



Thierry Chopin was on Grand Manan Island, in the middle of the Bay of Fundy, in July to talk about IMTA to **both children and adults**. Yes, **IMTA extension work** and **community outreach** is important if, as scientists, we want our ideas to get more exposure and understanding with the general public of all ages.

In the afternoon of July 15, he conducted a workshop with children, aged from 7 to 16, at the **Grand Manan Museum**, with **Mary Joan Edwards**, the Curator/Director of the Museum. Children made and ate seaweed pudding [the traditional Acadian “Blanc Mange” recipe, with carrageenans from the red seaweed called Irish moss (*Chondrus crispus*)], learned about IMTA research, and made some art in response to the presentation.

See <http://www.culturepass.net/events/eventDetail.php?id=8893>



In the evening, Thierry Chopin gave a presentation, entitled “Integrated Multi-Trophic Aquaculture (IMTA): an ecosystem approach to farming the sea” to an audience of “locals” (the year-long residents of Grand Manan), “summers” (Grand Mananers spending their summer vacations on the island) and “from away” (tourists, definitely from away!). The seminar went on, beyond the scheduled one hour and a very interesting discussion developed. The adults also wanted to test the remaining seaweed pudding... everything was cleaned!

See <http://www.culturepass.net/events/eventDetail.php?id=8892>



Arlene Benham, a journalist with *The Quoddy Tides*, which prides itself as being “the most easterly newspaper published in the United States of America”, wrote a very interesting article indicating that she carefully listened, as it captures the main points of the presentation very well.

Read the article: [UNB professor advocates shifting aquaculture to ecosystem approach](#)

Mary Joan Edwards, the Curator/Director of the Grand Manan Museum, wrote a very interesting article on the youth workshop in the *Island Times*.

Read the article: [IMTA: an ecosystem approach to farming the sea](#)

David Scarratt wrote a nice article in *Aquaculture North America*, reflecting on the presentation by **Thierry Chopin**, during the Aquaculture Association of Canada conference in St. Andrews last June, entitled “The history of the development of the Canadian seaweed aquaculture industry”.

Read the article: [Seaweed culture slow to grow in western world](#)

The key points of **Thierry Chopin**'s presentation on the global perspective on seaweed aquaculture have just been published in *Global Aquaculture Advocate*.

Read the article: [Seaweeds: top mariculture crop, ecosystem service provider](#)



Yes, seaweed aquaculture development is progressing slowly in the western world. However, **IMTA offers an opportunity to reposition the value and roles seaweeds can have in integrated food production systems and in ecosystem health.** For example, the announcement, last month, about our industrial partner, **Cooke Aquaculture Inc.**, putting **organic IMTA kelps** on the market has triggered a number of articles in professional magazines and newspapers, radio interviews and comments on Twitter and Facebook.

Hear the interview: **Andrew Lively**, Director of Marketing at True North Salmon Company Ltd., on *CBC Radio Shift – Home Grown* [here](#)

Read the article: [Canadian IMTA kelps get organic certification and are ready to hit the marketplace in *Aquaculture Europe*](#)

Read the article: [Canadian certified organic kelps hit market in the latest *Cooke Aquaculture Newsletter*](#)



The work of **CIMTAN project D1P10** (Freshwater IMTA for land-based salmon hatcheries) is also featured in the latest *Cooke Aquaculture Newsletter*.

Read the article: [Taking Integrated Multi-Trophic Aquaculture \(IMTA\) from the egg to the plate: extending the IMTA approach](#)

Because it is also fun to take a light approach with our preferred organisms and what they can be up to, **Marah Hardt**, with the help of **Thierry Chopin**, updated her entry on the scandalous sex life of a seaweed, *Palmaria palmata*, also known as dulse and part of **CIMTAN project D1P2** (Complementary inorganic extractive species).

Read the update: Lolita of the Sea(weed): Update
<http://sexinthesea.org/lolita-of-the-seaweed-update/>
(This should be an entry in the forthcoming book by Marah: *Sex in The Sea: The conservation implications of the sea's salty erotica*)

At the end of July-beginning of August, **Thierry Chopin** spent a week in **Brazil**.

