



INTEGRATED MULTI-TROPHIC AQUACULTURE



IMTA

an ecosystem approach
to farming the sea



*Best wishes for the Holiday Season and Happy New Year!
From the Canadian IMTA Network (CIMTAN)*



Steven Backman, Samuel Backman, Caroline Longtin and Adrian Hamer returning from installing kelp ropes at the Magellan Aqua Farms Inc. site in Big Bay, New Brunswick (photo credit: Thierry Chopin).

Kelp lines installed at Magellan Aqua Farms Inc. Dr. Steven Backman, the owner of the farm, currently raising sea scallops (*Placopecten magellanicus*), had the site amended last spring, to be able to grow the red seaweed *Palmaria palmata* (dulse), and this fall to be able to grow several species of kelps. Seven lines were installed on November 15, as a trial for this season. If the site proves to be good for kelp cultivation, scaling up will take place next year. When Magellan Aqua Farms Inc. began operations, Steven Backman made a conscious decision to follow a development model which follows the natural processes of the ecosystem. They quickly learned that there are many complicated interactions between the physical and biological environments, which are well beyond our



understanding. They did make a few interesting observations, which laid the foundation for their interest in IMTA. Firstly, they noticed that, in the wild, green sea urchins are frequently observed sitting on scallops, and that these scallops have reduced fouling and damage from the annelid worm, *Polydora* sp. The second observation was that long lines with seaweed cover seemed to have markedly fewer starfish (predators of sea scallops) on them than the newly placed or recently cleaned long lines. After seeing several presentations by Thierry Chopin, the pieces started to fit together and the collaboration was born.

Exsymol SAM received the 2015 Sustainable Development Prize from the Monaco Economic Board on November 24. SAS Prince Albert II of Monaco awarded the Trophy to Pierre Bondon, General Director of Exsymol SAM, personally to emphasize his interest, and that of the Principality of Monaco, in environment conservation. He congratulated Exsymol SAM for its ability in investing in Green Chemistry and Clean Chemistry.

Exsymol SAM is the manufacturer of Exsymtal®, the cosmetic product extracted from our IMTA kelp, *Alaria esculenta*. The product is rich in polyphenols, mannitol and oligo-elements; it has anti-aging, anti-stress/anti-pollution, dermis filling (collagen booster) and epidermis renewal properties.

Exsymtal® has contributed to positioning Exsymol SAM among the leading companies in the field of sustainable development and eco-responsible sourcing through IMTA. It certainly contributed to the awarding of the 2015 Sustainable Development Prize from The Eco Club of Monaco.

Read the following articles on the 2015 Sustainable Development Prize received by Exsymol:

<http://www.premiumbeautynews.com/fr/developpement-durable-monaco,8921>

<http://www.meb.mc/remise-des-trophees-du-club-de-leco-monaco-2015/>



Pierre Bondon accepting the 2015 Sustainable Development Prize of the Monaco Economic Board from SAS Prince Albert II of Monaco (photo credit: Monaco-Matin newspaper).

Thierry Chopin participated in the Seafood Fusion Festival, in Brest, France, on November 21-22. This “Festival International de Cuisine des Coquillages et des Algues” was held at the beautiful [Océanopolis](#) aquarium and discovery park.



As an “appetizer”, Thierry Chopin was invited by Eric Hussenot, the Director of Océanopolis and long-time friend, to give a seminar entitled “Integrated Multi-Trophic Aquaculture: an ecosystem approach to farming the sea” in the Marion Dufresne auditorium the evening of November 20, as part of the Océanopolis seminar series. Thierry Chopin was particularly pleased to see two of his “old” professors from the time he was a student at the University of Western Brittany, in the 1980’s, in the

audience. Both have remained very active and have almost not changed: amazing! Paul Tréguer (Chemical Oceanography) became the Director of the renowned European University Institute of the



Sea and is still on many committees and holds several advisory positions. **Michel Glémarec** (Marine Ecology) has been fascinated by the painter **Mathurin Méheut** (1882-1958) for years and has written several books on coastal biodiversity through the eyes of this artist with a unique, precise and colorful way of depicting marine life.

The Seafood Fusion Festival was born from the observation by **Thierry Larnicol** (from the [Keraliou](#) shellfish company), and a few of his chef, restaurant owner and producer friends, that shellfish and seaweeds have not yet conquered the tables of restaurants beyond the traditional “plateau de fruits de mer” (“seafruit platter”) and it was time to change that attitude by demonstrating that they can have their own central role in the preparation of succulent and astonishing dishes. The Festival was, in fact, under the patronage of renowned Chef [Olivier Roellinger](#) from Cancale. It was also about educating the general public to demystify these marine organisms and show how easy they are to cook with, the wonderful flavours they can reveal, and their excellent nutritional value. It was also intended to establish Brittany as a culinary destination for the gastronomic richness of its coastal regions.

