



NSERC Canadian Integrated
Multi-Trophic Aquaculture Network

Réseau canadien d'aquaculture
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CIMTAN *Snippets*

On October 30, 2014, the Integrated Multi-Trophic Aquaculture YouTube channel (<https://www.youtube.com/user/imtacanada/videos>) reached 50,000 views with 13 videos being posted.



The top videos at the “IMTA box office” are **Seaweeds - A part of everyday life** (18,171 views; 36%) and **Filter Feeders** (16,629 views; 33%).

The videos have been watched in 177 countries (31% viewing in the USA and 22% in Canada). In terms of demographics, our audience is made of 70% males and 30% females; 28% are between 25-34 years old, 26% between 18-24 years old, and 19% between 55 and 64 years young.

The top playback locations are YouTube watch pages (80%), embedded players on other websites (10%), mobile devices (8.3%) and others (1.7%).

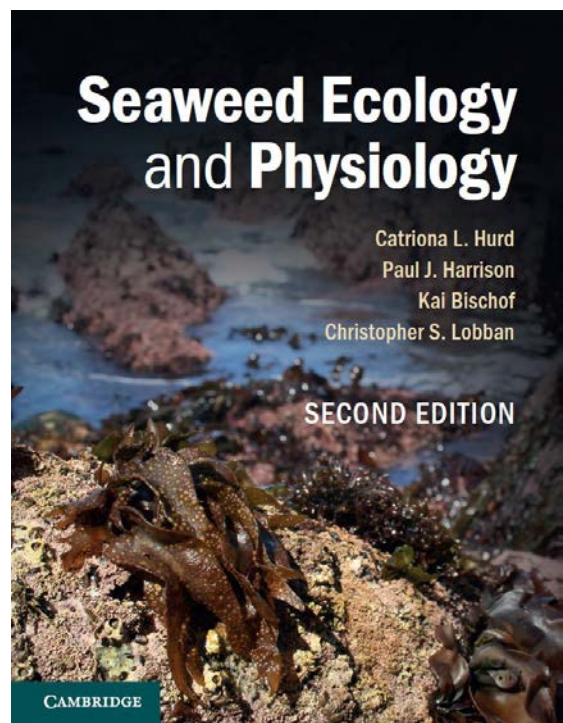
Associated with more traditional scientific tools, **YouTube** has been a **very efficient dissemination platform** for the **IMTA concept** and the principles it is based on.

The much anticipated **Second Edition** of the book **Seaweed Ecology and Physiology** is out!

As mentioned by **Thierry Chopin**, one of the three endorsers of the book on the back cover, “The first edition has always been my desk-side reading for my courses and a reference book for my undergraduate and graduate students. With the incorporation of the latest knowledge on seaweeds and the functioning of coastal ecosystems, and reference to the latest key papers, this significantly augmented second edition adds new content on topical subjects...”.

Chapter 10 is dedicated to seaweed mariculture and **section 10.9 is exclusively on IMTA** (including the well-known IMTA conceptual diagram).

The book is authored by **Catriona Hurd, Paul Harrison, Kai Bischof** and **Christopher Lobban**. Thierry Chopin replaced Chris at the University of New Brunswick in Saint John when Chris decided to go to warmer places (the island of Guam, a USA territory in the western Pacific Ocean).





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Rachel Skubel, the blog coordinator for the student-run Canadian research network called **COASTNet** (Canadian Ocean Awareness Student Network), contacted **Thierry Chopin** to know more about **IMTA** and what **CIMTAN** is doing.

COASTNet is working on shaping its website, canadianoceans.ca, into a hub for students researching ocean science and policy throughout Canada. So far, much of the content has been from the West Coast and Ontario, and Rachel would love to incorporate some of the multitude of work being produced on the East Coast. She found our work on IMTA “absolutely fascinating and with wide-ranging applications”. Consequently, she is planning to integrate this type of content into the COASTNet repertoire for wider dissemination within its membership.

CIMTAN on the NSERC Dashboard

The Natural Sciences and Engineering Research Council of Canada (NSERC) is the largest funder of science and engineering research in Canada. With funding from the Government of Canada, NSERC supports the world-class research of over 41,000 talented students and professors at universities and colleges across the country with an annual budget of \$1.1 billion.

NSERC provides support for every stage of research - from first discovery to final innovation. These include investments in Science & Technology priority areas that keep Canada on the leading edge of opportunities for future growth, and in strategic areas that are developed in consultation with industry, academia and the Government of Canada.



With the NSERC Dashboard, you will find a province-by-province breakdown of where NSERC invests its funding, and the benefits those investments are creating for Canadians. You can also generate your own reports containing the essential facts and figures you need.

CIMTAN is cited under “Innovation in Aquaculture” at <http://www.nserc-crsng.gc.ca/db-tb/index-eng.asp#index-eng.asp?province=4&category=0>



IMTA well represented at the Annual Conference of the European Aquaculture Society

This year's edition of the European Aquaculture Society (EAS) conference was one of the largest in the Society's history, with close to 1,500 participants in total, more than 1,000 signed up for the full conference (October 14-17, 2014).

The choice of the location was certainly a factor. San Sebastián (in Spanish), or Donostia (in Basque), is a coastal city in the north of the Basque Country. It is one of the most famous tourist destinations in Spain, 20 km from the French border. San Sebastián's picturesque shoreline makes it a popular beach resort, nestled in the wonderful Bahía de La Concha. The Old Town (Parte Vieja) was the place to find most participants continuing their discussions in the evening, at the numerous pintxos (Basque for tapas) bars. Donostia is renowned for its Basque cuisine. It is the second city with the most Michelin stars per capita in the world, only behind Kyoto, Japan.