He first visited **Primar Aquicultura Orgânica** (www.primarorganica.com.br), the aquaculture farm of **Alexandre Wainberg**, in **Tibau do Sul**, in the state of Rio Grande do Norte, 1.5 hour south of Natal. Thierry and Alexandre had met at an FAO workshop on "Building an Ecosystem Approach to Aquaculture (EAA): Initial Steps for Guidelines", in Palma de Mallorca, Balears Islands, Spain, in May 2007.



Since, Thierry has been waiting for an opportunity to visit this intriguing IMTA farm, always evolving based on a long-term dream and the admirable dedication and tenacity of Alexandre. Primar is developing IMTA with **organic shrimps** (*Litopenaeus vannamei*), **oysters** (*Crassostrea gazar*), **seaweeds** (*Gracilaria dominguis* and *Hypnea* sp.) and **seahorses** (*Hippocampus reidi*) in earthen estuarine ponds.

The shrimps are organically certified and produced for the Brazilian market. They are not fed artificial diets, the ponds are managed without aeration systems and are filled and emptied with controlled regimes, and the mangrove and other vegetations have been preserved, contrary to other operations. This enables Primar to send 11 g shrimps to market every 70 days. Moreover, because of the absence of artificial feeds, they do not need to be "deveined", which also saves on processing costs. And, of course, they are nicely firm and delicious!

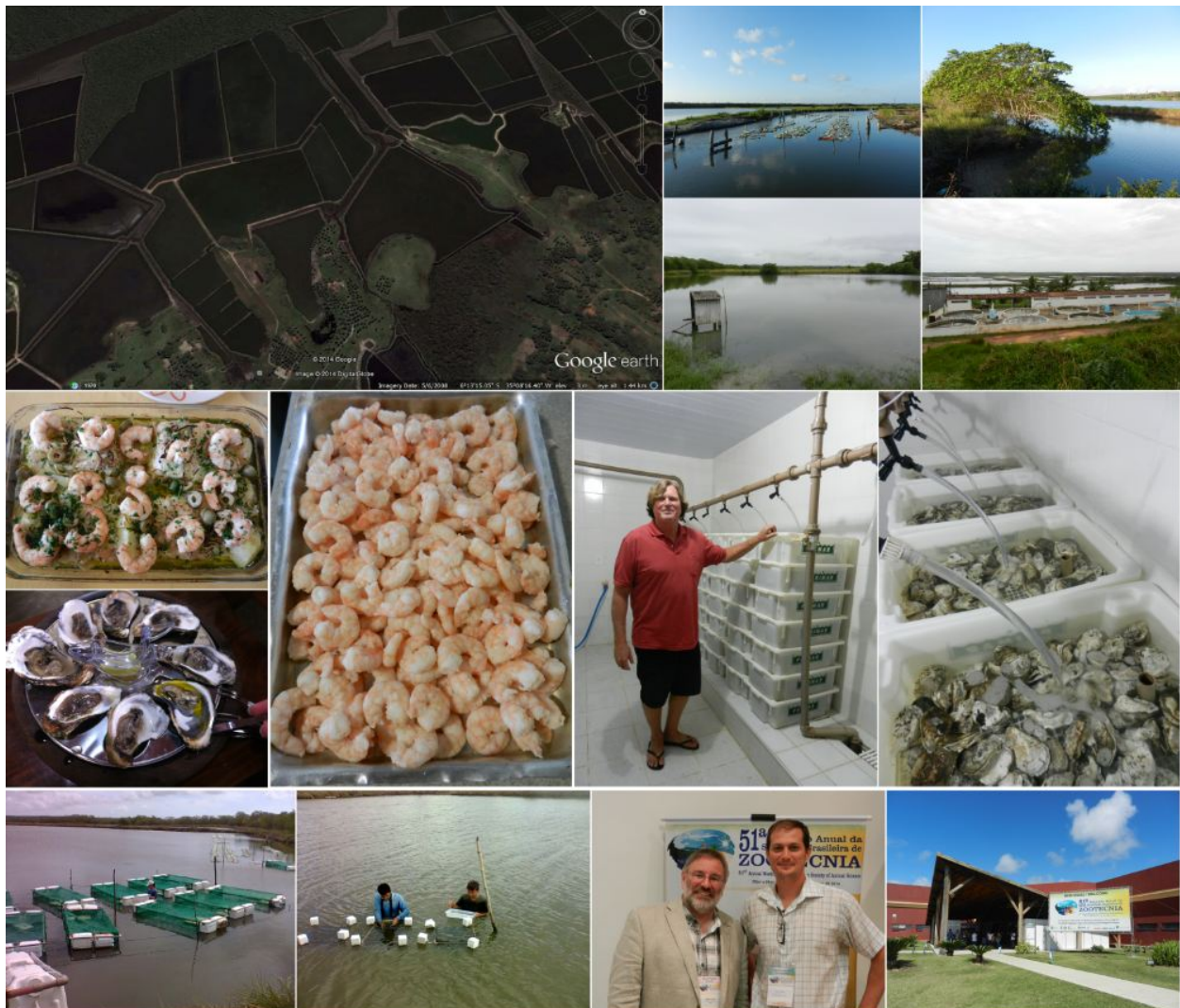
Alexandre also cultivates oysters in some of his ponds and canals. To be able to fully control the oyster cultivation process, he recently started to operate his own oyster hatchery. The oysters were also delicious! Of course, pouring some lemon on them is a traditional way of savouring them; fresh lemons from Brazil are very tasty. A variant is to swallow them after you filled the shell with very fragrant olive oil: highly recommended!

