



Kelptastic, algamazing and contalgious!



From Sydney (Australia) and Christchurch (New Zealand) to St. George (New Brunswick), from California, Washington State, Vancouver and Victoria to Saint John (New Brunswick), from Beirut (Lebanon), Portugal and the Canary Islands to Fredericton (New Brunswick), from Brest, Avignon, Paris, Copenhagen to St. Stephen (New Brunswick), from Moncton, Halifax, New York, Ottawa, Toronto, Michigan, Alberta, Colorado and Arizona to St. Andrews (New Brunswick)... we received the same message: "please, send me some, I want to try it!"



A few testimonies:

Bonjour Thierry! I'm sitting at home very much enjoying a mug of "Kelp". I am a fan of dark ales and this is certainly one of the better ones I have tasted. Let's hope its popularity warrants further production!

It is pretty awesome. I love the smooth and slightly sweet follow-up compared to a traditional stout or porter of similar body. It would go great with sushi - plus, what a great story. I feel younger and more vibrant already and I haven't even cracked the top. Mmmmm - delicious, nutritious beer!

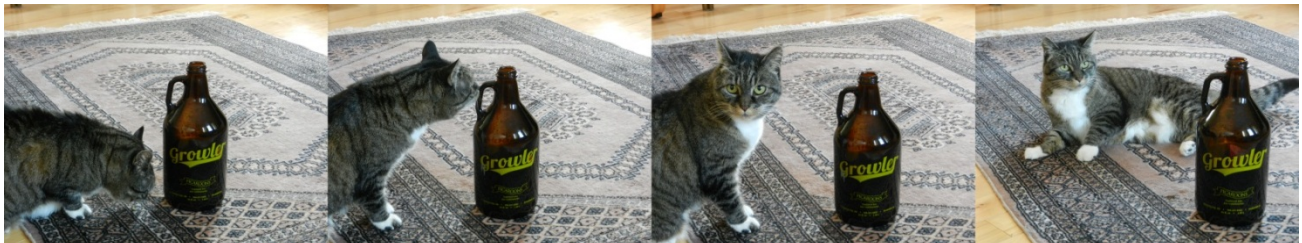
They just couldn't "kelp it"! Picaroons makes tasty brew made from sugar kelp!

So cool! Congrats Picaroons and Thierry Chopin for your new kelp beer! New Brunswick Tourism

Wow, what a complex beer!

From several aquaculture veterans: *Dear Thierry, now you're talking! Cheers,*

Thanks for your research! I wanted to let you know that I tried the Kelp on the Way from Picaroons. I prefer darker beers/ales and really enjoyed it and would definitely buy it again.



When Kelpy, the cat, meets Kelp on the Way, the beer... she is first intrigued and, then, content too! (photo credit: Thierry Chopin)



“If you like sweet and salty combinations, then you are going to enjoy this beer”, said Sean Dunbar, the owner of Picaroons Traditional Ales. “The neat part for me is the saltiness, the way the salt hits your tongue at the very end of the flavour profile. The salt receptors pick up that sweet, silky smooth salt thing at the end of the drink. So, the beer goes to the back of your throat, crosses your tongue and your taste buds and then you go “Oh, What is that and where did it come from?””.

“It’s kelptastic... It’s exactly what we wanted! A kind of toffee impression mixing the sugar and the salt together” added Thierry Chopin.



Members of the Chopin Lab taste-testing (or test-tasting) the precious stuff... for experimental purposes only, of course!
(photo credits: Thierry Chopin and Caroline Longtin)

Seeing the first batch of 600 litres of Kelp on the Way sell out in less than three days, and reading very positive feedback comments, are clear indications that the recipe was right. The development of a very smooth beer with character and the combination of two great Canadian Maritimes stories is certainly a winner. Picaroons is a well-regarded microbrewery from Fredericton, with a great sense of humour for developing unique beers with equally amazing names. This beer also represents our efforts at diversifying and commercializing our differentiated IMTA products. Seaweeds lend themselves very well to the Integrated Sequential BioRefinery (ISBR) approach. With careful planning at the time of harvesting and sequential processing, more than one product can be manufactured from seaweeds. Over the last decade, this is the strategy we have adopted with Cooke Aquaculture Inc.: IMTA kelps not only recapture some of the inorganic dissolved nutrients from fish farms, but we are also developing markets for kelp use in human consumption, for cosmetics, as a partial substitution in fish feed and for biochar production, along with obtaining organic certification in the spring of 2014.