The programme of the conference was also very attractive with 31 sessions (some spread over a full day and a few over a day and a half), 4 plenary presentations, 387 oral presentations and 439 poster presentations.

The first plenary was quite special, a very original culinary treat! Entitled "Adding societal value: from aquaculture to gastronomy", it was an opportunity for **Chef Mikel Gallo**, and his assistant **Diego Gelabert**, to make us drool while they prepared four dishes, live on stage with cameras zooming and the comments of two masters of ceremony: **Begoña Perez** from **AZTI Tecnalia** and **Alistair Lane**, the Executive Director of the EAS.

Chef Mikel Gallo runs the [restaurante ni neu](#), near the Kursaal (the conference center). [AZTI Tecnalia](#), based near Bilbao, is an expert technology centre in marine and food research, committed to social and economic development of the fisheries, marine and food sector, as well as to the study of the marine environment and natural resources in the context of sustainable development.

Featured on the menu were:

- Seaweed salad and mussels, provided by **Manuela "Noli" Buján**, the "seaweed lady" of Galicia with the company [Porto-Muiños](#). Noli is also the wife of **Javier Cremades**, one of the two protagonists of IMTA at the Universidad de A Coruña.
- Poached egg with caviar, the latter supplied by **Arnault Chaperon** (who is also the President of the Federation of European Aquaculture Producers).
- Turbot with a special herb sauce, with the colourful comments from **Javier Ojeda** (General Secretary of APROMAR, the Spanish Marine Fish Producers Association) and his equally colourful apron!

Among the many comments on the contribution of aquaculture to the production of sustainable seafood and value-added gastronomy, was a very interesting one by Noli, who stated that IMTA was certainly the path of the future for a successful aquaculture industry in Europe. That triggered a round of applause in the auditorium.

The IMTA session was called "Beyond Monoculture", reminiscent of the EAS conference in Trondheim, Norway, in 2003, whose theme was also "Beyond Monoculture" (the IMTA acronym was created in 2004). This year's session, co-chaired by **Thierry Chopin** (CIMTAN) and **Kenny Black** (IDREEM), was a full day long, with 16 oral presentations illustrating IMTA research in 11 countries. There were 4 other oral presentations on IMTA (from Portugal, Norway and France) in other sessions



of the conference. If we add the 8 oral presentations in the session on aquaponics, which is also a form of IMTA (freshwater IMTA or FIMTA), this makes a total of 28 oral presentations on integrated systems, or 7.2% of the conference's oral presentations, which is a sign of significant progress of the IMTA concept. There were also 13 poster presentations on IMTA and 2 on aquaponics.

The "Beyond Monoculture" session included 8 presentations by the European project IDREEM (Increasing Industrial Resource Efficiency in European Mariculture), with representatives in the UK, Ireland, Israel, the Netherlands, Portugal, Italy and Cyprus, and 8 presentations highlighted other IMTA projects from Canada, Norway, Denmark and Brazil.

The eight speakers from IDREEM provided an overview of all the activities being carried out by the consortium and the preliminary results achieved so far.

Adam Hughes (Scottish Association for Marine Science, Scotland) provided an overview of the IDREEM project's rationale, the importance of IMTA and its expectations, the current and future activities within the IDREEM consortium and its achievements so far. Growing at approximately 8% per annum for the last 30 years, the global aquaculture industry now supplies over 50% of fish and shellfish for human consumption. On the contrary, the European Union aquaculture industry grows only at approximately 1% per annum and Europe is the world's largest market for fish and fishery products, importing 16B€ of seafood annually. In this context, IMTA offers an opportunity to reduce inputs, maximise productivity and minimise waste, converting waste products into secondary raw materials.

Daryl Gunning (Daithi O' Murchu Marine Research Station, Ireland) presented the status of implementation of IMTA at the different pilot sites and showed the differences and results achieved so far at the Mediterranean and Northern sites.

Richard Corner (Longline Environment Ltd., UK) spoke on the importance of computer modelling to aquaculture and IMTA. Bioenergetics models are able to provide overall mass balance estimates; therefore, they can be used to some extent as a quantitative indicator of performance of monoculture species, to increase our understanding of their impacts within an IMTA system.

Dafna Israel (University of Haifa, Israel) presented the first results of her experimental trials with growing grey mullet as bioremediators at a seabream farm, Suf Fish Farm. A digestibility trial was conducted with particulate effluents of seabream, in order to quantify the extent to which grey mullets can utilize seabream waste. Results showed that freshly produced waste material does not possess any nutritional value for mullets; however, aged material, accumulated over time on the seafloor, thus becoming enriched in microbes and undergoing chemical alteration, can be available to grey mullets. This indicates that mullets could be used as bioremediators in an IMTA system, provided that their cages are moored directly on the sediment where particulate organic matter can accumulate and be predigested by microbes.

Angelica Mendoza Beltran (Leiden University, the Netherlands), spoke on the status of the assessment of IMTA life cycle (LCA) and the quantification of its environmental effect. The qualitative description is finalized for most small and medium enterprises (SMEs) and the quantification of input and output flows is currently ongoing. Infrastructure, total feed use, fish production, energy/fuel consumption and other chemical and material uses have been reported for the foreground processes for most of the SMEs. The next step to be taken is the collection of appropriate feed and growth data.