Seaweed cultivation is being developed under an R&D partnership with **Eliane Marinho-Soriano**, of the Oceanographic Department of the Rio Grande do Norte Federal University. The next step is to develop a pilot-scale production system. The development of seahorse aquaculture is a project coordinated by **Lilia Pereira Souza Santos**, of the Oceanographic Department of the Pernambuco Federal University.



It was a pleasure to see Alexandre, and his wife Marcia, in their warm, welcoming home and farm, their life and dream for over the last 21 years. Marcia is a very creative graphic designer (www.mkdesign.com.br), who operates her company in a building next to the farm.

One afternoon, Alexandre took Thierry to Barra do Cunhaú to visit **Aquatec**, a large shrimp larviculture operation (www.aquatec.com.br). They were given an exhaustive tour of the facility by **Ana Carolina de B. Guerrelhas**, owner and director. Ana is passionate about the company she created, 25 years ago, and always looking for new innovative approaches as well as some diversification (hence the interest in IMTA). Ana has a vast knowledge of hatchery operations and an in-depth understanding of the fact that changing one part of the process may have several consequences, some not always anticipated. During the conversation, going from building to building along a gravity-fed system, Ana made a very interesting remark: "some people believe I am cultivating shrimp larvae and artemia; in fact, I am mostly cultivating water". Indeed, water chemistry, temperature, aeration, light penetration, etc. are key for a hatchery operation.





Thierry, then, flew to **Aracaju**, in the state of Sergipe, to attend the **51st Annual Meeting of the Brazilian Society of Animal Science**. For the first time in its history, the Society had an Aquaculture Section and Thierry was the guest speaker of the aquaculture session, chaired by **Paulo Carneiro**. His presentation was entitled "**Integrated Multi-Trophic Aquaculture (IMTA): an aquanomic approach to farming the sea and how it might work for Brazil**".

Initially not sure how IMTA would fit in a meeting of the Sociedade Brasileira de Zootecnia, it became clearer when realizing that this year's theme was "The Animal Production in View of Climate and Technological Changes". Giving a presentation on the last day of the conference was, for a change, an advantage and allowed for adjusting a few slides and creating a few to comment on what had been said on previous days. It became clearer that aquaculture has some significant potential to be explored in Brazil, including IMTA, and could be an interesting food production model for the systems of tomorrow.