The launching of Kelp on the Way triggered at least 18 articles in newspapers and professional magazines, 1 radio interview and 1 television interview.



Making linkages: Exploring the future of aquaculture and the potential of IMTA in British Columbia – An opportunity to learn and discuss IMTA potential with First Nations communities



Erin Latham (CIMTAN PhD candidate at the University of Victoria, British Columbia) facilitating the Vancouver workshop (photo credit: Thierry Chopin).

CIMTAN has been disseminating the knowledge it has acquired over the last five years and is contributing to the growing IMTA movement promoting further research, development and commercialization around the world. In British Columbia, IMTA has reached the discussion tables of First Nations. Following the research of a recent CIMTAN Master student, **Katie Tebbutt**, supervised by CIMTAN researchers, **Mark Flaherty** and **Stephen Cross**, **Erin Latham's** PhD research is now broadly examining First Nations engagement in aquaculture governance in British Columbia. As an entry point to the research, Erin engaged in an open discussion with interested First Nations representatives to explore the opportunities and challenges of pursuing IMTA

development in their organizations and communities. Erin has been able to provide participants with the opportunity to learn, ask questions, and discuss IMTA directly with scientists involved in its research and development through a series of workshops.

The IMTA workshop series began by sending out a “Call for Interest” to host and/or participate in a discussion about IMTA. Three workshops were then scheduled in Terrace, Campbell River, and Vancouver, and two guest presenters from CIMTAN attended each workshop. **Chris Pearce** and **Stephen Cross** joined the ones in Terrace and Campbell River, and **Thierry Chopin** and **Stephen Cross** were at the one in Vancouver on March 4, 2015 (Chris Pearce participated in the discussions). Altogether, participants from 17 First Nations communities and organizations took part in the series, representing interests in both marine and freshwater IMTA.



The audience at the Vancouver workshop (photo credit: Thierry Chopin).



Stephen Cross giving his presentation at the Vancouver workshop (photo credit: Thierry Chopin).

Each workshop started by asking participants what drew their interest/attention to IMTA, and where they had first heard about it. Many participants had never heard of IMTA before, but CIMTAN organizers were reminded that First Nations have been practicing “IMTA” for thousands of years, and that First Nations peoples were amongst the first aquaculturists in the world. One participant from the Gwa'sala-'Nakwaxda'xw Nation, whose traditional territory is on the central coast of British Columbia, recounted that he had learned of IMTA through his Elders in the community and how their ancestors practiced husbandry methods in areas where they harvested fish, shellfish and seaweeds. Overall participants were keen to learn about the “vision” and scale of IMTA development. Presentations by CIMTAN scientists followed, and then Erin



engaged participants in a facilitated discussion exploring if and how IMTA meets their interests and values, as well as the factors that would influence decisions to pursue its development in their communities.

Each workshop closed by asking “What’s next for IMTA?”, and many participants were keen to learn more about IMTA opportunities and, possibly, pursue “IMTA demonstration projects”, as well as identify what IMTA resources were available to them. It was interesting to note an overall positive interest in IMTA as a practice close to the First Nations way of life vision. It was also considered a method that would be relatively simple to implement, with real prospect of direct employment opportunities for members of First Nations communities.

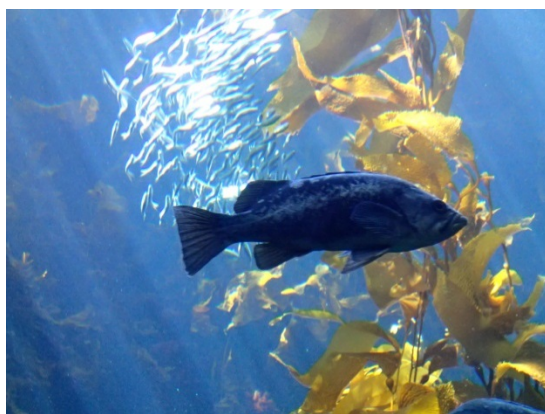
Erin will be tracking the development of this process and will be actively supporting participants as they seek additional information related to aspects of IMTA development. Erin will also be presenting this preliminary work, with an update on this process, at the upcoming Aquaculture Association of Canada conference this June in Nanaimo, British Columbia.

