

An overview of applied research on kelp aquaculture in Québec, Canada

E.Tamigneaux¹, A.Licois² & G.Hersant³

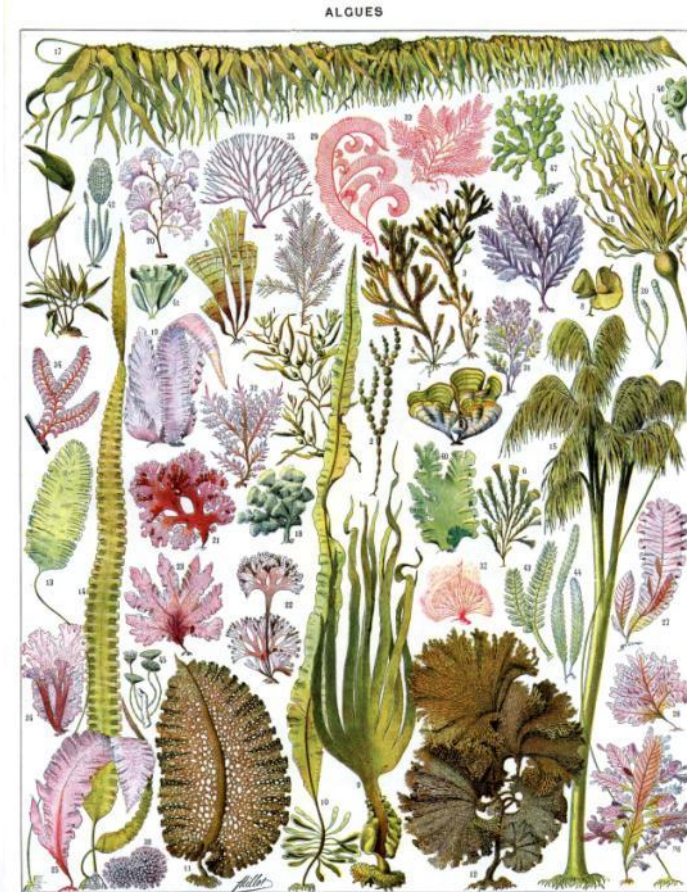
¹ ÉPAQ, Cégep de la Gaspésie et des Îles

² Merinov

³ Oleotek, Cégep de Thetford Mines

Outline of the presentation

1. Marine aquaculture in Québec
2. Portrait of the seaweed industry
3. Progress in kelp farming
4. Kelp product development
5. Industrial research chair grant



Dessin d'Adolphe Millot pour l'article "algue" du Larousse du XXe siècle (1931). Avec l'aimable autorisation des Éditions Larousse. \n1. Sargassum

1. Marine aquaculture in Québec

1.1 Playground

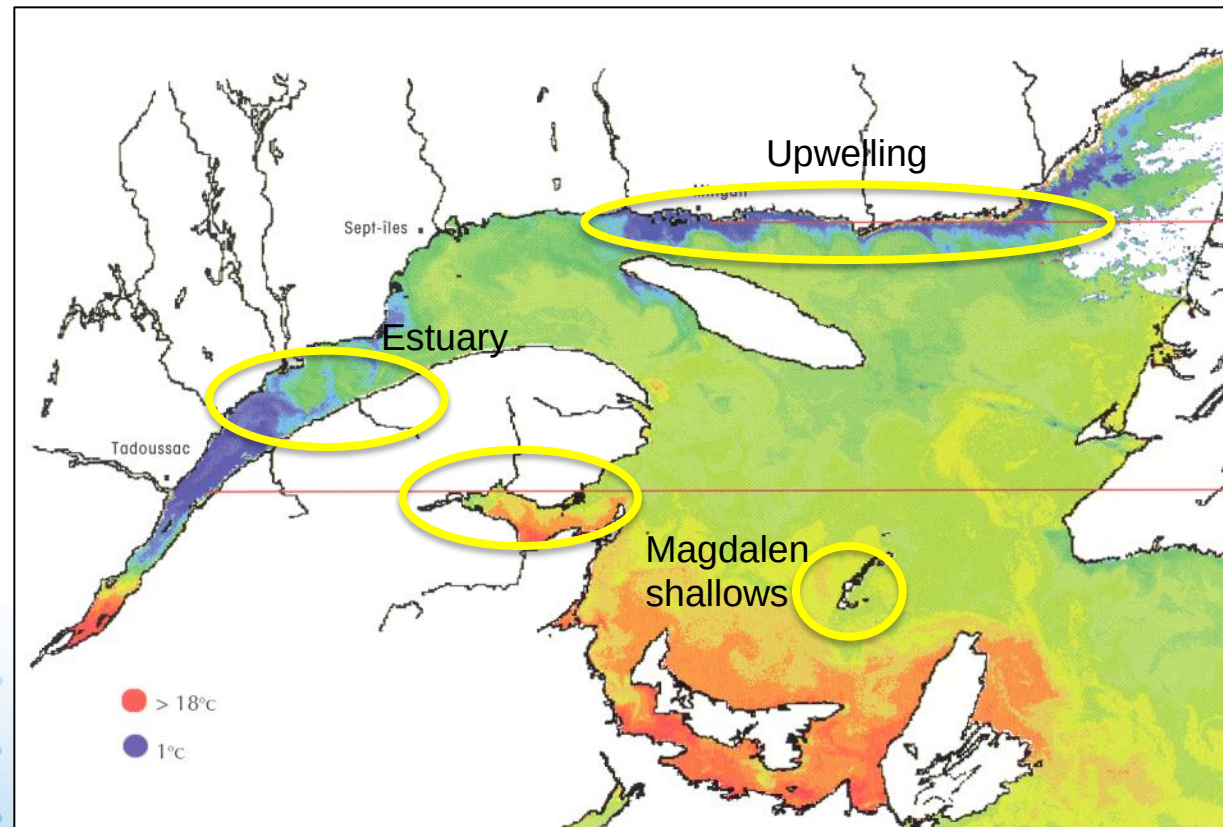
- Large territory N-S
- Diversity of climates
- No pollution or eutrophication of coastal waters



1. Marine aquaculture in Québec

1.1 Playground

Surface temperatures in the gulf of St Lawrence, on August 22 1990

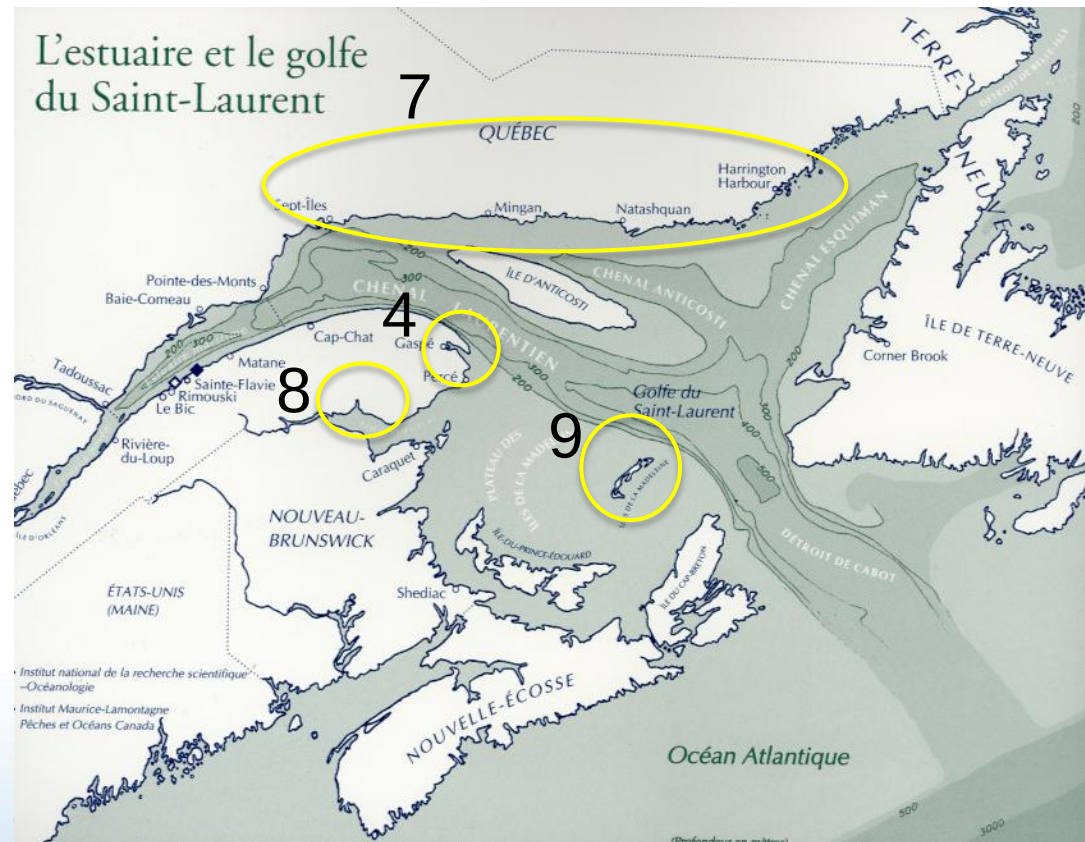


Températures de surface du golfe et de l'estuaire du Saint-Laurent, le 22 août 1990.
Image traitée par Daniel A. De Lisle, Groupe de recherche en environnement côtier (GREC), INRS-Océanologie.

