



CIMTAN successful in getting additional funding under the NSERC Strategic Network Enhancement Initiative program.

CIMTAN received \$99,954 from NSERC to support the following 4 initiatives:

- 1) A workshop, for up to 10 of our Highly Qualified Personnel (HQP), on flume tank operation and training through the investigation of hydrodynamic properties of model fish cage arrays. This workshop will be led by Dr. Gregor Reid, our CIMTAN modeller, and will take place at the world renowned Flume Tank facility of Memorial University of Newfoundland.



Flume Tank facility of Memorial University of Newfoundland.

- 2) Increased knowledge and technology transfer to industry through the validation and commercialization of a bacteria-based assay to monitor the benthic environment at aquaculture sites. One of our postdoctoral fellows, Dr. David Thumbi, will lead this project in collaboration with Dr. Ben Forward (Research and Productivity Council in Fredericton), Dr. Shawn Robinson (Fisheries and Oceans Canada – St. Andrews Biological Station) and Dr. Thierry Chopin (University of New Brunswick in Saint John).
- 3) Dr. Gregor Reid will be able to travel to Norway to increase our international linkages and develop collaborative initiatives with IMTA colleagues at the Institute of Marine Research in Bergen and Bioforsk in Bodø.
- 4) An IMTA workshop in Chile, for 5 CIMTAN investigators and 5 CIMTAN HQP joining the members of the i-mar Centre of the Universidad de Los Lagos (ULL) in Puerto Montt, and with the attendance of Chilean aquaculture industry representatives, regulators, policy makers, and the general public. This initiative will be coordinated by Dr. Thierry Chopin and Dr. Alejandro Buschmann (ULL).

These 4 initiatives will provide HQP training supplements, increased knowledge/technology transfer with expended Network partners, and improved international linkages, all aspects key to the goals of CIMTAN and its members (investigators and HQP).



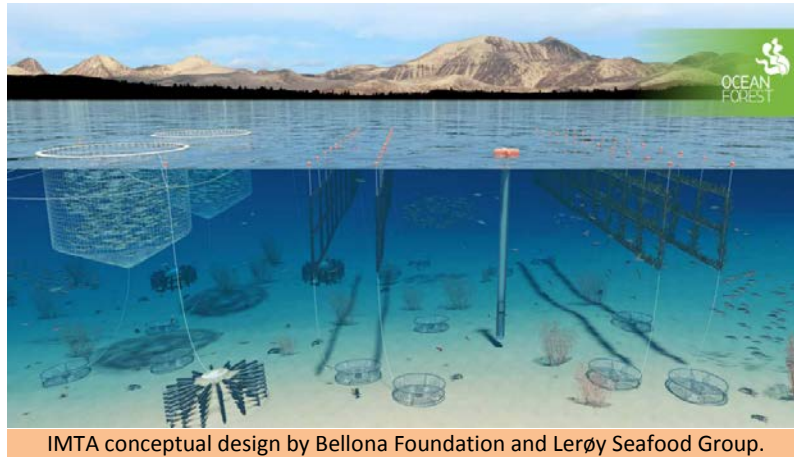
Salmon and mussel aquaculture in Chile (photo credit: Alejandro Buschmann).



IMTA more and more recognized and recruiting disciples!

In **Norway**, one of the largest producers and exporters of Atlantic salmon, **Lerøy Seafood Group**, and the environmental NGO, **Bellona Foundation**, combined forces to launch a new aquaculture company, **Ocean Forest**, at the Aqua Nor conference and exhibition in August 2013.

<http://www.leroyseafood.com/en/Business/About-us/News/20131/August/Leroy-and-Bellona-launch-aquaculture-company/>



IMTA conceptual design by Bellona Foundation and Lerøy Seafood Group.