Erin would like to express her sincere gratitude to all the participants for their time and their input – it was truly an informative experience for everyone!



Thierry Chopin giving his presentation at the Vancouver workshop (photo credit: Erin Latham).

IMTA session at the National Shellfisheries Association conference



Fish in the giant kelp tank central to the Monterey Bay Aquarium, highlighting the ecosystems formed in nature, which provide models for IMTA practices (photo credit: Shawn Robinson).

On March 24, 2015, a special session on IMTA and Offshore Aquaculture was held at the 107th Annual Meeting of the National Shellfisheries Association in Monterey, California. The session was co-chaired by **Scott Lindell**, from the Marine Biological Laboratory in Woods Hole, and **Shawn Robinson**, from the Fisheries and Oceans Canada Biological Station in St. Andrews and UNBSJ-CIMTAN. The first speaker of the session was **Muki Shpigel**, who gave an overview of IMTA and the history of its development. Muki was one of the early initiators of what became IMTA in Israel, following up from the seminal work carried out in Woods Hole and Harbor Branch Oceanographic Institution by **John Ryther**. Nine other presentations encompassed topics such as on-land recirculation systems, extraction of nutrients in the Baltic Sea as

well as in New England, trials and tribulations of farming mussels in US coastal waters, the ecological role of microbes and nutrient dynamics around salmon farms (CIMTAN student **Hannah Bradford**) and a final presentation about where and how IMTA needs to evolve in the future by Shawn Robinson. The session was very well attended and drew participants from a wide diversity of fields, ranging from industry to management.



The Annual Meeting featured a number of special sessions highlighting climate change and ocean acidification, and the world abalone industry. The last plenary presentation was given by **Paul Dayton** and addressed "The Loss of Nature and the Nature of the Loss".

The Proceedings of the Aquaculture Canada 2014 Conference are out!

<http://www.aquacultureassociation.ca/publications/bulletin-of-the-aac/aquaculture-canada-2014-proceedings-of-contributed-papers/>

Four papers were contributed by CIMTAN members:

Chopin, T., 2015 - Monitoring the invisible with highly visible consequences: let's not forget the dissolved inorganic nutrients so we can use them efficiently. *Bull. Aquacul. Assoc. Canada* 2015-1: 53-61.

Day, J., Chopin, T., and Cooper, J.A., 2015 - Comparative study of the aquaculture environmental monitoring programs for marine finfish in Canada and other jurisdictions: time to go beyond sediment related impact monitoring and consider appropriate tools for water column and ecosystem related impact monitoring. *Bull. Aquacul. Assoc. Canada* 2015-1: 34-52.

Khoda Bakhsh, H., Chopin, T., Murray, S.A., Belyea, E., and Hamer, A., 2015 - Adapting tropical integrated aquaponic systems to temperate cold freshwater integrated multi-trophic aquaculture (FIMTA) systems. *Bull. Aquacul. Assoc. Canada* 2015-1: 17-25.

Reid, G.K., Filgueira, R., and Garber, A., 2015 - Revisiting temperature effects on aquaculture in light of pending climate change. *Bull. Aquacul. Assoc. Canada* 2015-1: 85-92.

Interestingly, this means that 45 pages of the 88 pages of papers contained in this document were provided by CIMTAN members, *i.e.* 51% of the knowledge transfer and dissemination of this document. Bravo!

A Lousy Day at the Farm! An example of west-east coast mobility by CIMTAN graduate students



Craig Smith and Allie Byrne getting ready for sampling (photo credit: Shawn Robinson).

CIMTAN Master student **Allie Byrne** (University of Victoria, British Columbia) visited CIMTAN investigator **Shawn Robinson** (Fisheries and Oceans Canada (DFO), St. Andrews, New Brunswick) between September 26 and October 5, 2014. With CIMTAN Master student **Taryn Minch** (University of New Brunswick in Saint John, New Brunswick) and DFO technician **Craig Smith**, they conducted a complete one-day field experiment at the Crow Island Cooke Aquaculture Inc. IMTA site near St. George, New Brunswick, on September 28-29. The primary goal was to determine how sea lice larvae are distributed in the water column during both the day and night, which has



implications for preventative louse control techniques that aim at capturing their free-swimming stages (e.g. with IMTA filter-feeding bivalves).