1. Marine aquaculture in Québec

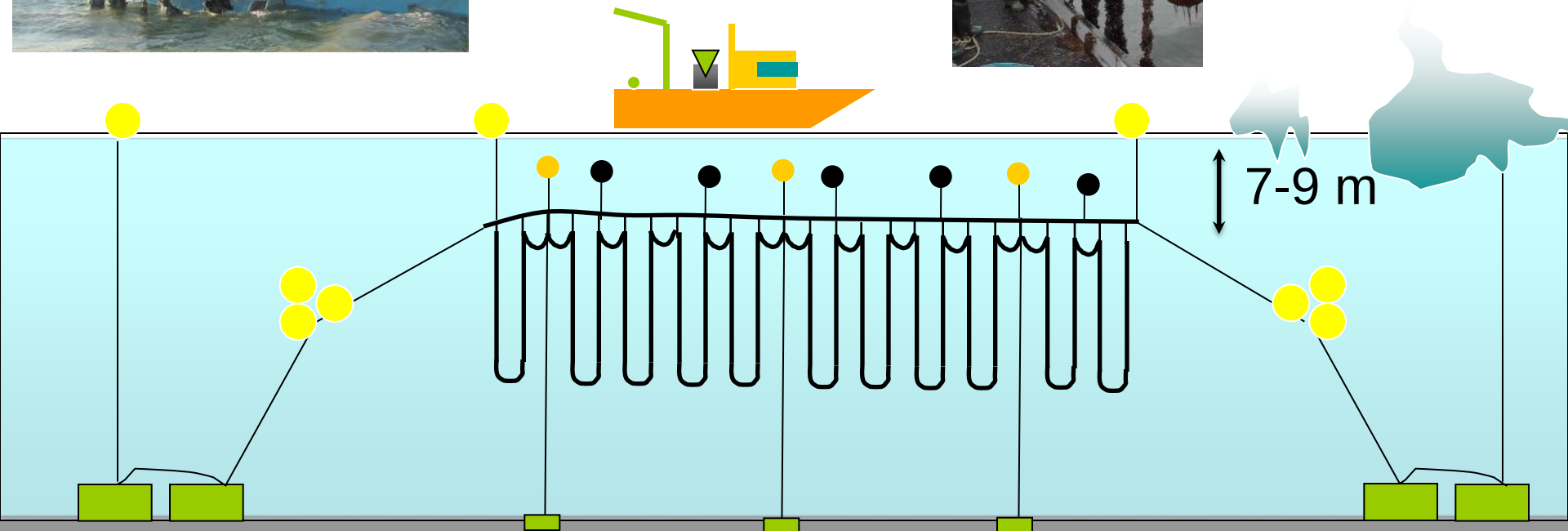
1.2 Marine aquaculture industry

- 20 small companies
- Shellfish producers
 - Mussels (11)
 - Scallops (4)
- 500 tm/yr (mussels)



1. Marine aquaculture in Québec

Submerged longlines



E. Tamigneaux

2. Portrait of the seaweed industry

2.1 Which seaweeds are available ?

Green	<i>Ulva lactuca</i> (sea lettuce)		
	<i>Monostroma</i> sp.		
	<i>Enteromorpha</i> sp.		
Brown	<i>Ascophyllum nodosum</i> (knotted wrack)		
	<i>Eucus</i> sp. (bladder wrack, etc.)		
	<i>Maccharina longicruris</i> (kelp)		
	<i>Alaria esculenta</i> (dabberlocks)		
Red	<i>Chondrus crispus</i> (Irish moss)		
	<i>Palmaria palmata</i> (Dulse)		
	<i>Porphyra</i> (Nori)		

Subarctic province = brown seaweeds

2. Portrait of the seaweed industry

2.2 Which are commercially harvested ?



*Ascophyllum
nodosum*

(Knotted wrack)



Fucus sp.

(Bladder wrack, etc.)



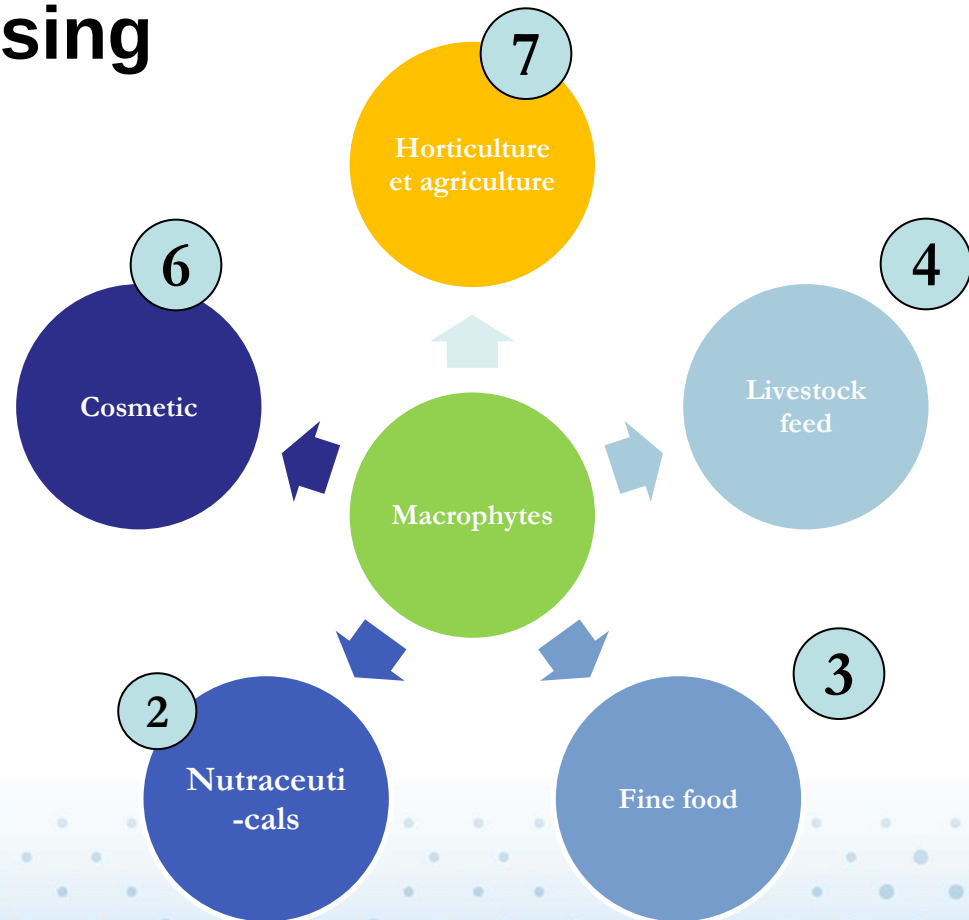
*Saccharina
latissima,
S. longicruris*

(Kelp)

2. Portrait of the seaweed industry

2.3 Harvest and processing

- 22 companies involved
- 4 companies harvest
- 100% wild resources, (150 mt / yr)
- Fertiliser, cosmetical, nutraceutical, livestock feed, fine food



2. Portrait of the seaweed industry

2.4 Low value products

Compost, fertilizer, biostimulant

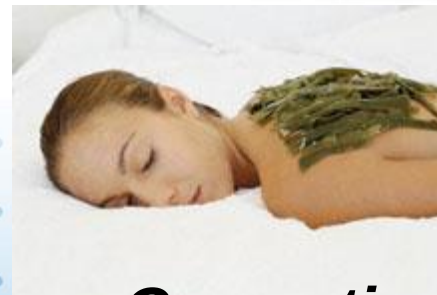


2. Portrait of the seaweed industry

2.5 High value products



Food



Cosmetic

Nutraceutical

2. Portrait of the seaweed industry

2.6 Limiting factors

- Inventories geographically limited (1980)
- Access to the shoreline (truck)
- Harsh climate, exposed shoreline, depth, erosion of seaweed beds by drifting ice
- Overgrazing by green urchins
- Strict and complex regulations
- DFO in favour of cultivation

=> Should we turn towards seaweed aquaculture ?