Shirra Freeman (University of Haifa, Israel) gave an overview of the preliminary results of her assessment of the economic value of IMTA. The major reason for interest in promoting IMTA production systems is the double dividend potential of improved profitability and environmental performance. In addition to the improved profitability for fish farmers and investors, IMTA can bring other important economic benefits associated with improving environmental performance. A





combination of financial analysis, market analysis, conjoint valuation methods and ecosystem service assessment is used to estimate the monetary value of these benefit flows.

Joao Ferreira (Universidade Nova de Lisboa, Portugal) spoke about the environmental effects of Atlantic salmon cage culture, modelling and mitigation with IMTA. In this regard, the IDREEM project has allowed the validation of production of various finfish species in monoculture, including salmon in Norway and Ireland; however, further work is needed to improve simulation.

Karen Alexander (Scottish Association for Marine Science, Scotland) spoke on the social criteria and public acceptance of IMTA, presenting the results of the international survey she conducted, the first of its kind in Europe. The survey showed that 65% of the people interviewed recognize that IMTA can improve the sustainability of aquaculture overall, despite uncertainties on the perception of the effect of IMTA on food quality and on preventing disease outbreak.

Three presentations covered some of the work carried out by the Canadian Integrated Multi-Trophic Aquaculture Network (CIMTAN) in Canada.

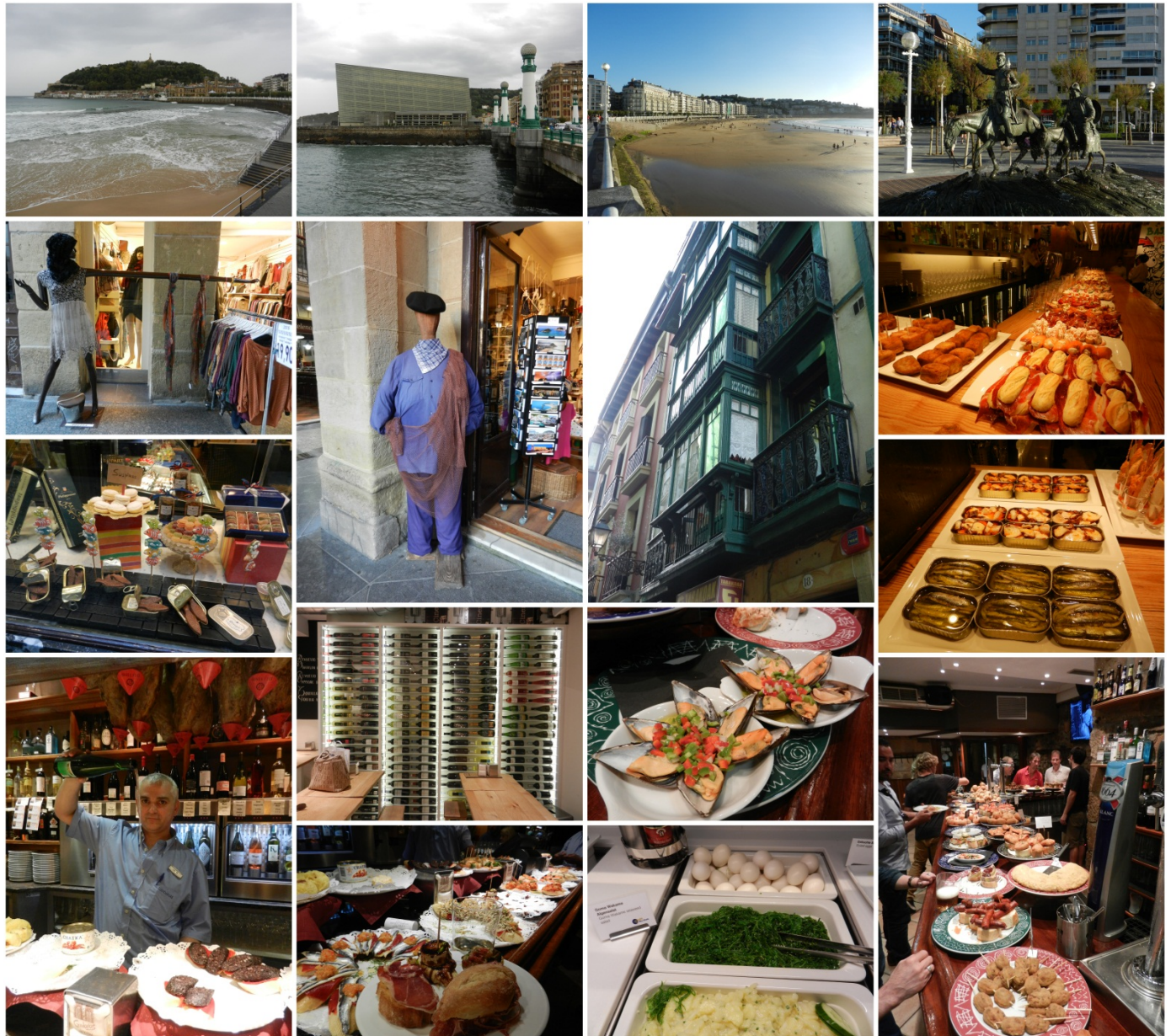
Thierry Chopin (University of New Brunswick, Canada) explained the breadth of the IMTA concept and its many variations. The ecosystem services provided by extractive aquaculture should be recognized and valued by fed aquaculture and society, and lead to the implementation of nutrient trading credits (NTCs), used as financial incentive tools. Nutrients are not necessarily wastes and recycling, encouraged on land and in agriculture, should also be at sea and in aquaculture. There is a renewed interest in the mariculture of seaweeds for their integrated cultivation, the ecosystem services they provide and novel uses. Business models will have to embrace the emerging Integrated Sequential BioRefineries (ISBR) concept. Extractive aquaculture will have to be developed in a more evenly distributed manner throughout the world. In the western world, IMTA systems are being developed by modifying fish aquaculture systems and adding, presently proportionally small, organic and inorganic extractive components to build FIS (Fish/Invertebrates/Seaweeds) IMTA systems. In Asia, large scale co-cultivation systems of seaweeds and invertebrates already exist, to which are added, presently proportionally small, fed fish components to build SIF IMTA systems. Are we comparing apples and oranges when comparing the efficiency of these FIS and SIF IMTA systems, and should we work towards more integrative solutions?