Over a 24 hour period, nearly 300 plankton samples were collected next to a salmon pen by pumping seawater from 6 depths through fine mesh. Samples were preserved and analyzed for sea lice back in the laboratory at the St. Andrews Biological Station during the week that followed. Interestingly, almost all sea lice larvae found in the night time samples were near the surface (1-6 m), whereas almost no larvae were found near the surface during the day, contrary to what most literature reports. Allie was happy to put her sea lice and plankton skills, acquired in the laboratory of CIMTAN investigator **Chris Pearce** at DFO's Pacific Biological Station (Nanaimo, British Columbia), to good use on the east coast.



Taryn Minch and Craig Smith measuring chlorophyll *a* and particulate concentrations inside a salmon cage (photo credit: Shawn Robinson).

The *multi*-tasking and *multi*-talented team also gathered other samples while at the farm, to maximize the efficiency of this short but productive field trip, staying true to the *IMTA* principles!



Shawn Robinson, the "supervisor" at work (photo credit: Allie Byrne).

Before sampling sea lice, one set of sediment traps was deployed beside a salmon pen, and another 50 m away, to investigate the organic content of settled material after 24 hours. As well, Taryn measured vertical profiles of chlorophyll *a* and particulate concentrations directly in a salmon pen and 10 m away in between plankton samples. This work ties into Taryn's MSc project looking at water flow and the movement of fish waste to help maximize nutrient recapture by extractive species at IMTA farms.

Overall, this CIMTAN collaboration was a lot of fun and will hopefully contribute to future research and publications!

On April 9-10, 2015, **Thierry Chopin** participated in the biennial meeting of the **International Advisory Scientific Council** of the **Institut Universitaire Européen de la Mer (IUEM)**, in Brest, at the western tip of Brittany, France.

The IUEM is a leading research institute for Marine Science innovation through its research, teaching and environmental monitoring/observatory missions; it is part of the **Université de Bretagne Occidentale**, the alma mater of Thierry Chopin. Its strong interdisciplinary approach spans from research in Human and Social Sciences to the Sciences of the Universe and Life Sciences, from the deep sea floor to the waves at the surface, from microorganisms to complex ecosystems and global biogeochemical cycles, and from the short time scale of storms to the long time scale of continental drift, putting the IUEM at the top of its field nationally and internationally.



Members of the International Advisory Scientific Council of the Institut Universitaire Européen de la Mer (IUEM), and some members of the IUEM, for a group photo outside the IUEM located just at the stunning entrance to the Rade de Brest (photo credit: Sébastien Hervé, IUEM).

Another member of the Council is **James Wilson**, from the **Université du Québec à Rimouski**. James and Thierry are developing a collaborative project on “property rights” in the aquaculture sector. They want to study how changing the rules of use, which are supported by regulations and needed for better management, may have changed the

industry structure. Such changes have occurred before and have been studied by economists, for example, in the case of the attribution of public lands and the evolution of property rights in the American West. A comparative study of what is happening in the aquaculture sector should be most interesting.

Moreover, it could be interesting to understand what is happening when new practices, such as IMTA, are “rattling the established order” in terms of regulations by considering the cultivation of species other than the dominant one of the day, and are pressing for a rethinking of how fish aquaculture should work within an ecosystem approach by integrating the cultivation of seaweeds and invertebrates and considering the ecosystem services and economic and societal benefits provided by such integration and diversification. The aquaculture industry in New Brunswick, for example, has certainly evolved significantly since the pioneer years of the late 1970’s, but has it reached maturity or a certain level of stability for now?

Thierry Chopin was one of the speakers at this year’s **Joan M. Kelly Sea State Lecture Series** at the **Gulf of Maine Research Institute (GMRI)** in Portland, Maine.



The Gulf of Maine Research Institute (GMRI) in Portland, Maine (photo credit: Thierry Chopin).

The GMRI provides an unusual mix of science, education and community programs to sustain both the region’s natural resources and the communities that depend on them. GMRI is catalyzing interdisciplinary solutions to the complex challenges of stewardship and economic growth. As this bioregion’s extraordinary potential is being realized, GMRI shares what they have learned and transfers the management models they have developed nationally and internationally.