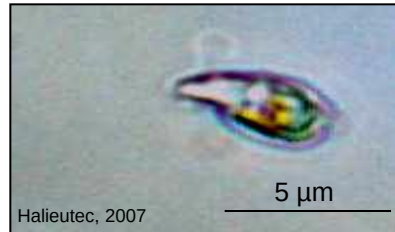


3. Progress in kelp farming

Seedling production in onshore facilities (hatchery)



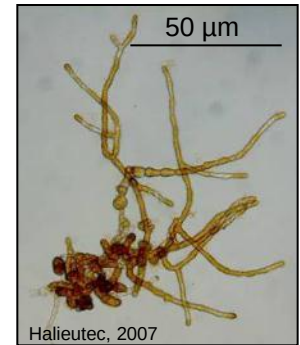
Mature blade with sorus



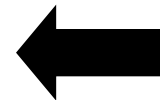
Swimming zoospore
with 2 flagella



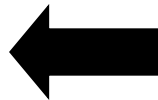
Nylon ropes



Seedling embryo



Seedling (0,5 mm)



Plantlets production

in the hatchery (30-40 days, 10° C)



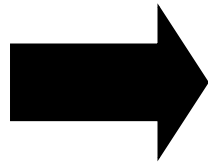
3. Progress in kelp farming

Outplanting at sea



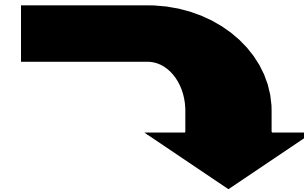
Halieutec, 2007

Rope seeded with 2-4 mm plantlets



Halieutec, 2011

Outplanting on longlines
(Oct-Nov.)



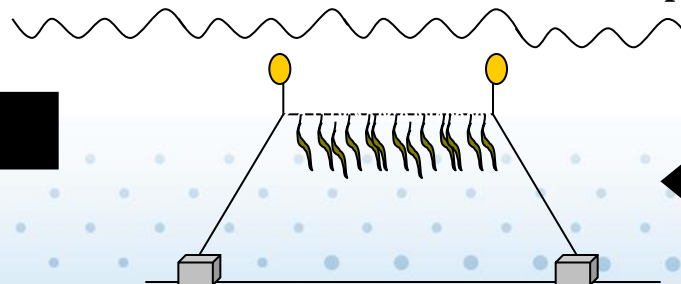
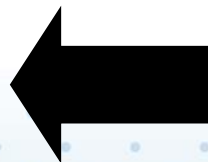
Halieutec, 2007

Kelp growing on the longlines

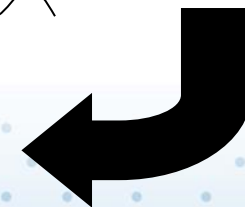


Halieutec, 2009

Harvest after 8-10 months
(June-July)

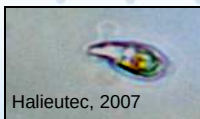
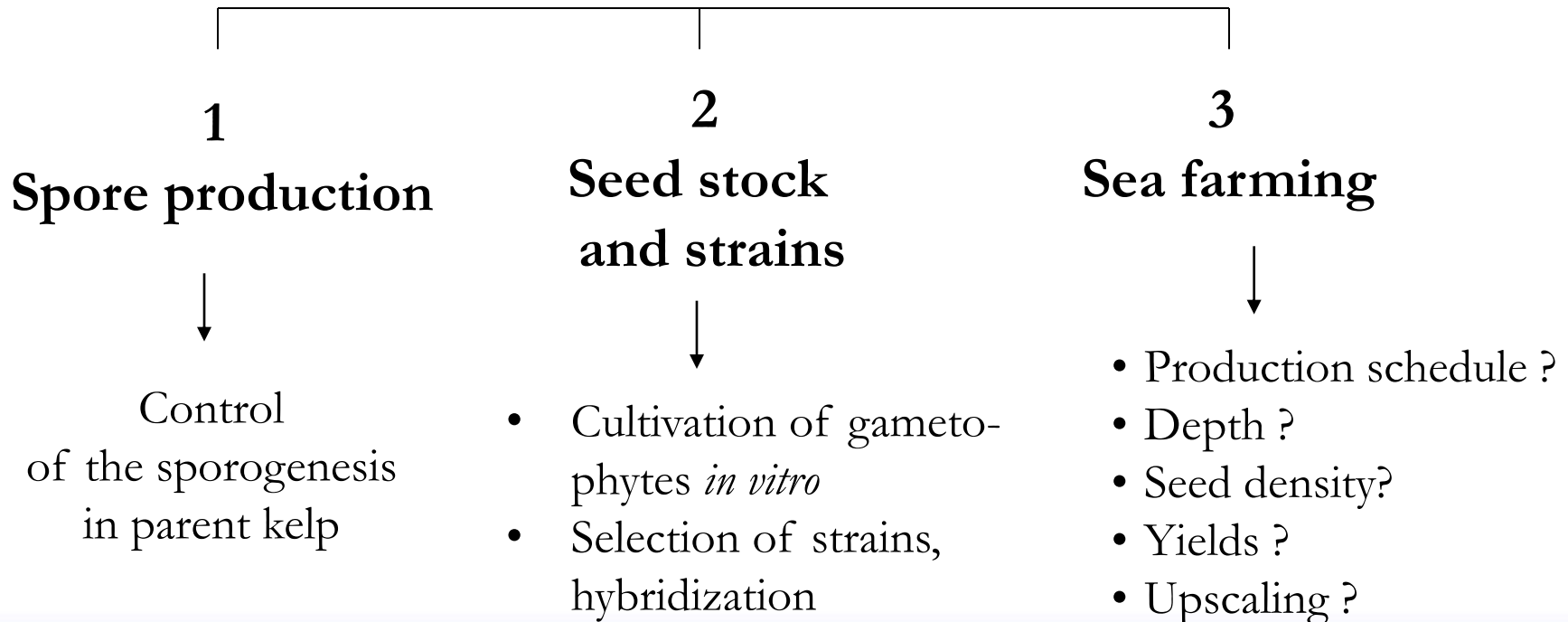


Marine farm



3. Progress in kelp farming

First trials allowed us to identify R&D themes (2006-2012)



3. Progress in kelp farming

3.1 Availability of seeds

3.1.1 Artificial induction of sporogenesis (Pang and Lüning, 2004)

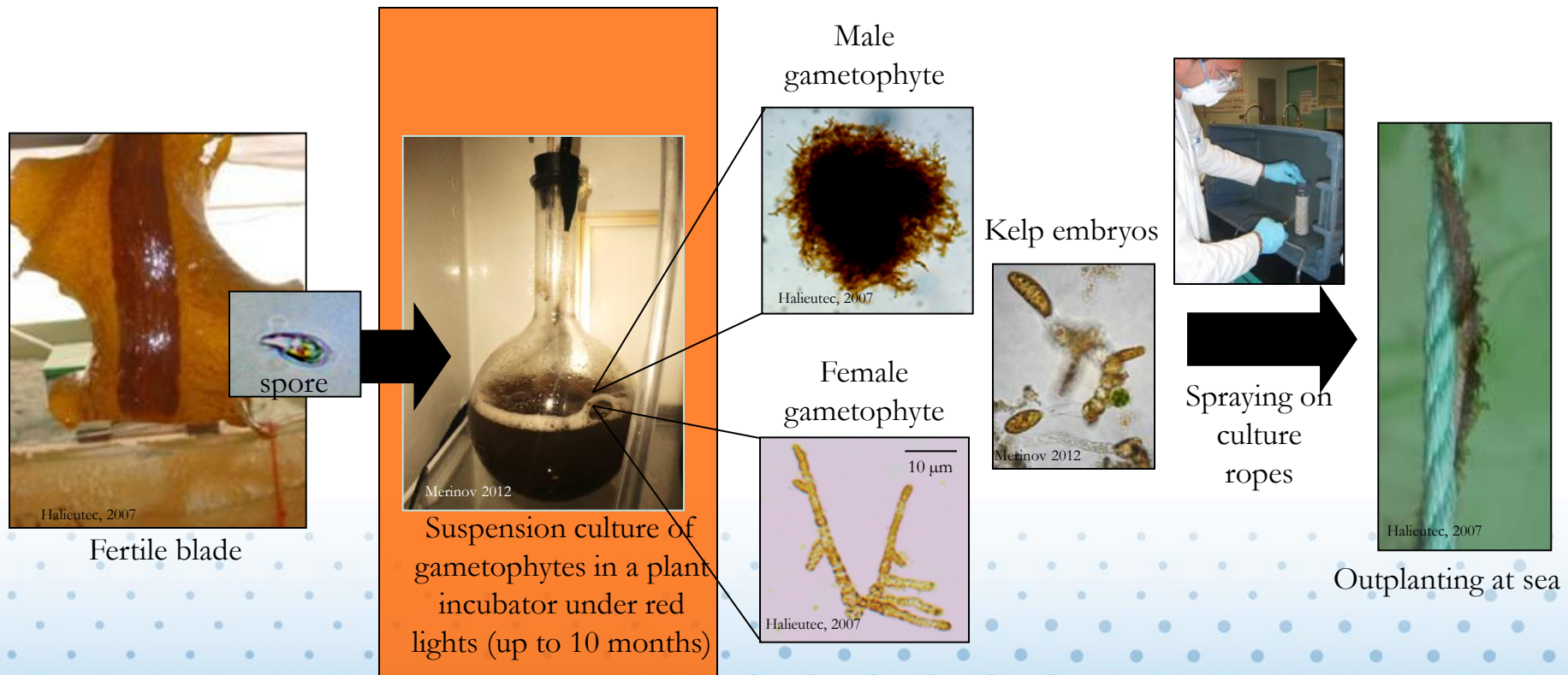
- Removal of the blade meristem area
- Constant short days (8:16) with fluo tubes
- 10-15 °C