Shawn Robinson (Fisheries and Oceans Canada, Canada) underlined the need to pay more attention to a significant component of IMTA systems: deposit-feeding organisms. At finfish sites, the bulk of the organic waste is represented by larger particles that have relatively higher settling velocities, which tend to keep them in close proximity to their original source. The deposition rate of these particles and the assimilation capacity of the sea floor underneath the farming operations will determine whether there will be a significant impact to the benthos, positive or negative. Since most of the organic matter available to IMTA species occurs near field, this level has the highest return potential for inserting deposit-feeding organisms. The species currently being investigated are the green sea urchin (*Strongylocentrotus droebachiensis*), the northern sea cucumber (*Cucumaria frondosa*) and the sea scallop (*Placopecten magellanicus*). Experiments are underway to evaluate the growth rates and assimilative capacities of these extractive species at the experimental IMTA sites in the Bay of Fundy. Hatchery protocols are also being developed. Research is also conducted on the assimilative capacity of aerobic bacterial populations to convert organic carbon from the waste carbohydrates into carbon dioxide.

Duncan Knowler (Simon Fraser University, Canada) demonstrated that economic analysis is critical to understanding IMTA's potential impacts and how he, and his collaborators, are developing an integrated economic-ecological, or "bioeconomic", IMTA model. They address several management and policy-related questions pertaining to the performance of IMTA versus monoculture operations and explore these possibilities using a social welfare maximizing framework. They use the model



formulation to analyze several aspects: introducing a fixed site area for the operations, considering the current regulatory regime in Canada, and considering the cases for a nutrient tax and a nutrient credit.



Two presentations covered some of the work carried out by the EXPLOIT project in Norway. **Henrice Jansen** (Institute of Marine Research, Norway) reported on the release and dispersal of dissolved and particulate wastes from a commercial Atlantic salmon farm and what the implications are for IMTA in Norway. High resolution mapping could not detect enhanced particle concentrations close to the farm. Slightly enhanced Turbidity : Chl a ratios at a fixed mooring station close to the farm identified the presence of organic wastes, however, their magnitude was interpreted as



negligible. Results from the systematic water sampling program confirmed these patterns. Dissolved and particulate nutrient concentrations around the salmon farm were not enhanced compared to background values, except for ammonia concentrations close to the sea cages. The sediment trap study indicated that most of the particulate wastes quickly settled at the bottom. The lack of strongly enhanced dissolved inorganic nutrient concentrations challenges the need for limiting the integration seaweed-fish to only the farm scale. High benthic deposition and absence of enhanced particulate material in the pelagic zone indicates that biomitigation of particulate wastes should focus on the benthic component.

Maria Bergvik (Norwegian University of Science and Technology, Norway) reported that the Norwegian salmon production is expected to increase from 1.2 to 3 million tons, requiring the use of 3.6 million tons of feed per year by 2030. There are some concerns regarding negative environmental impacts associated with an increased nutrient load due to increased production, and IMTA is being considered for bioremediation purposes. Blue mussels (*Mytilus edulis*) and scallops (*Pecten maximus*) were deployed close to an Atlantic salmon farm to document potential assimilations of nutrients from the farm. Scallops were also fed salmon feed and salmon faeces in a laboratory experiment to verify a potential assimilation. The salmon feed and salmon faeces from the farm contained high amounts of the fatty acid 18:1n-9. The share of 18:1n-9 in the digestive gland of blue mussels was higher at the farm station compared to the reference stations at 20 m depth, but there were no differences at 5 m depth. Scallops at the farm station showed a higher fraction of 18:1n-9 in their digestive gland at 5 m depth compared to the reference stations, while no differences were found at 20 m depth. The results of this study indicated that blue mussels and scallops were able to assimilate salmon feed and/or faeces released from salmon farms.

Hugo Quental-Ferreira (Portuguese Institute for the Ocean and Atmosphere, Portugal) reported on a 3 year assessment of IMTA practices in earthen ponds, the main aquaculture production system in Portugal. Production costs of extensive and semi-intensive fish cultures are still too high to offer sustainable economic activity due to low productivity. A possible means for improving the output with higher profitability and risk reduction would be to develop IMTA in these ponds using oysters as suspension filter feeders and sea cucumbers as deposit feeders. The results, accumulated over 3 years, indicate that:

1. The sea cucumber, *Holothuria tubulosa*, is not a species to grow in earthen ponds.
2. The integration of seabream (*Sparus aurata*, *Diplodus sargus* and *Diplodus puntazzo*) and meagre (*Argyrosomus regius*) with oysters may be the optimal combination for IMTA in earthen ponds. Fish were more robust, suggesting a better degree of nourishment, in these ponds.
3. Mesh bags floating at the surface are the most suitable grow-out structure for oysters in earthen ponds.
4. *Crassostrea gigas* grows faster than *C. angulata*.
5. Oysters growth was acceptable for commercial standards, but mortality rates need to decrease to increase the overall productivity.
6. The bacterial load in fish mucus is highly reduced by the presence of oysters.
7. IMTA ponds have higher benthic diversity, which helps in the remineralization processes and, subsequently, increases water quality.

