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Aquaculture Collaborative Research and Development Program (ACRDP) Fact Sheet

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Determining optimal culture periods for the Atlantic Kelp (*Saccharina longicruris*) in Gaspésie, Quebec

Summary

Commercial culture of marine seaweeds in Quebec is in the very early stages of development. Initial trials to culture algae began in the autumn of 2005 by *Les Gaspésiennes–Algues Inc*. The company was active in processing marine algae for various purposes and wanted more control over the quantity, quality and regularity of its supply. Initial trials of macroalgae culture focused on *Saccharina longicruris* and were conducted in 2006 and 2007 in Chaleur Bay in a production cycle lasting from April to November. During initial trials, major biomass losses were observed after the fronds were colonized by the bryozoan *Membranipora membranacea*, a non-native invasive species. This study investigated the possibility of reducing bryozoan-related losses by beginning the production cycle earlier in the year in order to avoid culturing during the summer, when the bryozoan has been known to establish on fronds. Concurrently, the study also tested a four month production cycle, so that three production cycles could be established per year (autumn, winter, and spring). Results indicated that short cycles do not produce sufficient harvest volume. However, transferring plantlets (young algal plants) to sea in late autumn and harvesting them in July of the following year (8- to 10-month Autumn-Summer production cycle) resulted in good harvest of the cultured algae in good condition and free of bryozoans.

Figure 1. Atlantic Kelp (*Saccharina longicruris*)

The Aquaculture Collaborative Research and Development Program (ACRDP) is a Fisheries and Oceans Canada (DFO) initiative to increase the level of collaborative research and development activity between the aquaculture industry and DFO. Projects under ACRDP seek to improve aquaculture environmental performance and support optimal fish health.

Introduction

Culturing marine macroalgae is a new activity in Quebec. It began in Gaspésie in the autumn of 2005 at the request of *Les Gaspésiennes–Algues Inc*, in Chaleur Bay. The company was already active in the processing of marine algae for food and horticultural purposes by harvesting wild plants, specifically Atlantic Kelp (*Saccharina longicruris*) (Figure 1), via underwater diving. It wanted greater control over the regularity, quantity and quality of its supply, and was considering culturing as a possible solution.

An initial sea culture trial was carried out in 2006 in Chaleur Bay, off Paspébiac. The culture was started with line seeded with spores from mature wild plants harvested from their natural environment. In the laboratory, six weeks after seeding, the lines with the young algal plants (plantlets) were placed in culturing tanks for four

months, and then transferred to sea for five more months. Unfortunately, this first culture trial failed in terms of harvested biomass because the fronds (Figure 2) had been colonized by the bryozoan *Membranipora membranacea*. This invasive species attaches itself preferentially to kelp fronds and forms colonies made up of dozens to thousands of individuals. In turn, this reduces the flexibility of the fronds, making them vulnerable to damage due to water movement (Figure 3).

A second culture trial was established in 2007. Work was carried out at two sites, one in Paspébiac and the other in Grande-Rivière, and seeded lines were hung at five different depths between 2 and 11 m. Conditions favourable to the survival and growth of cultured algae were present in Grande-Rivière, suggesting that culturing the kelp could be feasible in many areas off the Gaspésie coast. However, the kelp cultured at the Grande-Rivière site were also affected by bryozoan colonization. Depth was not observed to play a significant role in reducing bryozoan exposure. Kelp was observed to grow well at depths greater than 5 m. This finding was particularly important because it meant that kelp could potentially be cultured at depths at which aquaculture structures could be left in place year-round. The winter months had previously been ruled out as a potential culturing period because of the inconveniences associated with floating ice.

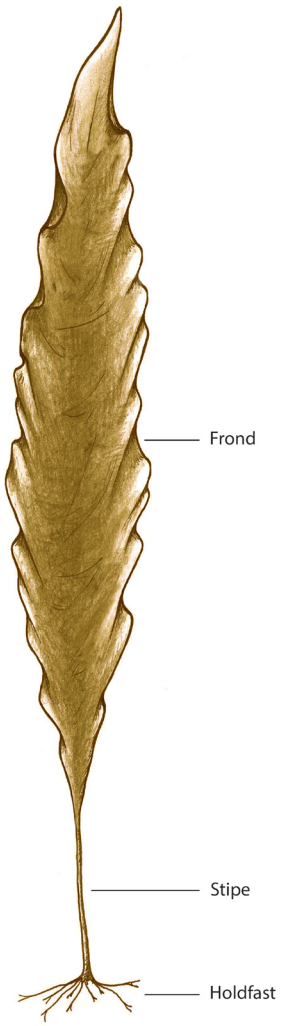

Figure 2. Illustration of Atlantic Kelp (*Saccharina longicruris*) showing the frond, stipe, and holdfast.

