NSERC Canadian Integrated Multi-Trophic Aquaculture Network

Réseau canadien d'aquaculture multitrophique intégrée du CRSNG

CIMTAN Snippets

Creation of the company **Chopin Coastal Health Solutions Inc.**

Thierry Chopin launched his own company on July 28. One side of the company will be about consulting on IMTA development. As the interest in this highly adaptable and innovative practice is growing internationally, there are a lot of opportunities to bring healthy solutions to coastal management in different parts of the world.

The other side of the company will be product development. We are not short of ideas. We will first focus on a few products and take them all the way to market. We have a new partner, **Magellan Aqua Farms Inc.**, which produces top quality sea scallops, and with its owner, **Steven Backman**, our imaginations are cooking up some interesting seaweed-based products in applications that will surprise more than one.

30 researchers (including **Thierry Chopin**) from **21 institutions** in **9 countries** just released a **Policy Brief** entitled **"Safeguarding the future of the global seaweed aquaculture industry"** through the **United Nations University - Institute for Water, Environment and Health** (UNU-INWEH, Hamilton, Canada) and the **Scottish Association for Marine Science** (SAMS, Oban, Scotland).

The Policy Brief has now been covered in English, Spanish, German, Chinese, Italian and Dutch by ~ 90 news sites in 38 countries, along with 1 TV and 4 radio interviews.

Seaweed aquaculture is undergoing a rapid global expansion and currently accounts for 96% of the world seaweed industry and 49% of the world mariculture production (27.3 million tonnes worth US$6.4 billion in 2014). There is an increasing need to address new challenges for producers and the environment, imposed by trade and market demand.

The rapid expansion of any industry can typically result in unforeseen ecological, economic and societal impacts, particularly in the early stages in new geographical areas, where policies to regulate and manage the industry are in their infancy. Valuable lessons can be learned from the major seaweed-producing nations (China, the Republic of Korea, Japan, Indonesia and The Philippines), and other agri- and aquaculture sectors, to avoid common pitfalls.

This Policy Brief highlights key issues that need to be addressed in order to create long-term sustainability in this emerging global industry: diseases and disease-resistant strains, introduction of non-indigenous pathogens and pests, keeping genetic diversity versus clonal propagation methods, technical improvements, direct and indirect ecosystem services, integrated multi-trophic aquaculture for nutrient bioremediation and crop diversification/economic stability, socio-economic development and costs for coastal communities, capacity building for crop management and independent financing, crop insurance schemes, etc.

The Policy Brief concludes by making the following recommendations for establishing a balance between economic growth and ocean health:
- Establish centres of research excellence in support of the sustainable development of the industry.
- Establish seed banks for maintaining a high health status of seed stock.
- Maintain the genetic diversity in wild stocks and encourage the development of local indigenous cultivars.
- Exercise the precautionary approach when introducing new or non-indigenous cultivars.
- Focus on developing and enhancing biosecurity programmes through capacity building and incentivise the development of detection tools and measures for disease prevention and avoid spreading.
- Incentivise long-term investment in the industry.
- Incentivise the integration of seaweeds, and other extractive species, with finfish in integrated multi-trophic aquaculture (IMTA) systems.
- Develop assessment and regulatory tools for marine spatial planning, risk management, appropriate licencing and the development of an ecosystem-based management approach to aquaculture.

Read the Policy Brief

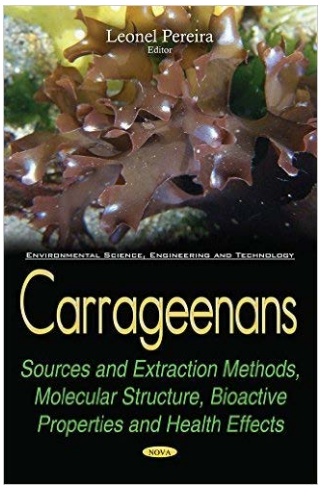
Citation:
Cottier-Cook, E.J., Nagabhatla, N., Badis, Y., Campbell, M.L., Chopin, T., Dai, W., Fang, J., He, P., Hewitt, C.L., Kim, G.H., Huo, Y., Jiang, Z., Kema, G., Li, X., Liu, F., Liu, H., Liu, Y., Lu, Q., Luo, Q., Mao, Y., Msuya, F.E., Rebours, C., Shen, H., Stentiford, G.D., Yarish, C., Wu, H., Yang, X., Zhang, J., Zhou, Y., and Gachon, C.M.M., 2016 - Safeguarding the future of the global seaweed aquaculture industry. *United Nations University (INWEH) and Scottish Association for Marine Science Policy Brief* ISBN 978-92-808-6080-1. 12 pp.