3. Progress in kelp farming

3.1 Availability of seeds

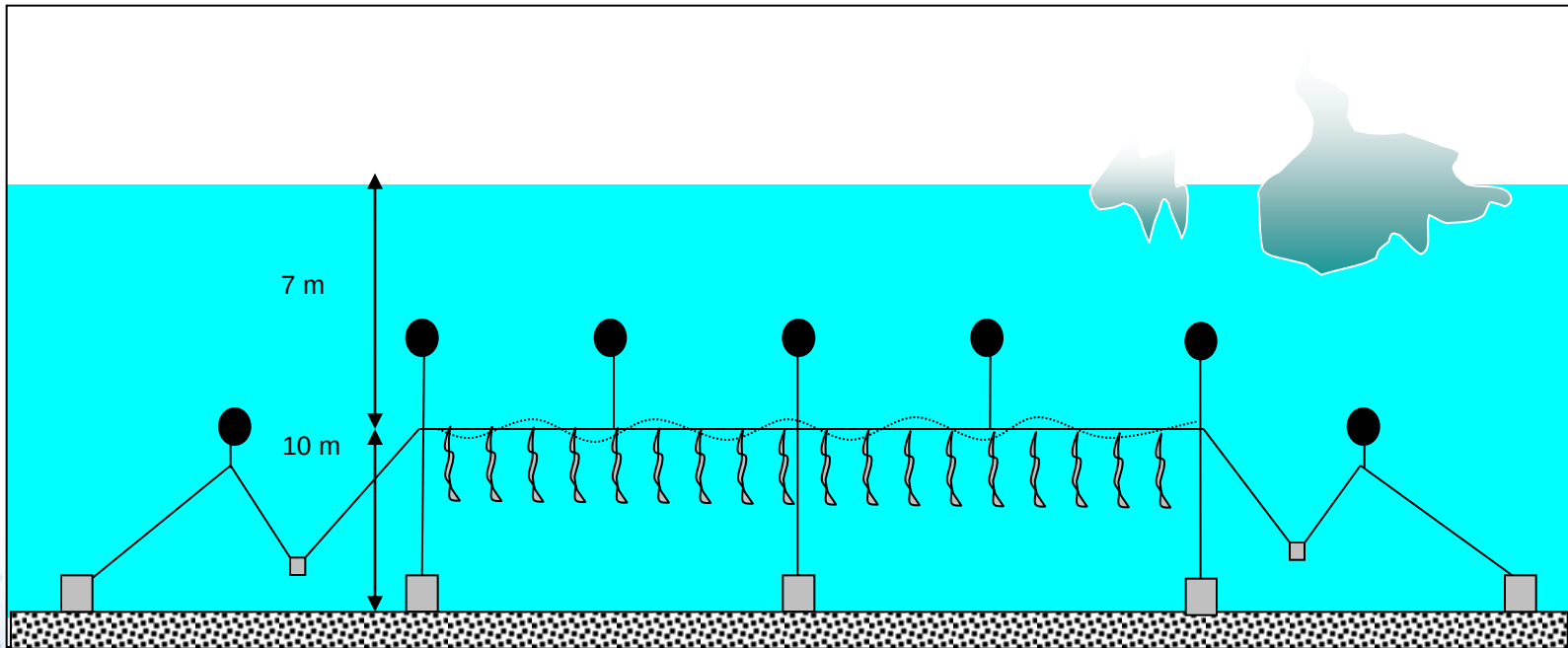
In vitro suspension culture of gametophytes (free-living)



3. Progress in kelp farming

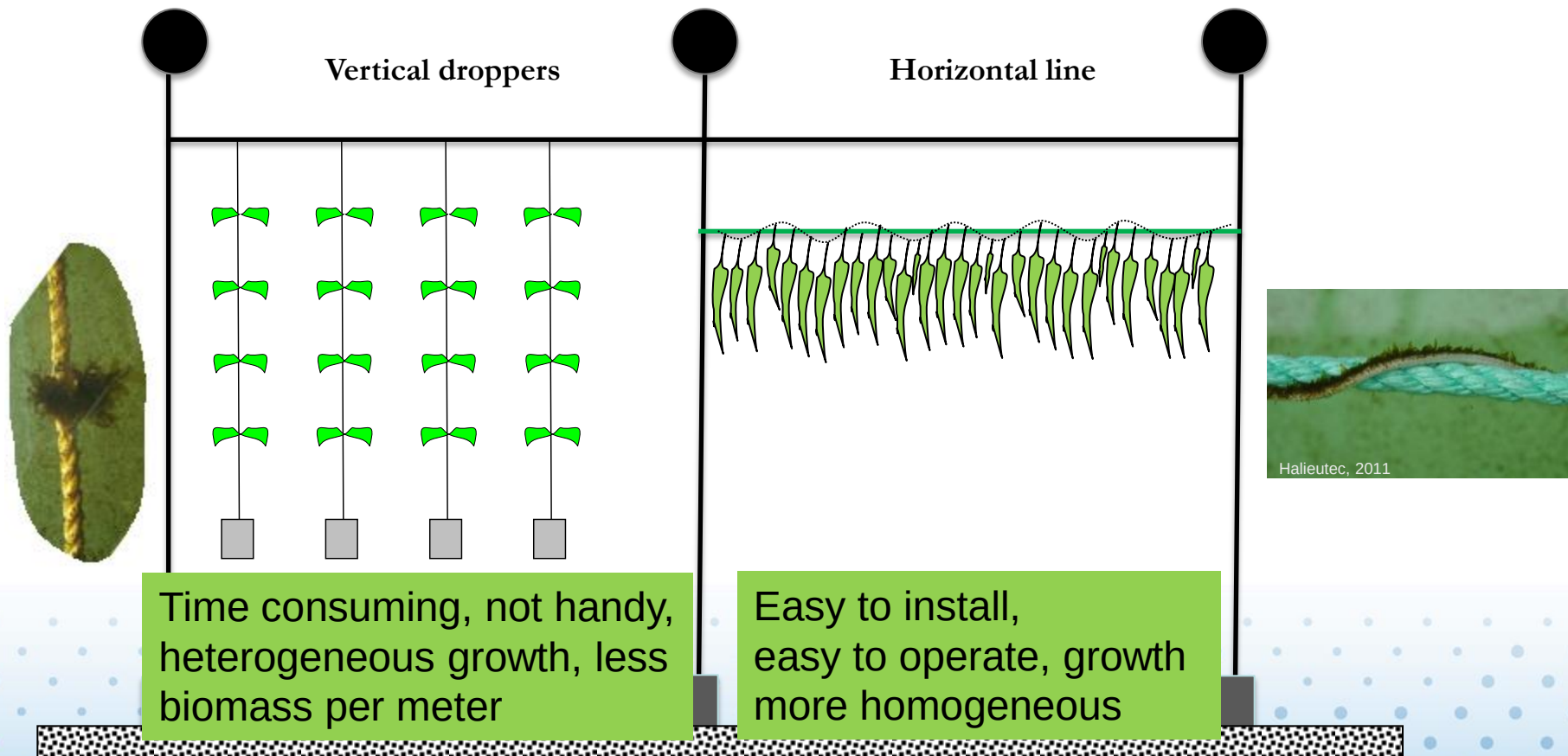
3.2 Culture gears

Adjustable submerged longlines: 7 m (winter) – 4 m (summer)



3. Progress in kelp farming

3.2 Culture gears



3. Progress in kelp farming

3.2 Culture gears

Double lines: main longline (move the boat using the starwheel winch)

+ culture line (support for kelp holdfast)