Based on results from the previous two phases of the project, kelp culture trials conducted in 2008 - 2009 in partnership with *Les Gaspésiennes–Algues Inc.* tested other culturing periods that might limit the colonization of fronds by the invasive bryozoan. The trials were also designed to determine whether it was possible to have more than one production cycle per year.

Figure 3. Atlantic Kelp (*Saccharina longicruris*) frond completely colonized by *Membranipora membranacea* bryozoan (bottom) and frond without bryozoan (top). (Photo: L. Gendron DFO)

Methods

Sea trials were carried out on *Les Gaspésiennes–Algues Inc.*'s aquaculture site in Chaleur Bay, off Paspébiac within the northeast corner of the site (Figure 4).

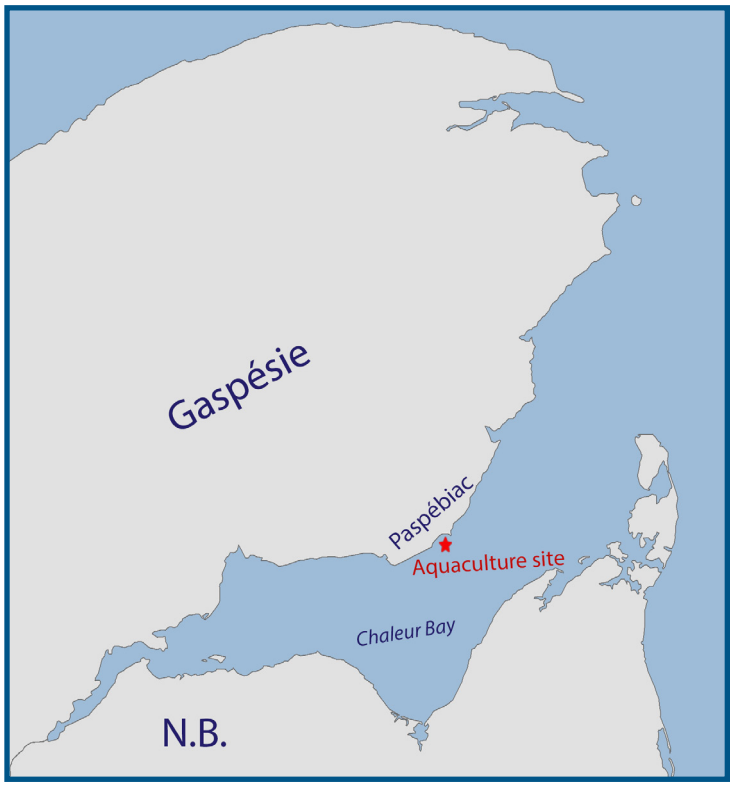

Figure 4. Map of Chaleur Bay off Paspébiac, showing the location of the aquaculture site.

To seed the culture lines with kelp spores, large wild adult plants were harvested either through diving (if found underwater) or at the surface (if found drifting). Sporulation was induced in mature plants in accordance with the protocol developed by Pérez *et al*. (1990). *In vitro* cultures of male and female gametophytes were also conserved to ensure constant availability of material without having to harvest additional adult plants.

White nylon fibre lines, 10 m in length, were used for culture. The lines were wound around PVC cylindrical supports (Figure 5A).

Figure 5. A) Culture lines on cylindrical supports B) Rolling culture lines on longline. (Photo: L. Gendron DFO)

To begin the seeding process, line supports were submerged in a spore solution for 12 hours. For the 2009 spring cycle, some of the culture lines were also seeded with a male and female gametophyte mix that was sprayed on using a compressor.

After seeding, the cylindrical supports were transferred to 50 L of sterile sea water enriched with a culture medium and kept in optimal conditions for sporophyte growth. After 30 to 40 days of controlled culturing, the plantlets had reached lengths of 2 to 5 mm and were ready to be transferred to the sea.

At the site, the bearing line was raised, and the lines containing plantlets were wrapped around it in a tight spiral. The wrapping was done by hand by winding the PVC support tube around the longline as the boat moved along the line (Figure 5B).

The initial planning was for three production cycles of 4 months each. As a result of various technical and weather related constraints, the anticipated schedules for the transfer to sea, monitoring and harvesting of the algae had to be modified. Therefore, the autumn cycle became an Autumn-Spring cycle of 205 days, the winter cycle became an Autumn-Summer cycle of 237 days and the spring cycle became a Spring-Summer cycle of 96 days (Table 1).

Table 1. Duration, interim sampling and harvest dates of algae culture trials.