Kelp biochar-filled net pot with Swiss chard seedlings (photo credit: Stacy Murray).

Thierry Chopin and **Stacy Murray** had their article entitled "Kelp biochar: a potential plant substrate for freshwater aquaponics" published in the latest issue of ***Hatchery International***.
In many aquaponic systems it is common to use a substrate such as foam, coconut coir, rock-wool or expanded clay for seedling production and plant support. However, these substrates are often not reusable and may not be produced locally. Efforts to gain environmental sustainability can be overshadowed by the sourcing footprint of such materials.
Being involved in the development of marine integrated multi-trophic aquaculture (MIMTA) systems over the last 15 years, we have also acquired experience in growing seaweeds as the inorganic nutrient extractive component of these systems at sea. As we want to diversify as much as possible the uses to which the harvested algal biomass can be put, with an Integrated Sequential Biorefinery (ISBR) approach, we have worked on seaweeds for human consumption (*e.g.* food items and the micro-brewed beer "Kelp on the Way"), for cosmetics, and for animal feed (partial

substitution of fishmeal in feed formulations and feed for sea-urchins). Our kelps have also gained organic certification.
We thought that another application for some of this algal crop could be to transform it into biochar for use as a plant substrate in our freshwater IMTA (FIMTA) operation.
In this article, we report briefly on our findings, which Stacy will develop more in depth when she defends her MSc thesis in October, and in a paper in preparation.

This article is a follow-up to a previous article entitled "Freshwater IMTA - Developing Integrated Multi-Trophic Aquaculture systems for commercial salmon hatcheries" published in the January/February 2016 issue of *Hatchery International*.

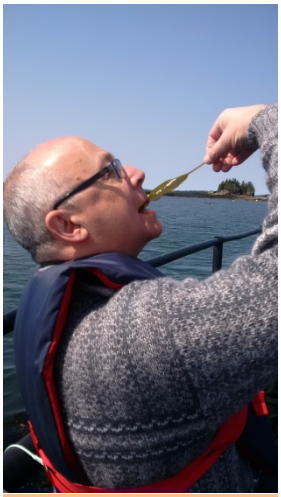


A **new book** is hot off the press: **Carrageenans: Sources and Extraction Methods, Molecular Structure, Bioactive Properties and Health Effects**, edited by **Leonel Pereira**, and available on **Amazon**: https://www.amazon.com/dp/1634855035/ref=cm_sw_r_fa_dp_t1_-vXVxbJ007E9F

Chapter 8, entitled "**Review of the chemotaxonomic significance of some phycocolloids present in economically important algae (Gigartinales, Rhodophyta)**", is co-authored by **Fabiana Soares**, **Thierry Chopin** and **Leonel Pereira**.

Thierry Chopin was contacted by **Becca Tucker**, the Editor of ***dirt Magazine***, a bi-monthly magazine covering the local green scene in the heart of the culturally and agriculturally fertile Black Dirt region of New York and New Jersey.
While researching for her debate "When I buy fish, should it be farmed or wild?" she came across our work on IMTA and asked if we could contribute to the debate.

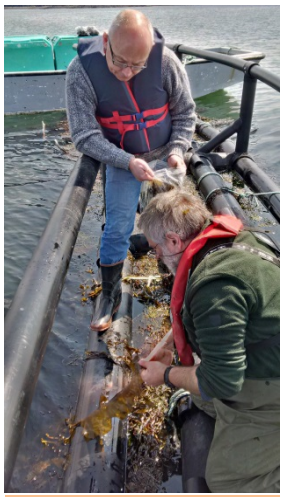
Read the resulting essay
"Fish farms are the way of the future, but they have to grow more than fish".