Over two days, the Seafood Fusion Festival was a most interesting mix of exhibitions by shellfish and seaweed harvesters/aquaculturists/processors/retailers and local product farmers; around 20 chefs offering cooking presentations or battling each other fiercely after walking through the “Producers’ Market” to make their selection of what to cook with right on the spot; an oyster shucking contest;





scientific seminars; round tables and debates on pressing topical issues related to the oceans and marine resources; a workshop for the “Children of Nemo”; and a sumptuous gala dinner amidst the aquaria of Océanopolis.

Thierry Chopin gave a seminar entitled “A succulent recipe fusing fish, seaweeds and invertebrates and good for the environment: integrated multi-trophic aquaculture (IMTA)” and gave several radio, blog and TV interviews (see links below).

Kristen Guyomar was instrumental in organizing the “Seafood Échanges”, whose objective was to popularize a number of present issues (sustainability of the resource, new species of interest, climate changes, management of multi-user conflicts, etc.) by combining different contributors along the chain of custody who often do not sit together (harvesters, aquaculturists, natural scientists, social scientists, economists, marine protected area managers, regulators, processors, retailers, chefs and restaurant owners). Gathering them led to some thought-provoking sessions and round tables, coupled with cooking presentations illustrating the diversity of the topics approached.

Of particular interest were two round tables. “Les Algues: de l'estran à l'assiette” (“Seaweeds: from the shore to the plate”) saw a scientist (Philippe Potin of the Roscoff Marine Station), a seaweed harvester and representative of the seaweed harvester association (André Berthou), a seaweed product distributor (Henri Courtois of the company “Algue Service/Bord à Bord”) and a chef (Romain Pouzadoux of the restaurant [L'Imaginaire](#) in Brest) discuss why seaweeds are not eaten more in the





western world, despite being abundant along many shores. Then, how can we improve their recognition and appreciate their benefits so that they appear on our tables more frequently? During the round table, Romain Pouzadoux prepared an amazing clam/wakame (the brown seaweed *Undaria pinnatifida*) /raspberry powder dish, some seaweed gnocchis and squids with sea beans (the brown seaweed *Himanthalia elongata*). Delicious!

The Master students in Valuation and Management of the Coastal Zone at the European University Institute of the Sea led a round table entitled “Nos coquillages auront-ils toujours la pêche dans 20 ans?” This was a funny play on words which is difficult to translate in English. “Avoir la pêche” is approximately “to be on top form”, with la pêche being the peach fruit; but, in French, la pêche is also fishing. So, that round table was about discussing whether shellfish resources along the coast will still be in good shape in 20 years. How can we keep traditions while looking for added-value and sustainable development of this coastal, cultural, gastronomic and economic resource? What are the impacts of recreational fishing, trampling, etc. on a fragile coastal ecosystem? This round table was “culinarily illustrated” by Chef Patrick Jeffroy, of the [Hôtel de Carantec](#) in Carantec.

A walk through the Producers’ Market was most delectable, with an incredible abundance of shellfish and seaweed products. Even the long-time denigrated invasive species *Crepidula fornicata* was getting a newer reputation as the “coquillage coquin” (“naughty shellfish”) and was served as a new dish. Seaweeds could be tasted raw, in flakes, in sausages, in several tartars of the world, in flavored vinegar and in flavored alginate pearls. [Pierrick Le Roux](#), well-known chef cooking with seaweeds, prepared a succulent recipe of gratinées oysters with a sabayon of seaweeds, which astonished more than one member of the mesmerized audience. The halophyte *Salicornia* could be tasted fresh or in flavored vinegar. Farmers and artisans were also presenting other local products such as addictive jams, delicious charcuterie, intriguing mushrooms, most interesting micro-brewed beers, etc. The company [Penn Ar Box](#) has even developed a survival kit for the expatriate Bretons or “Bretagnophiles” of the world who can register to receive a box containing ten different products from Brittany by mail every month! The music group [Libenter](#), specialized in the sailor song repertoire, provided the maritime atmosphere and entertainment.

This was the first edition of the Seafood Fusion Festival. Its success, its convivial, dynamic and festive atmosphere, and the unique setting of Océanopolis guarantee that it will not be the last.

- Look at the site of the Seafood Fusion Festival: <http://www.seafoodfusion.com/festival-2015>
- Listen to interviews of Thierry Chopin, Eric Hussenot and Thierry Larnicol on France Bleu Breizh Izel Radio
- Read the blog of Jean-Louis Courleux and watch the interview of Thierry Chopin
- Watch the documentary on Tébéo TV - Télévision Bretagne Ouest
- Read the inserted Gazette for Le Télégramme newspaper
- Read the Magazine of the Seafood Fusion Festival

Thierry Chopin was involved in a short video clip (<https://www.youtube.com/watch?v=bfiz0V46q8>) advertising the Marine Biology Program at the University of New Brunswick, one of only a few programs of this kind in Canada: an interdisciplinary, experiential, hidden little gem!