Brazil being a key animal meat producer on the world stage, Thierry heard a lot about ruminants, pigs, chicken and their problems (temperature and humidity regulation and adaptations in the midst of climate changes). What could have turned into an overdose of methane production and greenhouse gas emissions became very interesting for comparative purposes: aquaculture is, in fact, well-positioned, but not recognized enough, to become a responsible form of protein, carbohydrate and lipid production. With cold-blooded animals (and seaweeds with no blood!), growing in 100% humidity, and much better food conversion ratios (FCRs; around 1-1.2 for fish versus 2 for poultry, 3 for pigs, 4-6 for sheep and 5-8 or more for cattle), aquaculture species appear to be much more efficient transformers of feed into food because a significant part of their energy is not channeled towards maintenance (heat and humidity regulations) but meat production. Thierry also learned that the more a cow produces milk, the less it produces methane, *i.e.* the less it farts! Yes, this has been studied scientifically! It is also unfair to blame these poor cows, when, in fact, it is the archeobacteria colonizing the rumen which should be blamed! However, from an evolutionary perspective, why would nature have preserved rumen fermentation if it was such an inefficient system? Have we thought of all the possible services in these life cycle analyses?

In response to the theme of the conference, it was also important to point out that the IMTA multi-crop diversification approach (fish, seaweeds and invertebrates, and different species within these groups of organisms) should be considered as an economic risk mitigation option to address pending climate change impacts. It seems that after years of selection for efficiency in a particular environment, there is now a willingness to consider sacrificing some efficiency for gain in robustness through adaptation and acclimatization. Basically, should we match organisms to their environments (privileging genetics and genomics) or should we match environments to organisms (privileging adaptation and physiology), or maybe strategize in both directions? Species diversification in an IMTA context gives even more flexibility.

It was also striking to realize how people cannot imagine solutions outside the terrestrial world. Agricultural yields have levelled off, fisheries yields have levelled off or decreased... where will the proteins (and carbohydrates and lipids) for the 9 billion people announced for 2050 come from? As Thierry concluded in his presentation, "It is time to make the Blue Revolution greener and apply agronomic principles to the management of aquatic environments and "aquatic fields". It is, consequently, time for the Turquoise Revolution and Agronomy, as humans will soon not be able to continue to think of mostly land-based agricultural solutions for securing their food and many derived products".



The development of aquaculture in Brazil is quite recent. Its production reached 544,490 tonnes, of which 394,340 tonnes were in freshwater, in 2011; it increased by 54% between 2000 and 2006. There are 8,400 km of coastline in Brazil, but most of it is sandy and exposed, and not necessarily amenable to aquaculture development, which is happening more in estuaries and in a high number of freshwater reservoirs. However, with the drought of the last few years, the water levels of these reservoirs and their carrying capacities are going down. The development of aquaculture, particularly of tilapia (which represents more than half of the Brazilian production), and higher demands for irrigation and human consumption, are creating situations where water quality has decreased while sedimentation and aquatic plant biomass (so far undesirable) have increased.

Choices will have to be made in the development of aquaculture in Brazil. Freshwater and/or seawater will be a key decision to make. With such a north-south geographical extension and large latitudinal differences, species selection will be critical and no single solution can be expected. Integrating agriculture and aquaculture is maybe an option and $A + A = IAA$ is the new math! Adopting IMTA early on is maybe the appropriate approach for doing it right in a developing sector. Combining environmental protection and social development will also be critical; non-governmental organizations (NGOs) should evolve in their positions as aquaculture methods are evolving, knowing how to recognize when companies, like Primar, are making efforts to change practices instead of continuing to paint the whole sector with the same brush.