Auditor Conrad Powell, from SAI Global, tasting our organically certified IMTA kelps (photo credit: Jennifer Wiper).

Cooke Aquaculture Inc. gets its **IMTA kelps organically re-certified** for the third year.
The audit took place in May 2016 with auditor **Conrad Powell**, from **SAI Global**. **Thierry Chopin** was on hand to answer questions regarding the process from the microscopic spores to the several meter long mature kelps. He went to the Crow Island IMTA site with the auditor and **Jennifer Wiper**, the Corporate Sustainability Manager of Cooke Aquaculture Inc., where he provided more information and the opportunity to taste the fresh material right on site.

Read the article on the Cooke Aquaculture Summer 2016 newsletter



Thierry Chopin explaining a few things about the life cycle of kelps to auditor Conrad Powell (photo credit: Jennifer Wiper).

The **Summaries of the Monaco Blue Initiative 2016** were published in the *Monaco Blue Initiative Newsletter #4*.

The 7th edition of the Monaco Blue Initiative took place in São Paulo, April 3rd & 4th, 2016, and **Thierry Chopin** had the pleasure of being invited as a panelist at this most interesting conference.
The Summaries document, with the concluding remarks of **HSH Prince Albert II of Monaco**, reflects the content of the presentations and discussions held during the 5 sessions very well in 21 pages.
It is very interesting to note that the terms/concepts of ecosystem services, IMTA, circular economy, biorefinery, regulatory barriers to innovation, aquaponics/freshwater IMTA, Turquoise Revolution, aquanomy, climate change, and food security permeate through the entire document.
Thierry Chopin was very pleased to see one of his ideas among the eight quotes illustrating the antepenultimate page:
"We have to change our business models from the old linear approach – one species, one process, one product – to the integrated sequential biorefinery approach – one species, several processes, several products".

Following **two episodes of devastating algal blooms** along the coast of **Chile**, the Chilean magazine ***AQUA Acuicultura + Pesca*** dedicated its July issue to **"Cultivo de algas: un mar de posibilidades (Cultivating algae: a sea of opportunities)"**.
It contains the article **"Acuicultura multitrófica integrada - Contención natural para las Floración Algal Nociva (FANs)? (Integrated Multi-Trophic Aquaculture - A natural approach to contain Harmful Algal Blooms (HABs)?"** resulting from interviews with **Alejandro Buschmann** (Universidad de Los Lagos, Puerto Montt, Chile) and **Thierry Chopin**.

Read the article

Are all algal blooms equal? Are they all harmful? Was killing all these salmon necessary after the first algal bloom hit Chile last March?

Red tide along the shore (photo credit: Alamy).

Gustaaf Hallegraeff, a recognized world expert on algal blooms from the University of Tasmania, Australia, was recently invited to Chile to comment on the catastrophic outbreaks of algal blooms in recent months along the Chilean coast and made quite a splash on his own: Chilean farmers lost millions by needlessly throwing away salmon after the first episode of algal blooms.
The culprit was identified to the species level: the brown phytoplanktonic alga *Pseudochattonella verruculosa*. It was not toxic to the fish, but clogged their gills, mixed with mucus, and suffocated them. There is also no evidence that this species has any human health effects. Consequently, the fish could have been harvested right away and sold to market, instead of dying and later thrown into the sea. Approximately 25 million fish died, equivalent to more than 100,000 tonnes, which could have filled more than 14 Olympic-size swimming pools. Around 30% of the dead fish were taken to landfills; however, because no local facility was equipped to process the rest on land, the Chilean Navy and fisheries managers authorized its dumping at sea, about 130 kilometers off the island of Chiloé.
A second algal bloom followed a few weeks later, this time of the toxic dinoflagellate *Alexandrium catenella*, and waves of dead sardines, clams, jellyfish, birds and even mammals covered kilometers of shoreline. While the possibility of a link between the decomposing salmon thrown into the sea and the *Alexandrium* bloom is still being investigated by a government ordered commission (could it be blamed on El Niño and other oceanic conditions?), some non-governmental


Massive mollusc die-off along the shore of the island of Chiloé (photo credit: Alvaro Vidal/AFP/Getty Images).

organizations and fisherman's unions did not wait and made the link, resulting in a nightmare public relation situation for the salmon aquaculture industry, besides its already major loss of sales estimated at more than US$800 million. As fishing was banned around the island of Chiloé, fishermen went on strike for 3 weeks, blocking salmon companies from moving their fish from the island, around which a lot of salmon aquaculture is taking place.