Halieutec, 2011

Set up



Halieutec, 2011

Installation of the seeded twine on the culture rope

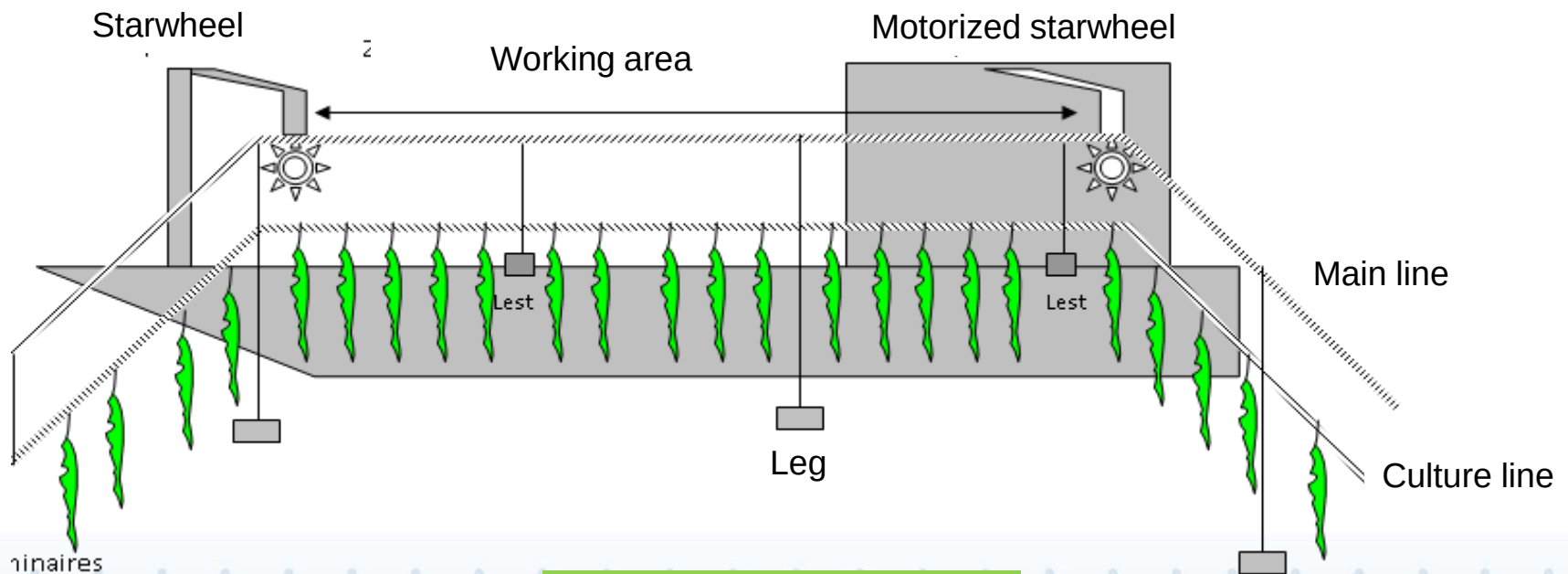


Halieutec, 2011

Harvest

3. Progress in kelp farming

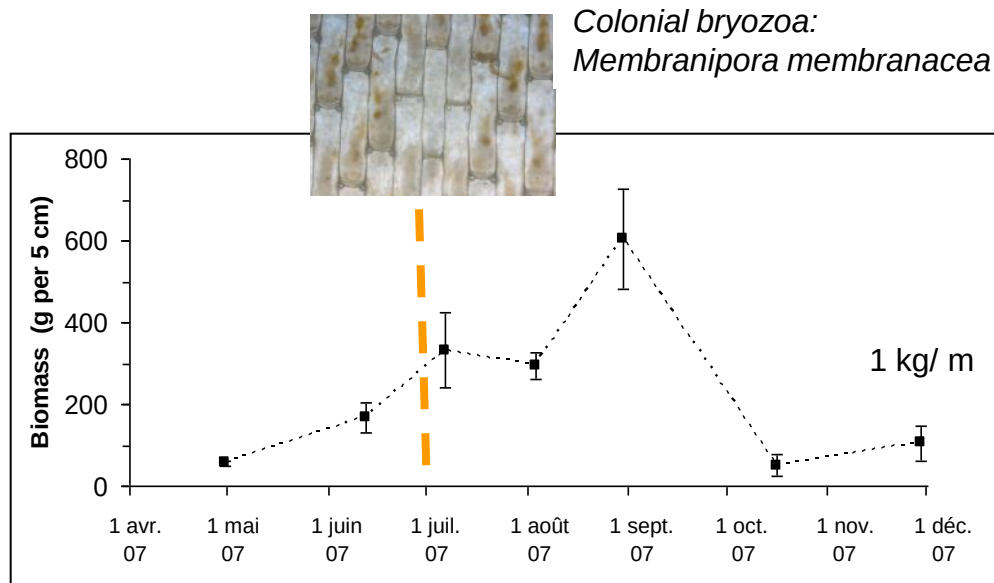
3.2 Culture gears



Quick, easy to operate

3. Progress in kelp farming

3.3 Schedule & yields, first trial (2007)



Subsurface longline (2 m deep)
October: **1 kg wet/m** (vertical dropper)

=> Harvest in late June-July

August 2007

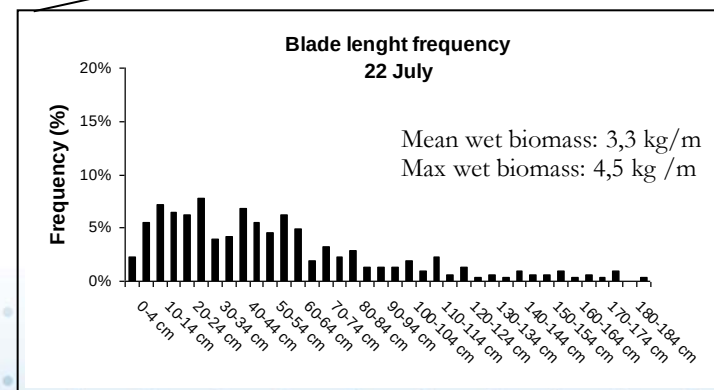
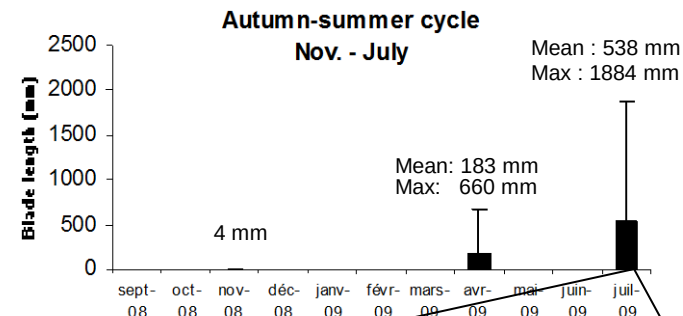
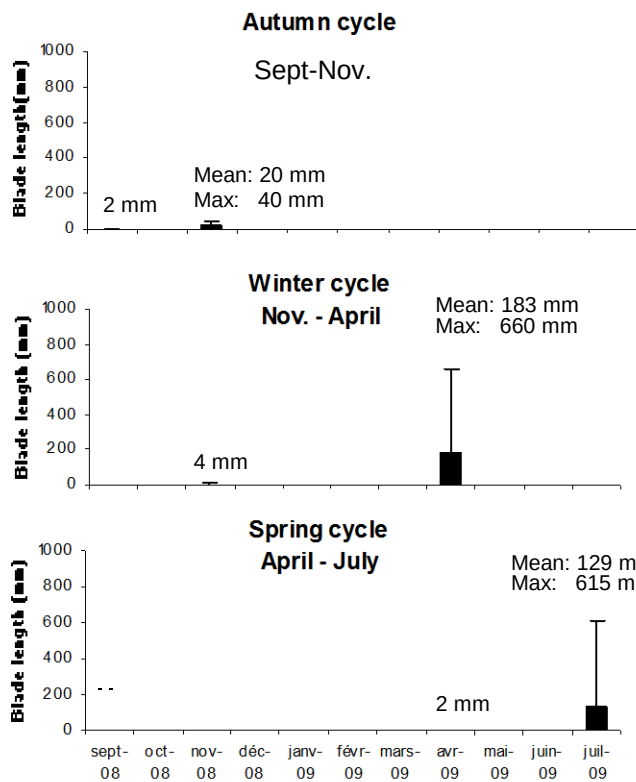


November 2007



3. Progress in kelp farming

3.3 Schedule & yields (2009)

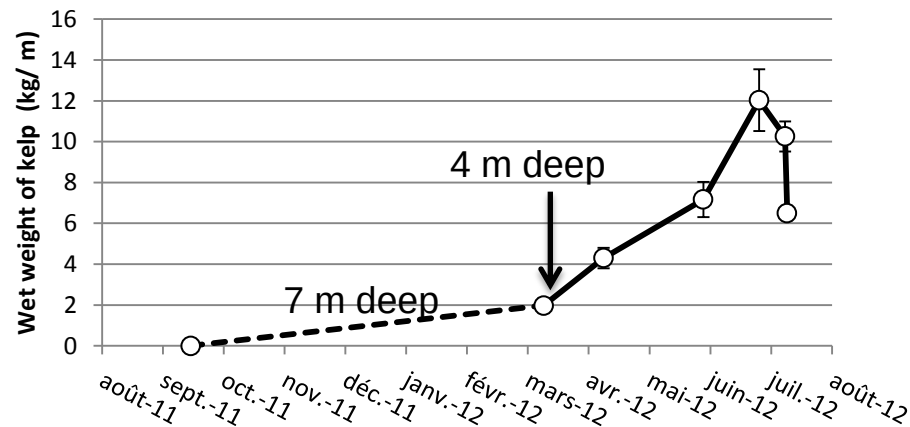


Submerged longline (7 m deep)
Nov. 2008 – July 2009 : **4,5 kg/m** (horizontal line)

3. Progress in kelp farming

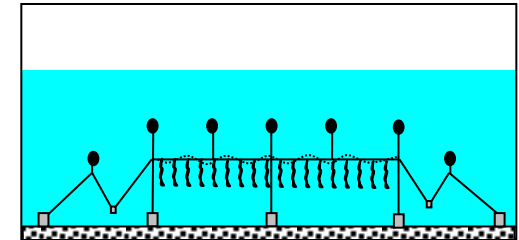
3.3 Schedule & yields (2012)