Adopting IMTA in Brazil comes with a lot of still unanswered questions, much as what happens when dealing with a new practice in any field. These include:

- When growing new species, there is a lack of knowledge and skill, especially at the hatchery stages.
- What will the interactions be between the co-cultivated species? Some will be positive (what we have seen so far), but some could be negative and some combinations of species will have to be advised against.
- What will the proportions between the different species be?
- How will the different production cycles be synchronized? What will the labour and operational constraints be?
- Business plans will have to be developed.
- The lack of regulatory frameworks, both nationally and internationally, could become impediments, delaying market developments and exportations.
- The lack of recognition for the provided ecosystem services and for increased societal acceptability amounts to a lack of incentives to support an evolution/switch in practices.
- Fear of unknown practices and new approaches are common in any society; however, are some perceived environmental, economic and societal risks really substantiated?

Are these comments, in fact, not applicable to a lot of other places, not only Brazil? Should we stand idly, doing nothing, or gradually start bringing answers as we move forward with our respective variations on the overarching theme of IMTA? It was really reinvigorating to spend a few days with enthusiastic pioneers Alexandre and Marcia Wainberg, and at a conference, which is not your usual audience.



Karin Schlott, editor of the German magazine *Natur*, das Magazin für Natur, Umwelt und besseres Leben (The magazine for nature, environment and better life), wrote an article entitled "Die Zukunft der Zucht" (The future of farming) in the special issue of the magazine dedicated to "Nachhaltiger Fisch" (Sustainable fish). IMTA is featured in the article as one of the solutions of the future.

Read the article: [Die Zukunft der Zucht](#)

This August, CIMTAN Modeller **Gregor Reid** spent two weeks in **Norway** to collaborate with two Norwegian Institutes, as one of the four initiatives supported by the NSERC Strategic Network Enhancement Initiative grant received by CIMTAN in 2014.

The first stop was in **Bodø** (pronounced Boo-da), north of the arctic circle, to work with **Celine Rebours** of **Bioforsk**, Norway's Agricultural Department. This project investigates a land-based IMTA approach. A marine pond was fertilized to enhance phytoplankton growth, which in turn produced zooplankton, as the live feed component for commercial juvenile cod production.



Gregor Reid found the time to mingle with some of the hospitable, colour coordinated Bergen locals (photo credit: Henrice Jansen).



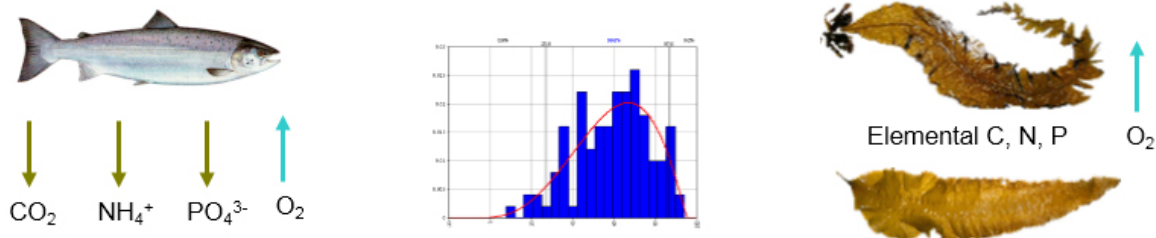
Older style Norwegian homes with grass roof near the Saltstraumen Maelstrom, outside Bodø, which claims to be the place with the world's strongest tidal current. Saltstraumen (which means salt current) is created when the tide fills or empties the Skjerstad fjord; it is a famous fishing spot, where fish get "trapped" in the fjord during flood tide (photo credit: Gregor Reid).

The second collaboration was with **Henrice Jansen** at the **Institute of Marine Research** (Havforskningsinstituttet) in **Bergen**. This collaboration involves developing a paper detailing sampling challenges and strategies for discrete water sampling at open-water aquaculture sites, particularly IMTA ones. This project was triggered by discussions held at a CIMTAN workshop in Saint John, New Brunswick, in November 2013, at which Henrice, and her colleague **Øivind Strand**, were guest speakers.