Cycle	Transfer to sea	Interim Sampling	Harvest
Autumn - Spring	24 Sept '08	27 Nov '08 (64 days)	17 Apr '09 (205 days)
Autumn - Summer	27 Nov '08	17 Apr '09 (141 days)	22 Jul '09 (237 days)
Spring - Summer	17 Apr '09	-	22 Jul '09 (96 days)

Sampling was conducted at the interim sample point, as well as at the final harvest, and four random samples of non-adjacent 1 m sections of longline seeded rope were taken from each bearing line. In the laboratory, each sample was weighed to determine the total wet weight of the algae per meter of longline. The algae were counted, and the stipe length and the length and width of each frond measured. The appearance of the algae and the relative quantity and nature of epibionts (organisms living on the surface of the algae) were documented.

Results / Discussion

In 2009, as observed in previous trials in 2006 and 2007, colonies of *M. membranacea* bryozoan began to appear on the fronds of algae in the month of July. No other biofouling, however, was found on any lines that were between 7 and 8 m deep, aside from a few filamentous algae. Additionally, no herbivorous predators were found.

The Spring-Summer cycle, which lasted three and a half months, did not produce a satisfactory yield. During the July harvest, only 11.6% of fronds were longer than 30 cm, and only 1% was longer than 50 cm. The density of plants on the culture rope was high, but the harvestable biomass was low, at less than 200 g / m.

The Autumn-Spring cycle, which lasted six and a half months, until April, also did not produce satisfactory results. Only 13% of fronds were longer than 30 cm and only 1% was longer than 50 cm. These results were comparable to the Spring-Summer cycle and were still insufficient for commercial purposes. At that time of year,

the density was fairly high (183 plants / m), but because of the small frond sizes, the harvestable biomass was no more than 300 g / m of rope. Starting the cultures in late September, however, did seem to be effective at avoiding colonization with biofouling in general.

The nearly eight-month Autumn-Summer cycle, from November to July, produced good results in terms of frond length and biomass. During the first phase of the cycle (firsts five months), plants reached an average size of 18.3 cm (with the larger plants extending to 37.1 cm in length). In extending the culture period until July, and providing three additional months of growth, yields of commercial potential were produced. It was also between April and July that growth rate was noted as being the fastest. At harvest time, 65.1% of the plants were longer than 30 cm, and 45.4% were longer than 50 cm. This translated into an average biomass of more than 3 kg / m of algae with an excellent appearance (Figure 6).

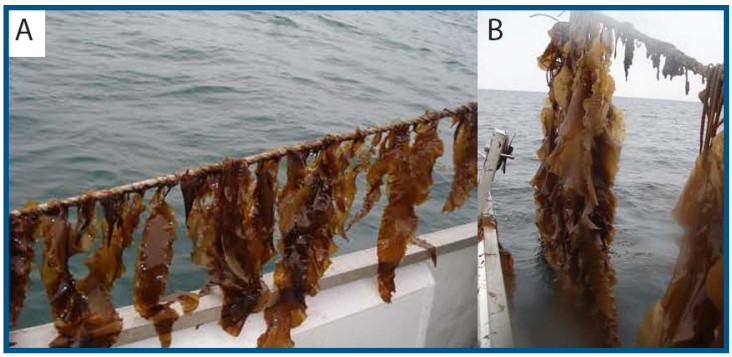

Figure 6. Algal appearance during Autumn-Summer cycle: A) at April 17, 2009 (interim monitoring) B) at July 22, 2009 (harvest). (Photo: L. Gendron DFO)

Conclusions

The results of this study were generally positive. It was determined that kelp plantlets at a length of more than 5 mm and transferred to sea in autumn on a longline placed 7 to 8 m below surface, can not only survive in the sea during the winter, but can also grow considerably until July. The algae benefits from the good growing conditions that prevail between April and July. A July harvest prevents the accumulation of biofouling and epibionts (organisms which settle on the kelp), which can become a nuisance later in summer. This is therefore the best culture strategy that has been tested to date.

However, short culture cycles (approximately 4 months) – whether they start in autumn, early winter or spring – do not produce sufficient biomass for commercial exploitation based on volume, to be used in fertilizers, for instance. Nevertheless, after being cultured for 2 to 6 months, the algae had certain characteristics (thin fronds, small size, etc.) that could be of interest to the human food sector.

Yields obtained in 2009 (3.3 kg / m), after being cultured at sea for 8 months, are double the yields that had been obtained at the end of the 2006 and 2007 trials, and the plant quality was better. These yields could be increased by raising the longline by a few metres in early spring. Future research could help determine whether decreased plant density on the longline could produce greater yields.

This ACRDP project (QC-06-01-002) was a collaborative effort between the Department of Fisheries and Oceans and *Les Gaspésiennes–Algues* Inc.. One of the scientists on this project, Louise Gendron, can be reached at **louise.gendron@dfo-mpo.gc.ca.**

For further information on this and other ACRDP projects, visit: **www.dfo-mpo.gc.ca/science/enviro/aquaculture/acrdp-pcrda/index-eng.htm**

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