The overall picture reveals a promising future for IMTA practices in Portugal and other countries with strong focuses on earthen pond aquaculture.

Paula Canal-Vergés (Technical University of Denmark, Denmark) spoke about the Seaweed Challenge in Europe, due in part to the lack of incentives to produce seaweeds: seaweeds are relatively new



products and therefore not part of most European cultural heritages or culinary traditions. Nevertheless, seaweeds and seaweed aquaculture have many attractive attributes and European seaweed aquaculture has the potential to become an asset for the future of human nutrition. The introduction of seaweeds into the European diet will require changes in mentality and attitude and therefore a transfer of knowledge rather than straight forward public relation campaigns. In order to promote economically sustainable seaweed production, a multidisciplinary study incorporating all parts of the value chain was conducted: cost efficient production farms (*Saccharina latissima* and *Palmaria palmata*) adapted to local conditions in the Limfjorden, Denmark; documentation of the positive properties of seaweeds in a Danish context; development of new seaweed based products (*Saccharina* sushi plates, smoked *Palmaria*, seaweed bread, seaweed cheese, seaweed sausage and seaweed "schnapps"); and their introduction to both the general public and primary school children followed by evaluation surveys. The study found that, with the correct application, seaweeds may become an important product for human consumption in the near future and that seaweeds can be produced at costs compatible to similar products. In addition, the way in which new products are introduced and the information presented to the public regarding the environment, health and business could be key for the further development and introduction of seaweeds in the market.

Fernanda Seles David (São Paulo State University, Brazil) reported on the quantification of the phosphorus balance in multi-spatial and multi-trophic systems growing Nile tilapia (*Oreochromis niloticus*) and Amazon River prawn (*Macrobrachium amazonicum*), with the addition of different substrates and the use of hypereutrophic water. The most representative compartments of phosphorus inputs were allochthonous diet, followed by inlet water, fertilizer, stocked tilapia, rainwater and stocked prawns. In treatments without substrate and geotextile blanket, the input values were higher than the output. Sediment was the compartment with more accumulated phosphorus, followed by tilapia, freshwater prawn and periphyton. In bamboo treatment, the input values were higher than the output. The phosphorus contained in the feed was the component that contributed the most to the entry of this element in the system, followed by the inlet water. This can be associated with the large supply of allochthonous food and the high amount of nutrients present in the hypereutrophic water, combined with the large volume to replace seepage. The phosphorus retained in the periphyton was low; however, it regenerated the phosphorus into a form available for reared species ingestion. The periphyton can, then, replace part of the allochthonous diet.

The abstracts of all the presentations can be read at

<https://www.was.org/easOnline/SessionAbstracts.aspx?Code=AE2014&Session=4>

It is interesting to realize how IMTA has gradually gained legitimacy at international conferences, which now regularly schedule full-fledged IMTA sessions with between 15-20 speakers from as many as 10-15 countries at a time. The room for the "Beyond Monoculture" session in San Sebastián was, in fact, too small and a sound system was brought into the hallway for the people standing outside. What an indication of increased popularity of the topic!



Galicia indicates its **firm commitment to IMTA**, which will be part of the **Galician Aquaculture Act** to be published before the end of this year.

Read the articles in *La Voz de Galicia* and in *Panorama Acuicola*:
http://www.lavozdeg Galicia.es/noticia/galicia/2014/10/11/mar-deja-clara-firme-apuesta-acuicultura-multitrofica-integrada/0003_201410G11P36991.htm
http://www.panoramaacuicola.com/noticias/2014/10/13/mar_d_eja_clara_su_firme_apuesta_por_la_acuicultura_multitrofica_integrada.html

Thierry Chopin was very pleased to meet **Salvador Guerrero** and **Javier Cremades** at the European Aquaculture Society conference in San Sebastián, Spain. Salvador and Javier have been tireless advocates of IMTA and, in 2012, they published the book *Integrated Multi-Trophic Aquaculture - A sustainable, pioneering alternative for marine cultures in Galicia*.



Thierry Chopin and Salvador Guerrero at the European Aquaculture Society conference in San Sebastián, Spain (photo credit: Javier Cremades).

Ireland is targeting a €- 10 million seaweed farming industry in the next five years.

“We’re starting on the high-valued products, but a developed industry should involve this multi-trophic farming”.

Donal Maguire, Director of Aquaculture Development Services with Bord Iascaigh Mhara (BIM; in English, The Irish Sea Fisheries Board, which is the agency of the Irish State with responsibility for developing the Irish marine fishing and aquaculture industries)

Read the article:

<http://news.algaeworld.org/2014/11/ireland-targets-e10m-seaweed-farming-industry-next-five-years/>

Thierry Chopin and Mark Flaherty invited to PICES 2014, in Yeosu, Republic of Korea

The annual meeting of the North Pacific Marine Science Organization (PICES) took place in Yeosu, in the south of the Republic of Korea, October 20-24, 2014. A total of 365 persons, from 11 countries from the Pacific Rim and 9 non-Pacific countries, met at the conference center on the premises of the site of the 2012 International Exposition.