EFFECTS OF CIRCULAR FISH CAGE ARRAYS ON CURRENT DYNAMICS: IMPLICATIONS FOR NEAR-FIELD VELOCITY REDUCTION, NUTRIENT CONCENTRATIONS AND CAGE CLEARANCE TIMES

A. TURNER, J. DEL BEL BELLUZ, S. SPRAGUE, A. BYRNE AND G.K. REID

Influence of cage arrays on current flow can result in highly variable, and often turbulent, near-field hydrodynamics... (The rest of the abstract text follows in a similar format, summarizing the study's objectives and findings.)

Back in March 2014, a CIMTAN graduate student workshop was held at the world renowned Flume Tank facility of the Marine Institute at Memorial University of Newfoundland, in St. John's, Newfoundland. This was an intensive 4 day workshop where students worked and lived together to tackle real world research. The scientific objective was to document mixing behaviour and wake morphology of current flow passing through a model cage array to guide in the optimal placement of co-cultured species at IMTA farms. The training objective was to apply a team-based research approach to a complex problem, under conditions of time and resource limitations, with the goal of publishing the results. Well, the results are out! In the current issue of World Aquaculture Magazine (December 2015), the workshop outcomes are published in the article "Effects of circular fish cage arrays on current dynamics: implications for near-field velocity reduction, nutrient concentrations and cage clearance times". Thanks to all the participating graduate students, co-leaders Gregor Reid and Jordana Van Geest, and the NSERC's Strategic Network Enhancement Initiative for funding the workshop.

Watch the video of the workshop: <https://www.youtube.com/watch?v=snXt4qCLx6w>

Matt Jones wrote an article for the November/December 2015 issue of Aquaculture North America entitled "Bivalves potential as a sea lice solution" covering the CIMTAN research examining the ingestion of sea lice larvae by IMTA filter-feeding shellfish. The article (used with the permission of Capamara Communications) features an interview with project leader Chris Pearce (Fisheries and Oceans Canada, Nanaimo), who discusses the recent field trial conducted by CIMTAN graduate student Allie Byrne, and recounts previous discussions with Shawn Robinson (Fisheries and Oceans Canada, St. Andrews) and laboratory trials conducted by former CIMTAN graduate student Janis Webb and others, which led to this point.



CIMTAN graduate student Allie Byrne with oysters for the field trial at the Noo-la (previously known as Bennett Point) site of Grieg Seafood BC Ltd. (photo credit: Devan Johnson).

12-12-15 - Big News from Paris: To rousing cheers and tears of relief, envoys from 195 nations approved an accord to stop global warming, offering hope that humanity can avert catastrophic climate change and usher in an energy revolution.

French Foreign Affairs Minister Laurent Fabius ended nearly a fortnight of gruelling negotiations at the COP21 conference with the bang of a gavel, marking consensus among the ministers, who stood for several minutes to applaud and shout their joy.



The world came together around the historic Paris Agreement, a turning point in the climate crisis.



This “differentiated, just, sustainable, dynamic, balanced and legally binding” universal and ambitious agreement will limit temperature rise “well below” 2 °C, set national targets for reducing greenhouse gas emissions every five years, help financially poorer nations combat climate change and foster greener economies, set the goal of a carbon-neutral world sometime after 2050 but before 2100, drive innovation and efficiencies, and make the world safer for our children, grandchildren and future generations. It sends clear, loud signals to markets, business, investors, cities and regional and national governments to accelerate the shift to a robust, zero-carbon, clean energy economy.

This outcome marks a new type of international cooperation where developed and developing countries are united. It is both ambitious and powered by the voices

of the most vulnerable. The hard work is not over. In fact, it’s just beginning. It’s up to all leaders – in governments, board rooms, cities and civil society – to build on this agreement and ensure it leads to a true transformation to a strong, climate-safe economy.

“The Paris Agreement is a turning point in the world’s fight against unmanaged climate change, which threatens prosperity and well-being among both rich and poor countries” (Nicholas Stern, former chief economist for the World Bank).

Coastal regions and aquaculture will be, and are, in fact, already affected by climate change and ocean acidification. IMTA also has its role in this debate and, in fact, could bring mitigating solutions at several levels.

The IMTA multi-crop diversification approach (fish, seaweeds, invertebrates and microbes) could be an economic risk mitigation and management option to increase the resilience of the food production systems of the future and, hence, food security. In other words, do not put all your salmon eggs in the same basket! It is well-known agriculture and stock market practices; why would it be different with aquaculture practices? It is clear that, in some regions, the scope for expansion of monoculture activities is limited and that diversification of the aquaculture industry is imperative for maintaining its competitiveness.