CIMTAN modelling work highlighted as a case study by **Palisade Corporation**, a software company based in Ithaca, New York, USA

Palisade Corporation is the maker of the world's leading risk and decision analysis software **@RISK**. Historically, the software has most often been used for large undertaking projections, such as in the energy sector. The unique application of the software to sustainable seafood farming issues intrigued Palisade Corporation so they interviewed **Gregor Reid** in July and reported on the IMTA project on their website (<http://www.palisade.com/cases/UNewBrunswick.asp>).



Last year, Gregor Reid (in conjunction with co-authors **Thierry Chopin**, **Shawn Robinson**, **Paula Azevedo**, **Margaret Quinton** and **Ellen Belyea**) published the paper "Weight ratios of the kelps, *Alaria esculenta* and *Saccharina latissima*, required to sequester dissolved inorganic nutrients and supply oxygen for Atlantic salmon, *Salmo salar*, in Integrated Multi-Trophic Aquaculture systems" in the journal *Aquaculture*. They used the Palisade @RISK software to quantify uncertainty for nutrient recovery potential of two species of kelps in open-water IMTA systems. This intuitive software enables Monte Carlo simulations right in Excel and coding is not needed.

Years ago, when Gregor Reid was a graduate student affiliated with AquaNet, a former NSERC Network of Centres of Excellence for Aquaculture, he went on a research placement program to visit **Jon Grant's** laboratory at Dalhousie University, in Halifax. Jon introduced him to the @RISK software and Gregor has been using the software off and on ever since.



Ramón Filgueira setting up a model (photo credit: Dawn Kellett).

After completing his undergraduate studies, **Ramón Filgueira** started, in 2000, an MSc degree focused on trophic ecology using stable isotopes. In 2001, he began a side project with an aquaculture company in which he defined the growth curves of turbot cultivated in fish cages. This was his first contact with the aquaculture industry and since then pretty much all the research in which he is involved is related to growing seafood. Ramón obtained his PhD in Marine Sciences from the University of Vigo (Galicia, Spain) in 2007. In his PhD thesis, Ramón investigated the feeding behavior of *Mytilus edulis* and during this period he discovered what he wanted to be when he grew up... a modeller!