This winter/spring 2015, the theme of the Sea State Lecture Series was “**Amazing Algae**”. So, it was with great pleasure that Thierry Chopin accepted an invitation to give an evening presentation, on April 23, 2015, entitled “Responsible seafood farming: a fish, seaweed and invertebrate recipe”, which covered the interdisciplinary approach taken by CIMTAN to develop IMTA. Because the GMRI pays particular attention to fruitfully fuse science, education and community, the audience it attracts for its lecture series is always varied, interested and interesting, and the beautiful auditorium is conducive to a very enjoyable exchange of questions and answers after the presentation. That evening was no exception!



Thierry Chopin giving his presentation in the auditorium of the Gulf of Maine Research Institute (GMRI) in Portland, Maine (photo credit: GMRI).



The Marine Science Center on the Biddeford campus of the University of New England (photo credit: Thierry Chopin).

The next morning, Thierry Chopin visited the **Biddeford campus** of the **University of New England**, where **Barry Costa-Pierce** is the Director of the Marine Science Center. **Carrie Byron** took him on a tour of the facility before he gave his presentation entitled “Integrated Multi-Trophic Aquaculture (IMTA): an environmentally, economically and societally responsible aquanomic approach to farming the sea”. A nice lunch allowed the discussion and exchange of ideas to continue afterward.



From left to right: Zach Hope (graduate student), Thierry Chopin, Carrie Byron (Research Assistant Professor) and Adam St. Gelais (coordinator of the fisheries and aquaculture projects at the Marine Science Center) (photo credit: University of New England).



Workshop on “Climate Change and Aquaculture”



Huntsman Marine Science Centre Executive Director, and workshop facilitator, Jamey Smith, directs questions during a discussion period (photo credit: Gregor Reid).

A two day workshop entitled “Climate Change and Aquaculture: Atlantic Workshop” was held at the Huntsman Marine Science Centre (HMSC), in St. Andrews, New Brunswick, the last week of April. The workshop, funded by the NSERC Partnership program, was co-led by CIMTAN researcher **Gregor Reid** and **Betty House**, the Research and Development Coordinator of the Atlantic Canada Fish Farmers Association; it was facilitated by **Jamey Smith**, the HMSC Executive Director.

The primary goal of the workshop was to connect the aquaculture industry with researchers and managers to enable an understanding of how the impacts of climate change may affect their industry, and to strategize research approaches to ensure the ongoing viability of aquaculture under a changing climate. The workshop



Thierry Chopin asking a question (photo credit: Gregor Reid).

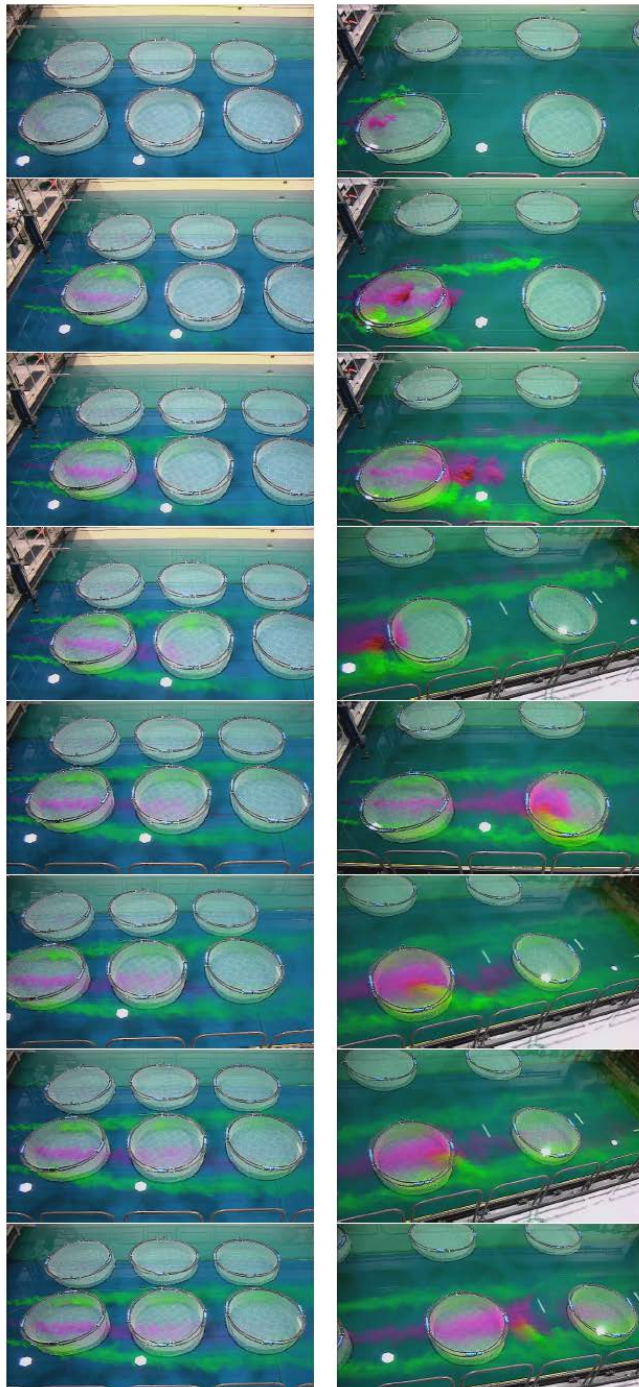
was a balance between consolidating existing multi-disciplinary information into succinct findings, identifying and prioritizing research gaps, while also ensuring that industry concerns were understood. Four workshop themes were used to partition discussion and initiatives: 1) fish and shellfish health, 2) storms and rising waters, 3) ocean acidification, and 4) warming waters.