How microalgae became part of the summer conversation without even being mentioned.

Microalgae are so small that we do not notice them, until they reach high concentrations and form algal blooms. Some of them can be toxic and are call "HABs", not the "Montréal Canadiens" hockey team, but "Harmful Algal Blooms".

Many areas are experiencing large algal blooms including Florida, Chile, the Great Lakes and New York Central Park. Closer to home, warning signs can be found around Harvey and Washademoak lakes. In Saint John, we are told to not feed the ducks in Rockwood Park: a well-fed, increasing population of ducks means increasing levels of faeces, which will release, into the water, higher levels of phosphorus and nitrogen, prime nutrients/fertilizers for algae to bloom and eventually choke other plants and animals, when they are deprived of oxygen consumed by the decaying bloom.

The diving well at the Rio 2016 Olympic Games turning greener by the day (photo credit: Sylvain Marchandise/Reuters).

Let's be careful, though, not all algal blooms are equal and not all are harmful. It depends on which species is the culprit. Interestingly, microalgae became part of the Rio Olympics a few weeks ago, but nobody mentioned them. Is "algae" such a dirty word that officials preferred to avoid pronouncing it?

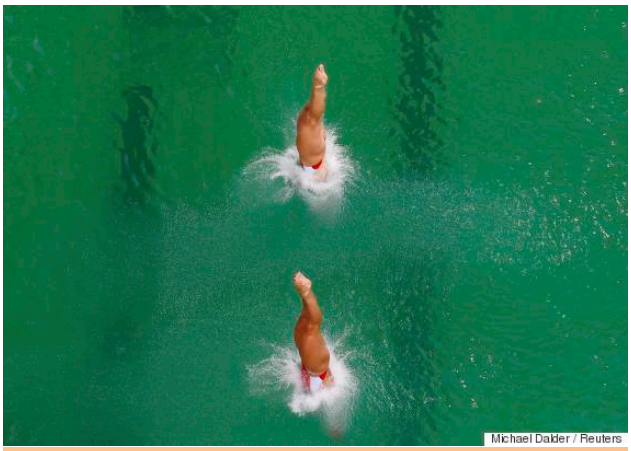
The Rio Olympics wanted to be the green Olympics, at least the pools at the outdoor Maria Lenk Aquatic Centre definitely turned green. The diving well became an increasingly darker green for several days. Chemicals and chemistry were blamed: chlorine, minerals, copper, pH and alkalinity entered the vocabulary of summer conversations. Even Rio 2016 spokesman Mario Andrada gratified us with a "Maybe chemistry is not an exact science after all"!

The organizing committee reassured athletes and spectators: the water was tested (chemically) and there was no risk to athletes. The diving training was cancelled one morning, as "the water must be still so the pool can return to its blue color as soon as possible".

A chemical imbalance had been introduced in the diving well water, but the question should have been what is responsible for this green hue?

Direct sunlight, warm weather and warm water were the perfect conditions for the development of an algal bloom, as microscopic algae - not chemistry - were the culprit for the colour. Microalgae reproduce very rapidly, especially in still water, which can get greener and greener within a matter of a few days. In fact, if the algal population becomes very dense (a bloom), it can drastically change the water chemistry, which becomes even more complicated to balance.

Then, the cooler water polo pool started to turn green overnight… how could that be possible, as the water in the diving well was supposedly now well contained? If people generally think that microalgae can be water-borne by not properly filtered water, they can also be air-borne in droplets from splashes, puddles around the pools, shared pool equipment, and in drops of rain (it rained quite a lot over this outdoor facility). Athletes, with their wet bodies and swimsuits, were also very efficient vectors to inoculate other tanks, relaxation hot tubs (not reported about much, but they also turned green) and, ultimately, the other swimming pools. Easy "multi-factor contamination"!