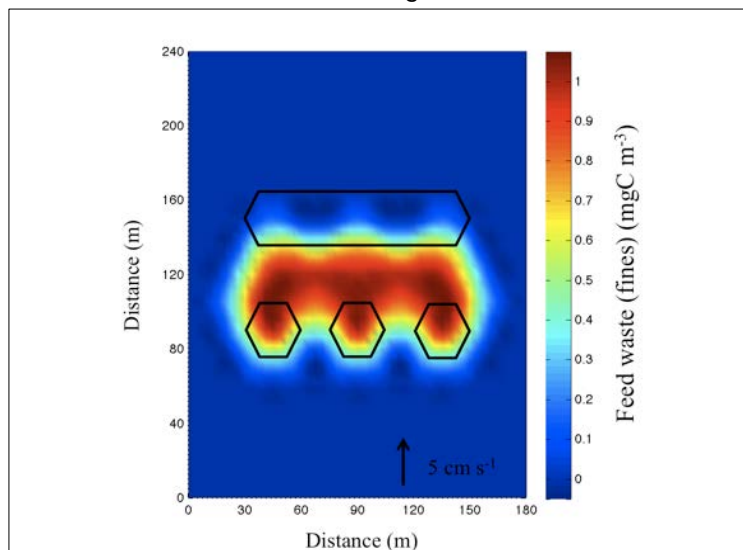


This is why in 2008 Ramón crossed the Atlantic Ocean (with his warmest coat) to start a great collaboration with Dr. **Jon Grant** at Dalhousie University, in Halifax, Nova Scotia. During his postdoctoral fellowship with Dr. Jon Grant, Ramón joined CIMTAN as a member of project D1P9, entitled "Evaluating the performance of proposed and existing IMTA sites using an ecosystem modelling approach". Currently, Ramón is a NSERC Visiting postdoctoral fellow in a Canadian government laboratory of Fisheries and Oceans Canada, working with Dr. **Luc Comeau** in the Gulf Fisheries Centre, in Moncton, New Brunswick, although he works remotely from Ottawa, Ontario. In project D1P9, Ramón works in collaboration with Drs. Jon Grant, **Gregor Reid** (CIMTAN University of New Brunswick/St. Andrews Biological Station) and **Peter Cranford** (Bedford Institute of Oceanography, Dartmouth, Nova Scotia) in the development of a highly configurable mathematical model that can be applied to existing or new IMTA sites with the aim of optimizing the farm design to maximize mitigation. The design of ocean-based finfish-shellfish IMTA farms is not trivial due to the complexity of coastal areas, particularly because biological processes in open-waters are influenced by water circulation, which includes the dispersal of finfish wastes. Consequently, the design of new IMTA sites or the evaluation of existing sites requires a combined study of biological and physical processes, which can be achieved by the execution and coupling of mathematical models. Their generic model takes into account the main environmental forcing, hydrodynamics, temperature and seston characteristics, as well as the physiology of the cultured species. The model allows for tracking of the different components of the seston in an IMTA site, including feed wastes, fish faeces, shellfish faeces, natural detritus and phytoplankton. Based on the

characterization of these fluxes of matter, the model can be used to explore different spatial arrangements for evaluating/improving finfish/shellfish farm efficiency. The main conclusion of the model is that mitigation efficiency is highly dependent on the background environmental conditions. In this way, the highest mitigation can be observed in oligotrophic environments, in which fish faeces can significantly alter the composition of the seston. A second conclusion is that given the dominance of vertical fluxes of particulate matter, organic extractive species should be emplaced below fish cages rather than adjacent in suspension in the water column, in order to maximize IMTA mitigation. So far the model has been applied to theoretical cases but the ultimate goal is to apply the model to the CIMTAN site on the west coast (Kyuquot SEAfoods Ltd.) and those on the East coast (Cooke Aquaculture Inc.).

When not working, Ramón is usually playing soccer (as a goalie!) and squash, snow shoeing, reading graphic-novels, watching soccer or TV or playing with his six month old son, Rafa.

CIMTAN member quote of the month: "Seafood provision is a key ecosystem service and providing seafood in a sustainable fashion, as CIMTAN aims, should be the goal of worldwide aquaculture" (*Ramón Filgueira, CIMTAN postdoctoral fellow*).



Mapping of feed waste (fines) concentrations (mg C m^{-3}) in a theoretical IMTA site when velocity peaks at 5 cm s^{-1} in the direction of the arrow. Regular hexagons represent fish cages and the irregular one shellfish longlines (figure credit: Ramón Filgueira).



In a previous issue of CIMTAN Snippets, we reported on a chair made of the brown seaweed *Fucus vesiculosus* by the interior architecture designers Nikolaj Steenfatt and Jonas Edvard in Denmark.

This time, we highlight the work of UK-based designer **Julia Lohmann**, who has been creating lampshades, hats, collars, wings, benches and sculptures with kelps, as a sustainable and versatile material for design and manufacturing.

In January 2014, Julia Lohmann won the acclaimed Arts Foundation Award for Materials Innovation, sponsored by the Clothmaker's Foundation, for her work with seaweeds (<http://www.julialohmann.co.uk/news/>).

Read the article: <http://inhabitat.com/lamps-made-from-seaweed-julia-lohmanns-kelp-constructs/>

Link to Julia Lohmann's website:

<http://www.julialohmann.co.uk/>



Thierry Chopin took the [ALS](#) (the kelps *Alaria*, *Laminaria*, *Saccharina*) ice bucket challenge at low tide on the shore of the Bay of Fundy, New Brunswick, Canada.

Adrian Hamer really enjoyed pouring the bucket of cold seawater and kelps!

Caroline Longtin (new CIMTAN postdoctoral fellow) enjoyed being on the other side of the camera, recording the video!

Watch the video:

- The full video [here](#)
- The short, slow-motion video [here](#)