Based on the SATO YAMA concept of wise management of natural resources between communities living around the forest, the Japanese government has been working, since 2007, on the development of SATO UMI, a new concept of sustainable coastal resource management to strengthen relationships between coastal communities with existing fishery resources. Within the development of SATO UMI, human intervention in the management should increase productivity and diversity of fishery resources. The balance of the availability of natural resources as a source of food is maintained through the stability of the ecosystem. Given the obvious convergent approach





between IMTA and SATO UMI, which can also be applied to aquaculture resources, a half-day session, dedicated to " *The ecological and human social analyses and issues related to IMTA and the SATO UMI concept*", was organized and financially supported by the government of Japan, and co-chaired by **Masahito Hirota** and **Mitsutaku Makino**.

The session was a contribution to the work of the PICES project on Marine Ecosystem Health and Human Well-Being (MarWeb). There were 3 presentations on IMTA:

- *Integrated Multi-Trophic Aquaculture (IMTA): an environmentally, economically and societally responsible aquanomic approach to farming the sea with many variations* by **Thierry Chopin** (CIMTAN, University of New Brunswick, Canada);
- *Obtaining a social license for IMTA: challenges and opportunities in British Columbia, Canada* by **Mark Flaherty** (CIMTAN, University of Victoria, Canada);
- *The effect of multi-trophic aquaculture on nutrient loading in fish and shrimp ponds, Karawang, Indonesia* by **Mark Wells** (University of Maine, USA).

These were followed by 3 presentations on SATO UMI:

- *Dissemination of SATO UMI for sustainable aquaculture development in Indonesia* by **Suhendar Sachoemar** (Agency for the Assessment and Application of Technology, Indonesia);
- *Implementation of SATO UMI concept in pond aquaculture in Karawang, Indonesia* by **Susanna Nurdjaman** (Bandung Institute of Technology, Indonesia);
- *Social-ecological studies towards the integrated management of local fisheries in northeastern Hokkaido, Japan* by **Emmanuel Sweke** (Hokkaido University, Japan).

The day before the session, **Dr. Chang-Hoon Kim**, from the Pukyong National University in Busan, took Thierry Chopin on a tour to the Fisheries Science & Technology Center, of which he is the Director. Dr. Kim, and his team, has an extensive programme on the cultivation of the rockworm, *Marphysa sanguinea*. Not only does it fetch a very good price as bait for fisherman, it is also an excellent candidate as a deposit feeder for IMTA systems. Co-cultivated with flounders, it removed approximately 50% of nitrates and phosphates during 13 week experiments. By removing these nutrients, *M. sanguinea* could also be used in the mitigation of harmful algal blooms (HABs), by what Dr. Kim calls "coastal preservation by polychaete-assisted aquaculture techniques". On the way back to Yeosu, Dr. Kim took Thierry Chopin to the Suncheon City Nagan Fortress. This fortified village, with more than 600 years of history, is beautifully preserved. A few hundred residents, artists and craft people still live in the village and traditional folk, music and food heritage can be enjoyed.

The day after the session, Dr. Kim kindly organized a most interesting tour for six of the PICES participants. The tour took them to Wando Island. From the Wando Tower, it was possible to understand what large scale aquaculture of abalone and seaweeds, and *de facto* large scale IMTA, is really about. It was most impressive! Kelps were just being transferred from the hatcheries to the sites, so big dark patches at the surface of the water could not be seen, as would be observed in the spring/summer. The Wando Seaweed Association offered a wonderful lunch. In the afternoon, the group drove along the coastal road and each turn presented more astonishing vistas on aquaculture sites (really aquaculture bays...). Arriving at the Jeongnamjin Tower, the promontory again offered an impressive panoramic view of aquaculture operations as far as could be seen, *i.e.* Geumdang-do Island, the birthplace of Dr. Kim.

After a wonderful eye-opening tour, the group arrived back to Yeosu to join the PICES Wine & Cheese & Seafood Reception. In discussion with several people, Thierry Chopin learned that PICES had an Aquaculture Working Group, but it never worked very well... Quite amazing when one realizes that



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most aquaculture products eaten worldwide come from the Asian side of the Pacific Ocean. After asking more questions, it became clear that the situation could be explained as a clash of two very different approaches. Along the eastern side of the Pacific Ocean, North Americans have developed what should still be considered small scale operations, and are “obsessed” with environmental impacts (which are hard to measure because of the small scale nature of their farms) and regulations, while on the western side, Asians have developed very large scale operations, with feeding their large human populations a priority and with a very pragmatic, flexible and highly evolutive approach to development and management, which would make any western regulator pull out their hair quite rapidly! This reinforced Thierry Chopin’s opinion that western FIS IMTA systems and Asian SIF IMTA systems are difficult to compare, but knowing the two ends of the spectrum should help build, incrementally, half-way IMTA systems, which could be appropriately manageable within a regulatory framework, enabling the development of new practices within an ecosystem/multi-species/multi-activity approach.