Canadian Meaghan Benfeito and Roseline Filion diving in the algal-rich water for the bronze medal in the women's 10 meter synchronized platform at the Rio 2016 Olympic Games (photo credit: Michael Dalder/Reuters).

At the end of the Olympic Games, we still did not know the results of any biological testing of the water. What species of microalga was responsible? One species? Several of them? Were they toxic/harmful species? Athletes were not complaining of the famous "swimmer's itch", which is generally triggered by bird and mammal parasites in lakes, but can, in unusual circumstances, also be caused by blue-green algae (also called cyanobacteria).

Algae invited themselves to the Olympic Games because humans created the perfect conditions for their proliferation: a perfect storm in a teacup - a diving well - of no comparison to devastating coastal green, red and brown tides, often the result of man-made nutrient imbalances in the ecosystems and enhanced by climate changes.

Their cleaning and reputational costs were certainly high, but the colour did not seem to hinder the athletes. In fact, Canadian Meaghan Benfeito, who took bronze in the women's 10 meter synchronized platform, said the green colour may actually have helped her performance. "It's not the same colour as the sky, so that was really on our side today" she said. She was just told to keep her mouth shut!

Maybe, in an environmentally friendly society with fewer chemicals, the new azure should be greener. After all, the sea is never as blue as in a swimming pool. Why should blue mean excellent water quality and green poor water quality? In fact, blueish tropical waters are generally nutrient/particle poorer than richer greener temperate waters.

So, let's call an algal bloom an algal bloom when we see one and let's devise strategies to manage them, understanding that, if maybe judged aesthetically unpleasant, not all are toxic.

Taryn Minch, though originally from the Prairies, spent most of her life in Montréal. In 2012, she decided to ditch the big city to study Marine Biology at the University of New Brunswick, Saint John (UNBSJ) and has been here ever since. After receiving her Bachelor of Science at UNBSJ in 2014, she worked as a summer research assistant for a CIMTAN graduate student, running experiments to determine the organic content in orange footed sea cucumber (*Cucumaria frondosa*) faeces, in St. Andrews, New Brunswick. This glamorous research sparked her interest in IMTA and resource

Taryn Minch mixing powdered milk and seawater for a tracer release trial at Navy Island Atlantic salmon farm in the Bay of Fundy, New Brunswick (photo credit: Adena Peters).

efficiency, which ultimately drove her to pursue her Master of Science at the University of New Brunswick, in partnership with the St. Andrews Biological Station.
Under the supervision of **Bruce MacDonald** and **Shawn Robinson**, Taryn is investigating the water velocity in and around Atlantic salmon farms, with the intent of optimizing extractive species placement for IMTA farms. Through the use of acoustic Doppler current profilers (ADCP), Taryn was able to collect high-resolution georeferenced water velocity data at farms in the Passamaquoddy Bay, Bay of Fundy. This physical descriptive information is largely unexplored within aquaculture farms, and will, hopefully, provide new perspectives on how to view them.

In addition, Taryn has investigated water dispersion at even smaller scales, downstream of fish cages. To achieve this scale of resolution, milk release trials were conducted at various fish farms. Milk acts as a passive tracer, and, interestingly, these trials were filmed with drones, which provided highly detailed videos and images. Findings from these trials may add an additional layer to the complexity of water movement through cages at aquaculture farms and may provide baseline information for pathogen/therapeutant dispersal.
In her free time, Taryn can be found hiking throughout New Brunswick with friends, running, or watching crime documentaries. When Taryn completes her MSc, she hopes to find a job in aquaculture research in the Maritimes.

Taryn Minch and Adena Peters setting up the acoustic Doppler current profiler (ADCP) to map the water speed within Navy Island Atlantic salmon farm (photo credit: Shawn Robinson).

CIMTAN member quote of the month: "Through CIMTAN, I gained experience conducting a diverse array of research, collaborating with various sectors, and communicating my research. A lot of interesting and novel research has been produced through CIMTAN, and, now that the network is coming to an end, I am excited to see how all of the research fits together for the future development and implementation of IMTA farms" (*CIMTAN MSc candidate Taryn Minch*).

People of Cape Breton, Nova Scotia, know what's up and needs to happen!
With a little kelp from our friends, the regulators!