Culture of *S. longicuris* on a submerged longline in Paspébiac, Qc (2011-2012)



Adjustable longline; horizontal culture line

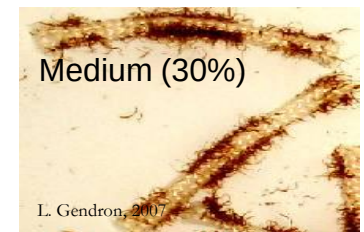
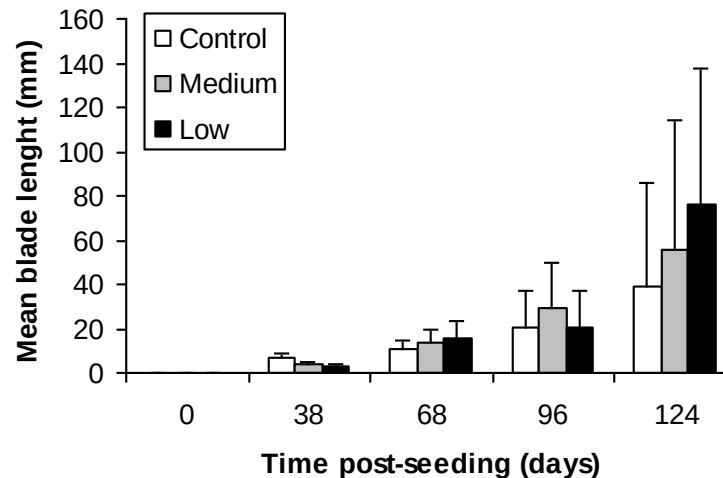
12 kg wet/m ; 250 cm (Oct 7, 2011 - July 18, 2012)



3. Progress in kelp farming

3.4 Adjustment of seedling density on ropes, in the hatchery

Spontaneous decrease of plant density observed on the culture ropes (auto-reduction?)



- **Medium & Low density > Control treatment (2 x; 90 days)**
- Can we still observe a difference on kelp when growing for 8 months on the marine farm (project in 2013)?

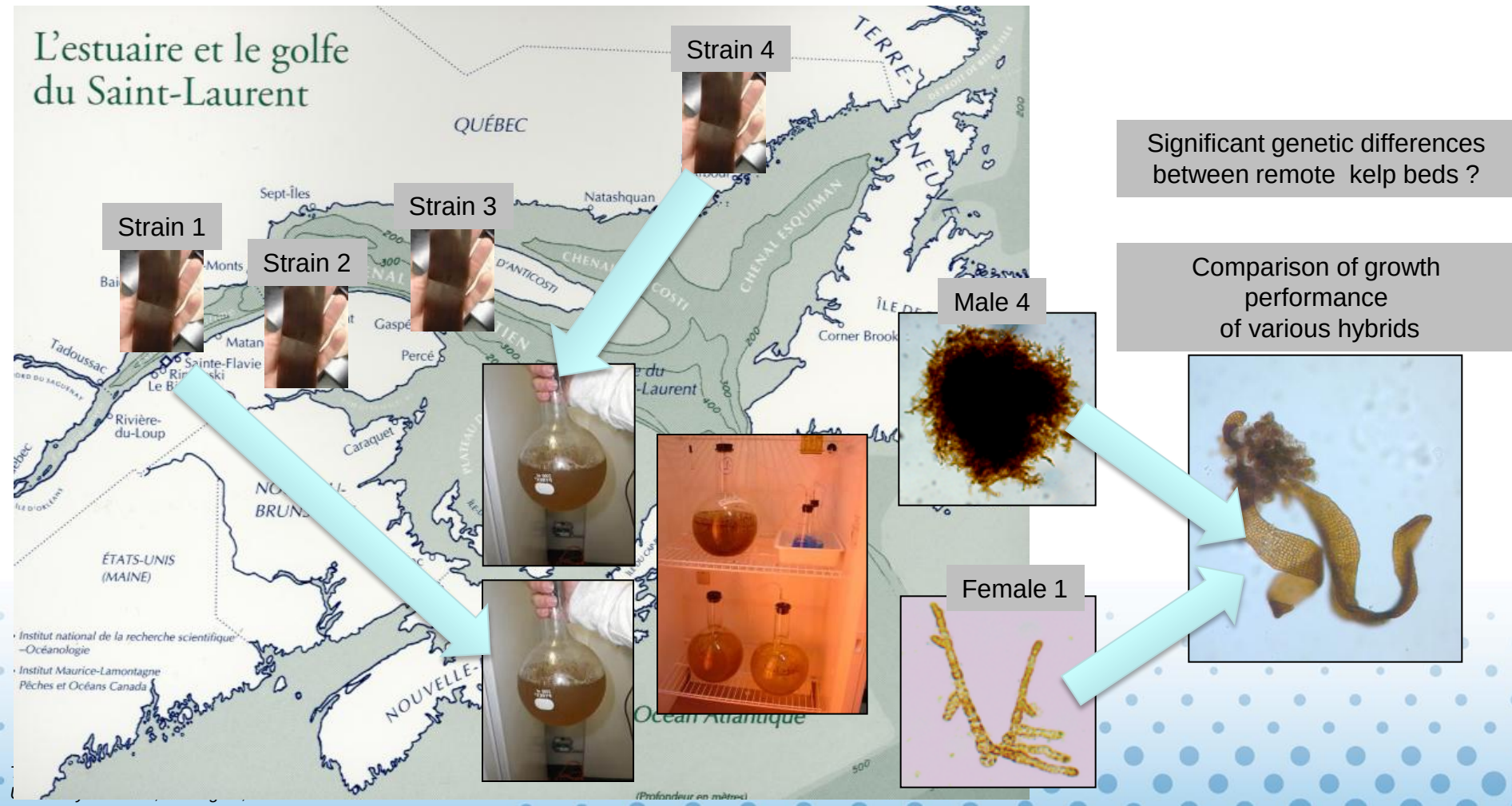
3. Progress in kelp farming

3.5 Polyculture shellfish-kelp

- *Diversification, empty longlines issue*
- *Trials on 2 mussel farms (2010 & 2011) and 1 scallop farm (running)*
- *Excellent kelp growth and quality in open waters, poor growth in marine lagoons*
- *Easy: same gears, same skills, less work*
- *Expect improved mussel /kelp growth and quality* Scoggan et al. (éds). FAO Training Manual 89/5 (RAS/86/024)



L'estuaire et le golfe du Saint-Laurent



3. Progress in kelp farming

3.7 Diversification: adapt and master cultivation of other sp.



Merinov, 2012

Hollow stemmed kelp

(*Saccharina longicruris*)



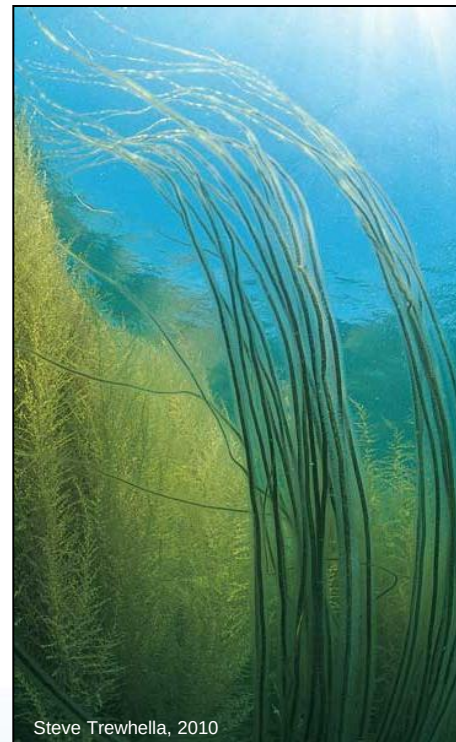
Halieutec, 2010

Sugar kelp
(*Saccharina latissima*)



Halieutec, 2006

Dabberlock
(*Alaria esculenta*)



Steve Trehwella, 2010

Sea lace
(*Chorda filum*)



Maeve Edwards, 2009

Dulse
(*Palmaria palmata*)

4. Product development: adding-value

1. ALHURE project

Species: *Saccharina longicuris*
Two parts: blade and stipe

- (1) To extract lipids and characterize fatty acids.
- (2) To extract the mannitol (polysaccharide).
- (3) To assess the potential of kelp fibers for the development of biobased composites.