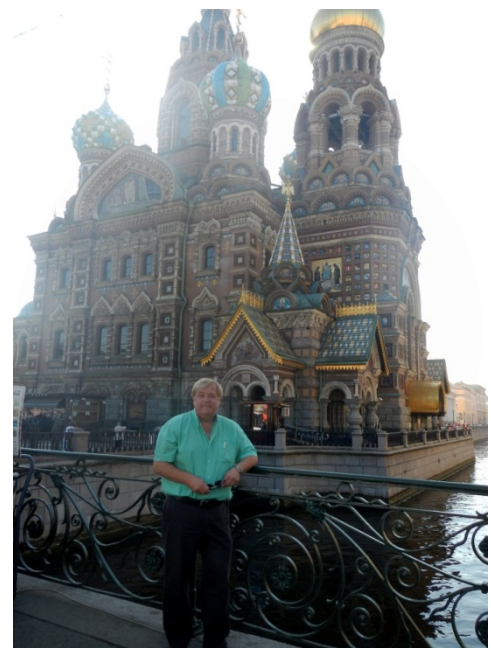
Between the Closing Session and the PICES Chairperson Reception at the Yeosu Expo Aqua Planet, Thierry Chopin and Mark Flaherty explored Yeosu: the Jinnamgwon Museum [the command post of Admiral Yi Sun-sin who, in 1592, started to repel the Japanese invasion with his turtle ships (Geobukseon)] and the busy waterfront around the city.

Bruce MacDonald recently attended the **49th European Marine Biology Symposium (EMBS)**, held in St. Petersburg, Russia, from September 8th to 12th.

The title of his presentation was *Suspension and deposit-feeding sea cucumbers as extractive species in Canadian open water Integrated Multi-Trophic Aquaculture (IMTA) settings*. His co-authors were **Shawn Robinson, Chris Pearce, Kurt Simmons, Emily Nelson, Gregor Reid, Dan Curtis, Lindsay Orr, Lindsay Hannah** and **Steve Cross**, representing CIMTAN members from across Canada.

One of the major themes for the conference was *Interactions between organisms and their environment*, which fits very well with the theme of the work of their CIMTAN project. Their objective was to compare the two candidate sea cucumber species, *Cucumaria frondosa* from the east coast and *Parastichopus californicus* from the west coast. In particular, they were highlighting the differences in the feeding characteristics and mobility that presented some unique challenges when assessing the capability for extracting organic wastes from salmon farms.

The presentation was very well received and Bruce fielded a lot of questions, particularly from the Russian scientists. He was surprised that they did not ask more about the details on the

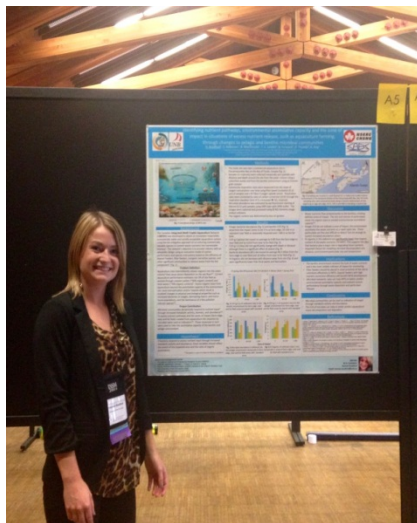


Bruce MacDonald standing in front of the Cathedral of the Resurrection of Christ (also known as the Church on Spilled Blood, built on the site where Tsar Alexander II was assassinated in 1881) in St. Petersburg, Russia (photo credit: Diane MacDonald).



sea cucumber capabilities (*e.g.* absorption efficiency, sediment deposition, etc.). Instead, they were more curious about the IMTA concept and whether it might apply to some of their farm systems and, in particular, how fish densities were regulated in Canadian salmon farms. They were also interested in how members of CIMTAN, from so many different institutions, worked together in a large country like Canada.

This was Bruce's first EMBS meeting and the attendance was significantly lower than anticipated due to various countries and individuals boycotting Russia. He had the opportunity to chair a session and meet several researchers from Europe, as well as some Canadians, enabling discussions about possible international and national collaborations in the future.



Hannah Bradford presenting her poster at the 9th International Symposium on Subsurface Microbiology (photo credit: Xiaofen Wu).

Hannah Bradford, CIMTAN MSc candidate, recently travelled to Pacific Grove, California, USA, to present her research at the 9th International Symposium on Subsurface Microbiology.

Her poster was entitled *Identifying nutrient pathways, environmental assimilative capacity and the zone of impact in situations of additional nutrient release, such as aquaculture farming, through changes to pelagic and benthic microbial communities* and was co-authored by **Shawn Robinson, Bruce MacDonald, David Thumbi and Benjamin Forward**.

The poster summarized how microbial community respiration rates are used to calculate units of carbon conversion. It explained that near-field effects of aquaculture are not visible when investigating microbial communities in the pelagic realm but are very evident in the benthic environment. This has allowed Hannah to hypothesize that additional nutrients from aquaculture practices predominately

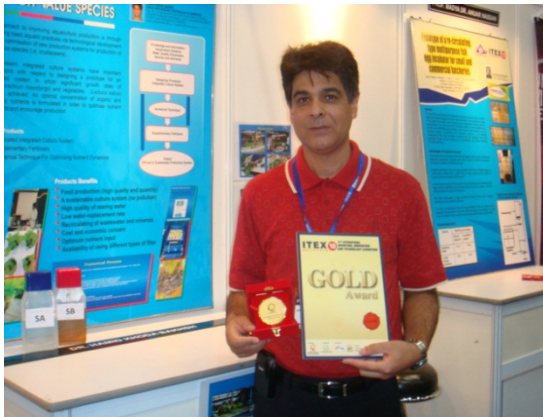
flow to the benthic environment in the form of large particulates and are recycled in the water column in the form of fine particulates and inorganics at a rate much faster than previously expected. This rate of carbon conversion in the water column, although not reflected in microbial activity, is supported by increased abundance values, which provides evidence that microbes will opportunistically feed on aquaculture waste nutrients when they are available. The poster also highlighted that microbial communities contribute greatly to the assimilative capacity of the environment, maintaining levels of organic content in the benthos well below what is expected to exit an aquaculture cage.