The “nutrition break-out group” in discussion. From left and clock-wise: André Dumas (Coastal Zones Research Institute), Nathalie Le François (Biodôme de Montréal and Université du Québec à Rimouski), Betty House (Atlantic Canada Fish Farmers Association), Kurt Simmons (University of New Brunswick, CIMTAN MSc candidate), Gregor Reid (CIMTAN investigator), Tom Taylor (Northeast Nutrition Inc.) and Alan Donkin (Northeast Nutrition Inc.) (photo credit: Jamey Smith).

The workshop was a great success with approximately 50 participants from six provinces in attendance. Break-out groups in the areas of 1) nutrition, 2) engineering, 3) management and governance, 4) shellfish, 5) fish health, and 6) genetics, assessed the state-of-knowledge and formulated recommendations.

The outcomes of this Atlantic workshop will be consolidated with those of the upcoming Pacific coast companion workshop to publish joint findings and develop tangible plans for collaborative research. The Pacific workshop will take place the last week of June in Campbell River, on Vancouver Island, and will be co-led by CIMTAN researcher **Helen-Gurney Smith** and **Joanne Liutkus**, the Research and Development Coordinator of the British Columbia Salmon Farmers Association.



Time-lapse pictures of the trajectory of dyes released upstream of scale model cage arrays. The green dye was released near the sides of the cages to observe flow acceleration around the cages, while the pink dye was released down the middle of the cages to observe velocity deficits of different cages. On the left is a cage array with a 0.27 cage diameter spacing between cages, and on the right is a cage array with a 0.91 cage diameter spacing between cages. Flow velocity for both cases is 0.13 m/s.

CIMTAN Master of Science in Engineering (MScE) student **Adam Turner** defended his **thesis** this past April 10th at the **University of New Brunswick's Fredericton campus** (co-supervision by **Tiger Jeans** and **Gregor Reid**). Not only was Adam's defence successful, but he also finished a semester early. Well done Adam! His thesis was entitled "Experimental Investigation of Canadian East and West Coast Fish Farm Hydrodynamic Wake Properties and Its Implications for Integrated Multi-Trophic Aquaculture". Adam's experiments consisted of measuring drag forces and wake velocities of scale model fish cage arrays to better understand the hydrodynamics of fish farms.

Drag measurements were completed for individual cages within the array with changing current velocity. Results show the highest drag forces for the first row of cages, with drag reducing significantly through rows two and three. A wake velocity study behind individual cages within the array and in the wake of the entire array was completed to observe velocity deficits, wake topology, wake recovery and turbulence in the flow field. Results show high velocity deficits directly behind cages within the array, causing flow to be accelerated around and below the cages. The presence of a shear layer in the wake of the cages is observed to cause high levels of turbulence downstream. This is expected to cause heavy mixing in the wake, thus dispersing nutrients from a cage site faster.