Developing IMTA systems should not only bring increased profitability per cultivation unit, through economic diversification by co-cultivating several value-added marine crops, it could also bring environmental sustainability, ecosystem resilience and societal acceptability.



UN Climate Chief Christiana Figueres, UN Secretary General Ban Ki-Moon, French Foreign Affairs Minister Laurent Fabius and President of the French Republic François Hollande just after the adoption of the historic Paris Agreement (photo credit: François Guillot, AFP).



While photosynthesizing, seaweeds also absorb carbon dioxide and, hence, participate in carbon sequestration, even if in a transitory manner. As such, by sequestering dissolved carbon dioxide and increasing pH in seawater, seaweeds could play a significant role in reducing ocean acidification, maybe not when considering large-scale impacts, but certainly at a local scale. Tide pools are well-known for experiencing diurnal fluctuations in pH, and can reach pH values of 10 or more when dominated by seaweeds. Such bio-buffering services provided by seaweeds could be put to good use at the scale of a shellfish hatchery, for example. In-coming seawater would first go through tanks filled with photosynthesizing seaweeds to have its pH raised before being moved to tanks containing shellfish larvae at the stages when acidic pHs would be detrimental to their shell calcification. Seaweeds would not only be an alternative to chemical buffering, but would also become an additional crop for the IMTA operation, ultimately increasing revenue. Such rearing strategies could, hence, be options to either protect sensitive life stages from environmental stressors or control conditions to promote adaptive responses.

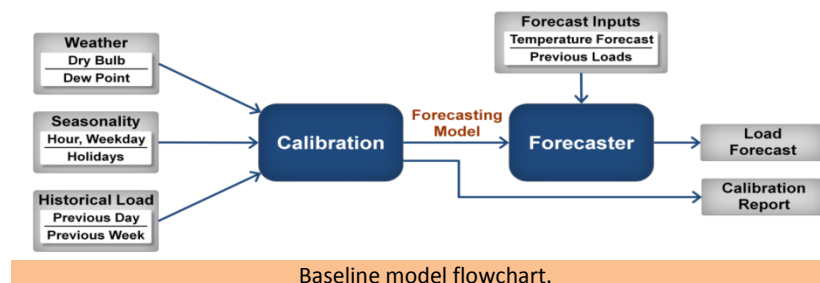
The value of the ecosystem services provided by the extractive components of IMTA systems should be recognized, accounted for, and used as regulatory tools and economic incentive instruments to encourage greater adoption and implementation of IMTA. There will be a need for regulatory changes to devise enabling and flexible regulations for the development of innovative aquaculture practices, such as IMTA, and allowing them to become sustainable food production systems, contributing to the food security of the greener economies being designed.



Nima Tehrani fishing at East Sooke, British Columbia
(photo credit: Majid Soleimani).

Nima H. Tehrani joined CIMTAN in 2014, and is working towards a Master of Applied Science (MASc) in Mechanical Engineering at the University of Victoria, British Columbia. Studying under the supervision of Curran Crawford, his research is focused on the baseline assessment of renewable energy production and load analysis for CIMTAN remote sites like the IMTA Kyuquot SEAfoods Ltd. facility, where a solar/battery renewable energy system has been designed and installed to power various pieces of equipment on-site starting with the extractive species winches. Baseline assessment is an integral part of performance analysis for remotely located sites (and renewable generation more broadly) and refers to building predictive models of generation

and loads based on historical data. The baselines can then be used for more optimal control or modifications to component sizing of the system, and also for optimizing future systems at other sites. Specific challenges related to rapidly varying electrical loads and resources require new methods of establishing baselines and quantifying their accuracy. Past research has attempted to address this using historical data analysis and ordinary regression techniques at best, which do not address uncertainty appropriately. Statistical





online machine learning techniques which update their solution iteratively is a promising approach towards baseline modeling. The mapping from the input dataset to the corresponding outputs is updated after the arrival of new dataset. A recursive Bayesian approach has been used as an online algorithm as new data become available in a sequential fashion. Specifically, we propose a self-learning and updating Bayesian Linear Regression model to predict power consumption and renewable generation using an autoregressive approach. The preliminary results show that this approach provide very promising forecast and the accuracy improves as more data are added. This model improves system optimization, which can be used to size renewable energy systems for current and future aquaculture sites.

When not working on his thesis, you will likely find Nima enjoying the beautiful Canadian West Coast, fishing and hiking whenever he gets the chance.

CIMTAN member quote of the month: “The unique aquaculture site environment has required us to come up with online learning techniques to deal with uncertainty and deliver more effective solutions for system optimization. We try to better understand how wrong our models have to be to not be useful” (*CIMTAN MASc candidate Nima H. Tehran*).