A group of participants in the symposium, including Hannah Bradford (second from the right in the front row), embarked on a kayaking day excursion and a unique tour of the giant kelp (*Macrocystis pyrifera*) forest along the Monterey Bay coastline (photo credit: Katie Vogel).



From the discussions generated by Hannah's poster, it is interesting to note that the audience at the symposium showed much interest toward the development of IMTA and appreciated some insights into an aquaculture practice that still remains to be explained to the larger public. Many scientists attending the symposium recognized the value in CIMTAN's holistic approach to aquaculture management and appreciated the inclusion of metabolic processes by microbial communities into our design, as microbes are often underappreciated for their impacts within ecosystems.



Hamid Khoda Bakhsh and the *Novel Design in Recirculating Integrated Aquaculture System and Nutrient Production Kits* Award he received at the 21st International Invention, Innovation and Technology Exhibition (ITEX '10) at the Kuala Lumpur Convention Centre, Malaysia, in May 2010 (photo credit: Universiti Malaysia Terengganu photographer).

Hamid Khoda Bakhsh obtained his PhD degree in aquaculture (nutrient optimization and computerized decision support programme) from the Universiti Putra Malaysia (UPM), Malaysia, in 2005. He developed a wide range of programme and numerical modelling procedures, collaborating with and supervising services for academic scientists and students to create efficient approaches in nutrient optimization techniques and wastewater management.

Hamid continued his academic and research activities for the following six years at the Universiti Malaysia Terengganu (UMT), Malaysia, as a senior lecturer. He taught several courses related to aquaculture production and engineering in the undergraduate and master programmes (aquaculture systems and design, wastewater treatment, bioremediation processes, aquaponics, water quality assessment tools and programmes). He received several scientific awards at national and international conferences and exhibitions for this work.

Hamid joined CIMTAN as a research scientist in August 2011 to be part of the newly approved project, led by **Thierry Chopin**, to develop Freshwater Integrated Multi-Trophic Aquaculture (FIMTA) for salmon hatcheries. Using his background, Hamid was able to assemble the necessary equipment and tools to conduct the procedures for water analyses at 8 salmon hatcheries of Cooke Aquaculture Inc. in New Brunswick (four flow-through and four recirculating).

During the first year of the project, Hamid established efficient laboratory and field survey methods to accurately analyze effluent samples at different sections of hatchery operations. Measurements of

Computerized visual assessment:
Freshwater hatchery and wastewater treatment system

Salmon Hatcheries

- Hatchery D
- Hatchery B
- Hatchery A
- Hatchery O
- Hatchery E

TP Results TS_TDS Results Solution Conclusions

Data analyses and Prediction chapters

Estimate: concentration of nutrients and necessary flow rate

Potential treatment efficiency (%) and nutrient discharge

Quit Clear

Front page of the computerized visual assessment tool developed by Hamid Khoda Bakhsh to evaluate and predict the effluent treatment processes and the efficiency of freshwater salmon hatcheries at recovering nutrients (photo credit: Hamid Khoda Bakhsh).



Hamid Khoda Bakhsh and the Hydrolab DS5X Multiprobe to measure water quality (pH, temperature, dissolved oxygen, specific conductivity, etc.) at one of Cooke Aquaculture Inc. hatcheries in New Brunswick, Canada (photo credit: Miko Leavitt).

selected nutrient concentrations and water quality parameters were conducted (dissolved oxygen, pH, temperature, phosphorus, nitrogen, specific conductivity, total solids, total suspended solids and total dissolved solids). The other important operational aspects, such as total biomass, feed ratio, feed conversion ratio, water flow, dynamic and effluent discharge rate (quality and quantity) were also monitored. The risk of nutrient discharge (especially phosphorus) was calculated during the study.

Having accumulated a large and reliable data set, Hamid developed a computerized visual assessment tool to evaluate and predict the performance of freshwater salmon hatcheries regarding effluent

treatment process and the efficiency of treatment systems (physical, chemical and biological processes).

Hamid has now identified one recirculating hatchery as a good candidate for FIMTA development and is further characterizing its water quality, a different step to understanding where nutrients are generated and where they can be recaptured, especially through plant cultivation.

He is also helping MSc candidate, **Stacy Murray**, who is selecting the best plants for growth and nutrient recovery under salmon hatchery conditions with the pilot-scale FIMTA system at UNB in Saint John. The next step will be to formulate and design a large-scale, pre-commercialization, FIMTA system transferable to our industrial partner, Cooke Aquaculture Inc., for commercial adoption and implementation.

When not sampling, analyzing or working at his computer, Hamid and his wife, Sanaz, are proud to help their son, Arash, become a fluently trilingual (Persian, French and English) seven year old smiling boy.



Arash Khoda Bakhsh and his lobster smile at the Hunstman Marine Science Centre Fundy Discovery Aquarium in St. Andrews, New Brunswick (photo credit: Sanaz Movassagh).

CIMTAN member quote of the month: "Water, fish and forest are for me the most enjoyable elements and my dreams came true when I moved to the east coast of Canada to work with CIMTAN on increasing aquaculture production in a sustainable manner to preserve the environment" (*Hamid Khoda Bakhsh, CIMTAN research scientist*).