1	100-1000
		2	100-1000
Fx-HAN-2 x Fs-HUN-2	sea	1	0
		2	1-10
	poll	1	10-100
		2	100-1000
Fx-HAN-3 x Fs-HUN-2	sea	1	0
		2	0
	poll	1	100-1000
		2	100-1000

Appendix 5

Inventory of reproductive individuals in the common garden experiment in the 25th of October

Morphotype	Total number of branch tips	Number of reproductive tips
Fucus x	86	8
Fucus x	421	14
Fucus x	27	17
Fucus x	287	49
Fucus x	48	7
Fucus x	33	4
Fucus x	178	39
Fucus x	12	12
Fucus x	91	12
Fucus x	40	11
Fucus x	72	10
Fucus x	44	7
Fucus x	64	29
Fucus x	120	13
Fucus x	41	7
Fucus x	170	34
Fucus x	63	4
Fucus x	57	8
Fucus serratus	34	5
Fucus serratus	94	12
Fucus serratus	21	1
Fucus serratus	50	5
Fucus serratus	64	6
Fucus serratus	38	2
Fucus serratus	57	1
Fucus serratus	59	4
Fucus serratus	69	6

Appendix 6

Individuals included in DNA-sampling

Date	ID	Type	Treatment	Tank	Code on DNA-Sample	Site	Mutation present = X
07-11-2018	30	Morph	Acklimatization	Bucket	30BM	Holmen	
	47	Morph	Acklimatization	Bucket	47BM	Holmen	
	83	Morph	Acklimatization	Bucket	83BM	Hakksteinpollen	
	96	Morph	Acklimatization	Bucket	96BM	Holmen	x
	62	Morph	Acklimatization	Bucket	62BM	Holmen	
	72	Morph	Poll	1	72PM	Hakksteinpollen	x
	93	Morph	Poll	1	93PM	Hakksteinpollen	x
	68	Morph	Poll	1	68PM	Hakksteinpollen	
	79	Morph	Sea	2	79SM	Hakksteinpollen	x
	33	Morph	Sea	2	33SM	Hakksteinpollen	
	34	Morph	Sea	2	34SM	Holmen	
	82	Morph	Sea	2	82SM	Hakksteinpollen	x
	65	Morph	Sea	3	65SM	Hakksteinpollen	x
	21	Morph	Sea	3	21SM	Holmen	
	78	Morph	Sea	3	78SM	Holmen	
	16	Serratus	Sea	2	16SS	outlet	
	80	Serratus	Sea	2	80SS	outlet	
	28	Serratus	Sea	2	28SS	outlet	
	15	Serratus	Sea	2	15SS	outlet	
	85	Serratus	Sea	2	85SS	outlet	
	94	Serratus	Sea	5	94SS	outlet	
	52	Serratus	Sea	5	52SS	outlet	
	4	Serratus	Sea	5	4SS	outlet	
	95	Serratus	Sea	5	95SS	outlet	
	11	Serratus	Sea	5	11SS	outlet	
	27	Serratus	Sea	5	27SS	outlet	
	71	Serratus	Poll	1	71PS	outlet	
	19	Serratus	Poll	1	19PS	outlet	
	54	Serratus	Poll	1	54PS	outlet	
	12	Serratus	Sea	3	12SS	outlet	

Appendix 7

Sequences obtained from sequencing mtIGS. Colors indicating differences between sequences.

SS4-Fucus x uten mutasjon-Site 2

GAAAAGTTAAATATATAACACAGGAAAGTTTTTTATTATAGTCAAAGGAATAAACCTATACTTGTTTCTTACGATAAGTTTTTTAGAGGCCTAT
CAAGTTAGCTAGTAGTTGCTCTTAAAAAGAAAAAGTTTATTTCAACTAAAAATATTACTCTCATCAGACGTCTACTTTTTTACGTCCAAAAAGA
CGCGTTGTTTTAGAGGGTAGCGCAGGTAGTTAACGTTATATCTTTTAGAAAATGATGAGACTTTAATTATCAAGAAGCCGTTTTGTATTTACGT
GCGTGTTATTATATATGCTTATTTAAGTGTAATATCGTATTG**C**GTTAAAGGGTATTTAAGATATCCGGTATATCCACTTTTTTAGTTTTTAGAA
CTTCGTTTATTAAATTAATTTTAAAAAGTAGTACGTATTTTTTTCTTTTTTAAAGAATTTACCT**TTA**TT**AT**AAG

SS6 Fucus x med mutasjon- Site 1

GAAAAGTTAAATATATAACACAGGAAAGTTTTTTATTATAGTCAAAGGAATAAACCTATACTTGTTTCTTACGATAAGTTTTTTAGAGGCCTAT
CAAGTTAGCTAGTAGTTGCTCTTAAAAAGAAAAAGTTTATTTCAACTAAAAATATTACTCTCATCAGACGTCTACTTTTTTACGTCCAAAAAGA
CGCGTTGTTTTAGAGGGTAGCGCAGGTAGTTAACGTTATATCTTTTAGAAAATGATGAGACTTTAATTATCAAGAAGCCGTTTTGTATTTACGT
GCGTGTTATTATATATGCTTATTTAAGTGTAATATCGTATTG**T**GTTAAAGGGTATTTAAGATATCCGGTATATCCACTTTTTTAGTTTTTAGAA
CTTCGTTTATTAAATTAATTTTAAAAAGTAGTACGTATTTTTTTCTTTTTTAAAGAATTTACCT**TTA**TT**AT**AAG

SS16 Fucus serratus-Site 3

GAAAAGTTAAATATATAACACAGGAAAGTTTTTTATTATAGTCAAAGGAATAAACCTATACTTGTTTCTTACGATAAGTTTTTTAGAGGCCTAT
CAAGTTAGCTAGTAGTTGCTCTTAAAAAGAAAAAGTTTATTTCAACTAAAAATATTACTCTCATCAGACGTCTACTTTTTTACGTCCAAAAAGA
CGCGTTGTTTTAGAGGGTAGCGCAGGTAGTTAACGTTATATCTTTTAGAAAATGATGAGACTTTAATTATCAAGAAGCCGTTTTGTATTTACGT
GCGTGTTATTATATATGCTTATTTAAGTGTAATATCGTATTG**C**GTTAAAGGGTATTTAAGATATCCGGTATATCCACTTTTTTAGTTTTTAGAA
CTTCGTTTATTAAATTAATTTTAAAAAGTAGTACGTATTTTTTTCTTTTTTAAAGAATTTACCT**TTA**TT**AT**AAGAGAAGTTTTTTG