Hydrodynamic results from Adam's experiments present some implications for IMTA component placement. Large velocity deficits observed behind fish cages suggest that organic extractive species, such as mussels, should be placed as close to individual cages as possible, so that particulate matter can be intercepted before it sinks to the seafloor. Placing IMTA infrastructure close to cages will cause further hydrodynamic implications, such as increased drag and velocity deficits, and should be carefully considered. Inorganic extractive species, such as kelps, should be placed



further downstream in the wake of a fish farm to benefit from increased flow velocities due to the recovery of the wake. Dissolved inorganic nutrients will be transported within the wake and spread with increasing distance from the farm. In case of an isolated farm, the balance between nutrient concentration and flow velocity must be carefully considered when placing inorganic extractive species and their infrastructures. In cases where the background nutrient levels in the water are high, due to multiple farm sites, the dependence on relative nutrient concentration from the cage site is decreasing and component placement is mostly a function of flow velocity.



Adam Turner adjusting the circular cage-array model in the flume tank at Memorial University's Marine Institute in St. John's, Newfoundland (photo credit: Justin Del Bel Belluz).

This successful research outcome was a great example of researcher-industry collaboration. Adam worked closely with GMG Fish Services Ltd. (a subsidiary of Cooke Aquaculture Inc.) and Marine Harvest Canada Ltd., both of whom contributed funding and in-kind support to help construct the complex model cage-arrays used for Adam's experimental trials in the flume tank at Memorial University's Marine Institute in St. John's, Newfoundland.

Hossein Ayouqi received his Bachelor degree in Aerospace Engineering in 2006 from Sharif



Hossein Ayouqi while visiting Cape Breton Island after the Annual General Meeting of CIMTAN in Halifax in May 2014 (photo credit: Neda Eskandari).

University of Technology, Tehran, Iran. He then made a decision to change his academic life by becoming an economist and he got his Master degree in Environmental Economics in 2010 from the Allameh Tabatabai University, Tehran, Iran. After graduation, he and his wife came to Canada. In 2013, he graduated with a Master degree in Agricultural Economics from the University of British Columbia in Vancouver. He then met **Duncan Knowler**, at Simon Fraser University in Burnaby, who offered him a PhD position in Resource Management with a research focus on the economic analysis of IMTA. He eagerly accepted the position as he was looking to move from theoretical economics to applied economics for his PhD. This is how

Hossein's academic journey started in the sky and ended up in the marine environment!

Hossein's research goal is to perform a comparative economic analysis of nutrient dynamics in IMTA and conventional net pen salmon aquaculture. For this purpose, he uses a bioeconomic modelling approach in which economic, biophysical and ecological analyses are integrated in order to develop appropriate decision support tools that address trade-offs between natural processes and economic



systems. Hossein is currently developing a biophysical model for IMTA and plans to submit it as a paper by the end of this year. **Gregor Reid** (CIMTAN-UNBSJ) and **Sean Cox** (Simon Fraser University) are on his PhD committee and will help him, especially with respect to ecological and biophysical aspects.

Hossein recently became a first time dad. Before that, his hobbies were watching movies and soccer, walking, visiting his friends and cooking, but now, while his hobbies still include cooking, they have changed to include laundering, diaper changing and soothing.

CIMTAN member quote of the month: "CIMTAN gave me the opportunity to pursue my education in an interdisciplinary program which always was my dream. Integrating biology and ecology with economics and policy analysis can lead to a great interdisciplinary PhD research. I believe the outputs of economic analysis can be critical for IMTA future. Hopefully, the results of my research may convince policymakers to make new decisions on promoting IMTA and on supporting innovative research networks like CIMTAN to develop further studies in this area" (*Hossein Ayouqi, CIMTAN Resource Management PhD candidate*).

Would the CIMTAN delegation, that attended the international conference and workshop entitled "Integrated Multi-Trophic Aquaculture (IMTA): an aquanomic approach to farming the sea" in Puerto Montt, Chile, last December, have guessed that the majestic **Calbuco volcano** would wake up 4.5 months later, forcing the evacuation of thousands of people and the move of millions of young salmon and trout? People are still assessing their losses.



Arriving in Puerto Montt on December 1, 2014: aquaculture operation in Lake Llanquihue (the second largest lake in Chile) in the foreground and the majestic Calbuco volcano in the background (photo credit: Thierry Chopin).



Eruption of the Calbuco volcano on April 22, 2015, as seen from Puerto Montt waterfront (photo credit: Alejandro Buschmann).