Parameters of the study

1. Wild and farmed seaweed
2. Harvest locations :
 - GR, P, C = kelp farms
 - Isle verte = wild beds
3. Methods
4. Particle size (541-3348 μm)
5. Extraction time
6. Water content

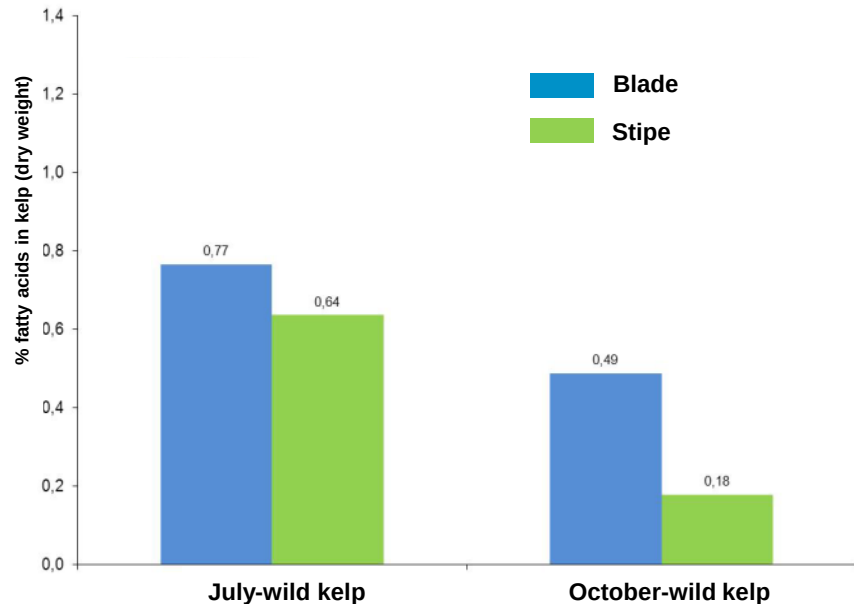


4. Product development: adding-value

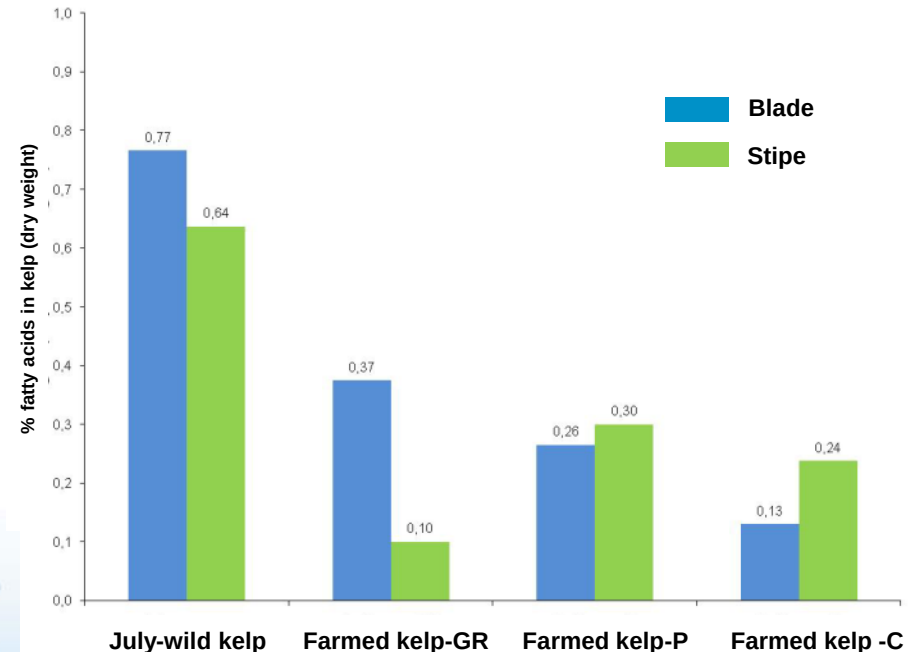


Lipids in *S. longicruris*

a) Season



b) Wild vs cultured, 3 locations



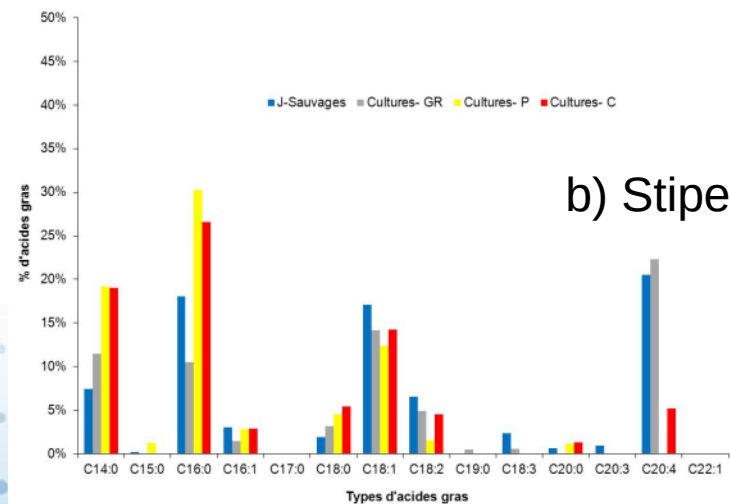
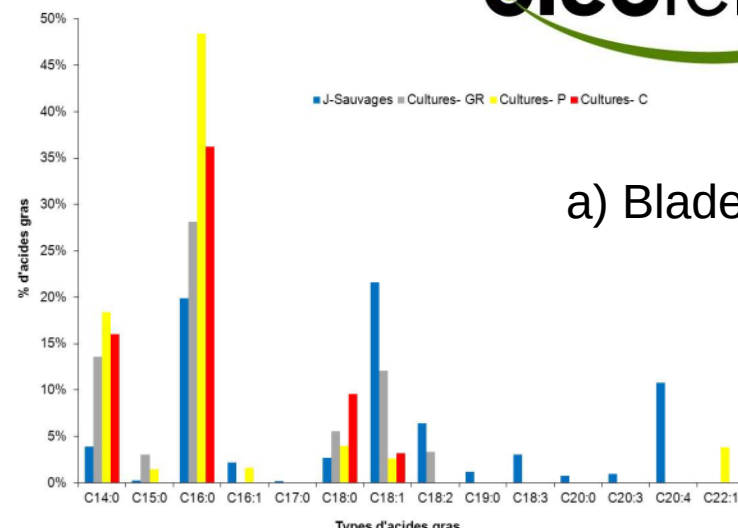
4. Product development: adding-value



Fatty acids in *S. longicruris*

Wild vs cultured kelp, 3 locations

Chemical forms	July-Wild	GR-Farmed	P-Farmed	C- Farmed
C14:0	3,9%	13,6%	18,4%	16,0%
C16:0	19,9%	28,2%	48,4%	36,2%
C18:0	2,7%	5,6%	3,9%	9,6%
C18:1	21,6%	12,1%	2,6%	3,2%
C18:2	6,4%	3,3%	0,0%	0,0%
C20:4	10,8%	0,0%	0,0%	0,0%

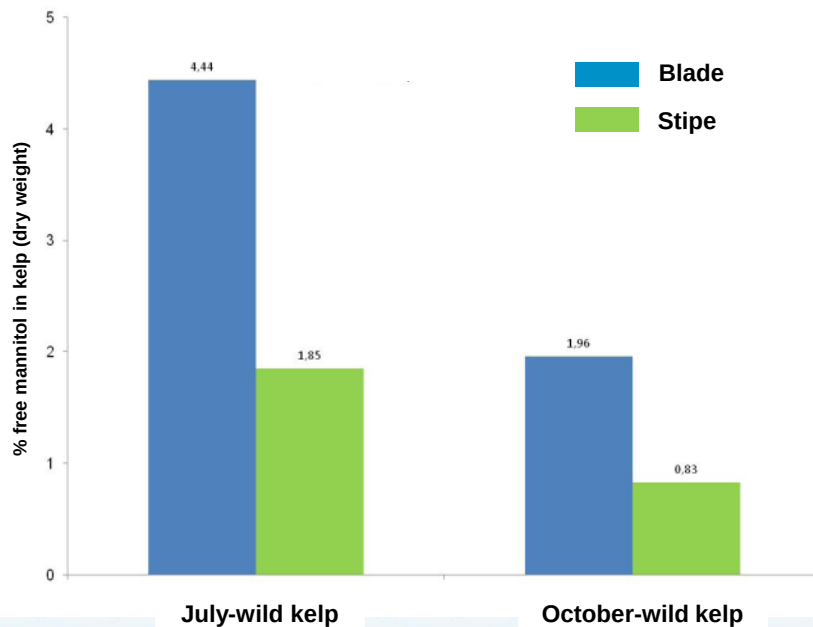


4. Product development: adding-value

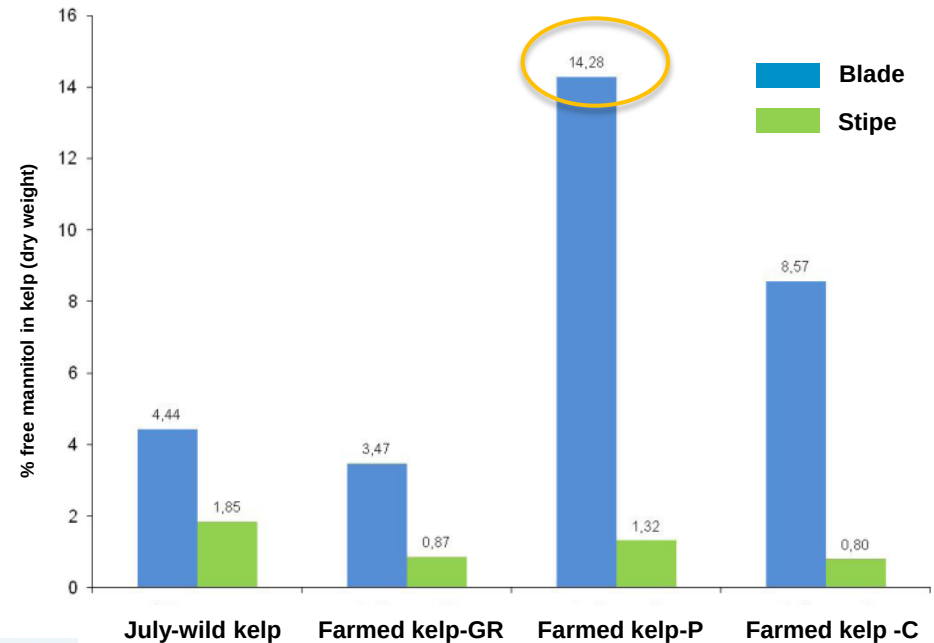


Free mannitol content in *S. longicruris*

a) Season



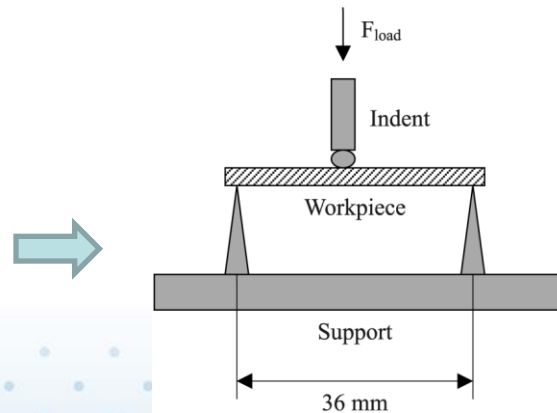
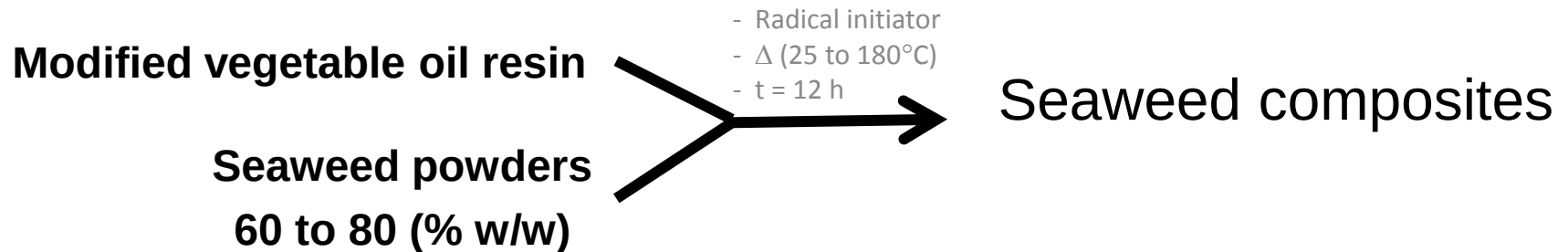
b) Wild vs cultured, 3 locations



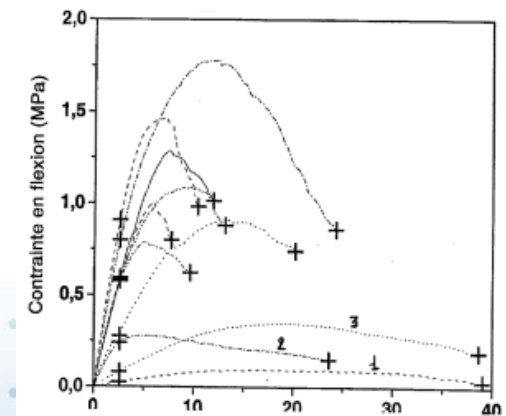
4. Product development: adding-value

Why to develop fully biobased composites ?

How to make seaweed composites:



Bending tests (standard BNQ-3805)



Preliminary results: same performance as plywood

5. Industrial research chair

Industrial Research Chair Grant from NSERC on seaweeds

1. Harvest of wild resources

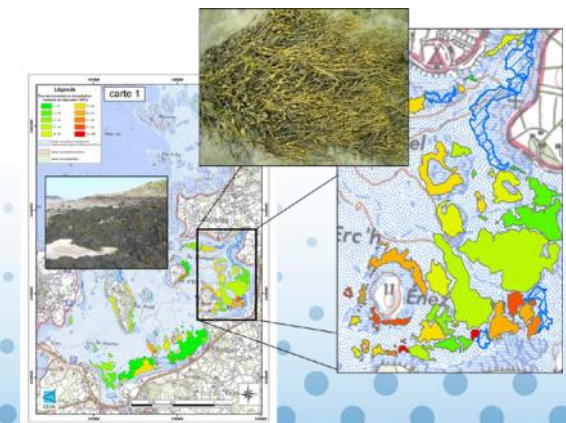
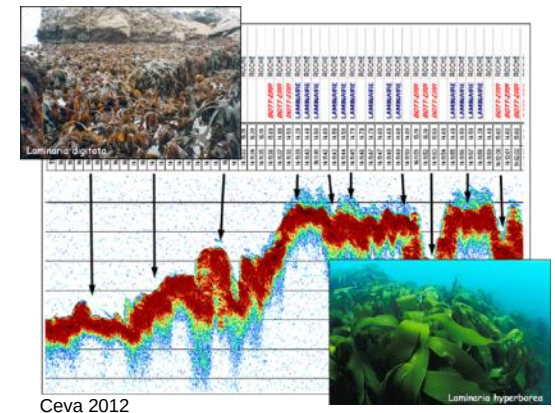
- Gather available data on seaweed beds*
- Import acoustic detection techniques*
- Develop new tools for seaweed harvest*

2. Cultivation on marine farms

- Optimization and scaling up*
- Co-cultivation shellfish-seaweeds*
- Master cultivation techniques for more sp.*

3. Processing and product development

- Food industry*
- Nutraceuticals / pharmaceuticals*
- Composite biomaterials*



PAPERS AND REPORTS



- Licois A., Hersant G., Tamigneaux E. & Bernier R. (2012). *Projet ALHURE. Valorisation des huiles et des fibres d'une algue brune (Saccharina longicruris) pour le marché des biomatériaux*. Ministère de l'éducation du loisir et du sport, rapport PART2010N035, 36 pages.
- Gendron L., Tamigneaux E., Leroux C. & Leblanc M.-J. (2010). *Ajustements du calendrier de culture de la laminaire à long stipe (Saccharina longicruris) en Gaspésie (Québec) pour éviter la colonisation des frondes par le bryzoaire Membranipora membranacea et augmenter le nombre de récoltes annuelles*. Rapport technique canadien des sciences halieutiques et aquatiques 284 : vii+53 p.
- Gendron L. & Tamigneaux E. (2008). *Expériences de culture de l'algue brune Saccharina longicruris en 2007 : essais en bassin et en mer au large de Paspébiac et de Grande-Rivière (Québec)*. Rapport technique canadien des sciences halieutiques et aquatiques 2820 : x+48 p.
- Leblanc M.-J., Tamigneaux E. & Larrivée, M.-L. (2008). *Amélioration des techniques de culture des algues marines : culture in vitro de semences de la laminaire à long stipe et ensemencement de cordes de culture*. Programme d'aide à la recherche technologique. Ministère de l'éducation du loisir et du sport, rapport PART2007N003, 52 p.
- Tamigneaux E. (2012). *Essais préliminaires de culture de l'algue rouge Palmaria palmata (Linnaeus) Weber & Mohr*. Rapport final PART2009N004, MÉLS : vi + 28.
- Tamigneaux E., Leblanc, M.-J. & Larrivée M.-L. (2011). *Amélioration des techniques de culture des algues marines: comparaison entre les rendements de Saccharina longicruris et d'Alaria esculenta*. Rapport final PART2009A019, MÉLS : vi + 32.
- Tamigneaux E., Leblanc, M.-J. & Larrivée M.-L. (2009). *Amélioration des techniques de culture des algues marines: test de faisabilité de trois récoltes annuelles pour la laminaire à long stipe (Saccharina longicruris)*. Rapport final PART2007N004, MÉLS : vii + 40.

How to join us:



General manager

Patrice Element, CEO
Gaspé (Québec)
Tél. 418 368-7638
patrice.element@merinov.ca

Project coordinator & chairholder

Éric Tamigneaux, Ph.D.
Grande-Rivière (Québec)
Tél. : 418 385-2241, poste 4108
etamigneaux@cegepgim.ca

Project manager

Aurélie Licois, M. Sc.
Grande-Rivière (Québec)
Tél. : 418 385-2241, poste 4123
aurelie.licois@merinov.ca



info@merinov.ca

www.cevam.qc.ca