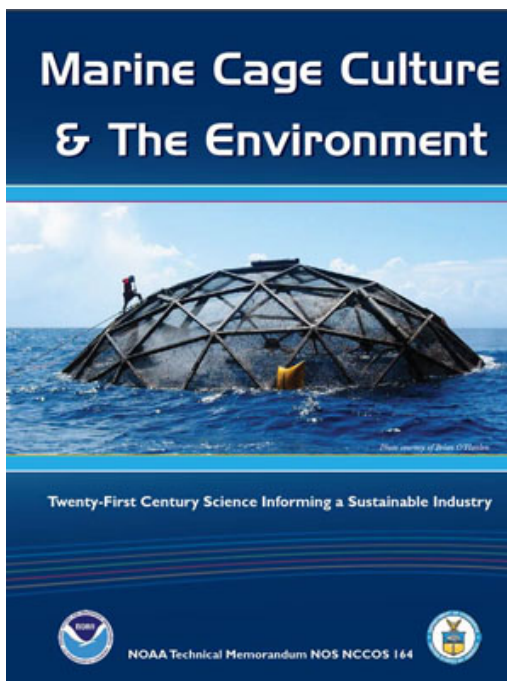
Read the report of Annelise Leonczek, Senior Advisor to the Bellona Foundation, entitled “Traditional and Integrated Aquaculture”:

http://bellona.org/assets/sites/6/Traditional-and-Integrated-Aquaculture_web.pdf

It describes today’s environmental challenges and the solutions of tomorrow, among which IMTA is abundantly emphasized.

At Lerøy’s largest salmon farm site in Rognøy, outside Bergen, sugar kelp (*Saccharina latissima*) and

blue mussel (*Mytilus edulis*) started to be cultivated at the end of 2013; a large artificial reef (7 tonnes) was added in January 2014 for other species.



In the **USA**, a team of researchers at the **National Oceanic and Atmospheric Administration (NOAA)** National Ocean Service, led by **Carol Seals Price** and **James A. Morris, Jr.**, have released a new technical memorandum entitled “Marine Cage Culture & The Environment”.

[http://www.noaanews.noaa.gov/stories2013/pdfs/2013-PriceandMorris_MarineCageCultureand-TheEnvironment\(5\).pdf](http://www.noaanews.noaa.gov/stories2013/pdfs/2013-PriceandMorris_MarineCageCultureand-TheEnvironment(5).pdf)

The report evaluated the environmental effects of finfish aquaculture, including interactions with water quality, benthic habitats, and marine life across various farming practices and habitat types. It concluded that ocean aquaculture can be environmentally sustainable, with little to no effect on coastal ocean environment seen with proper safeguards and planning.

Specific types of fish farming can be accomplished with minimal or no harm to the coastal ocean environment. “We did this study because of concerns that putting marine finfish farms in the coastal ocean could have adverse effects on the environment,” said James Morris. “We found that, in cases where farms are appropriately sited and responsibly

managed, impacts to the environment are minimal to non-existent.”



In the report, scientists said that continued development of regional best-management practices and standardized protocols for environmental monitoring are key needs for aquaculture managers. Two management tools are recommended: fallowing and IMTA. IMTA is described as “a tool that can both broaden the economic base of the mariculture industry while at the same time adding species to the farm facilities that can decrease nutrient loading, improve water quality and decrease sedimentation.” “This report contributes to the growing body of evidence supporting marine aquaculture as a sustainable source of safe, healthy and local seafood that supports jobs in coastal communities,” said Sam Rauch, acting assistant NOAA administrator.

Also in the **USA**, the NGO **Future of Fish** recently published its report “**Breakthrough Aquaculture**” which is uncovering solutions that drive ecologically sound and commercially viable models for farm-raised seafood.

http://www.futureoffish.org/assets-/pdfs/Aquaculture_Report_FoF_2014.pdf

To answer the question “How might we foster a business landscape where ecologically sound and innovative aquaculture can actually scale up and thrive?”, Future of Fish used a “**discovery framework**” to analyze the “stuck points” in the systems supporting “breakthrough aquaculture” to better understand how to shift this particular sector of the industry into a high growth phase. “**Breakthrough**” was defined as a significant innovation that reduces the environmental impact of farming or makes progress in furthering the economic viability of these eco-friendlier farming techniques. Fifty experts and entrepreneurs, working to build ecologically sound aquaculture models, were interviewed.

After the discovery phase, patterns pointing to overarching problems (“**barriers**”) were identified as well as underlying strategies (“**design principles**”) to solve them.

The five barriers identified were:

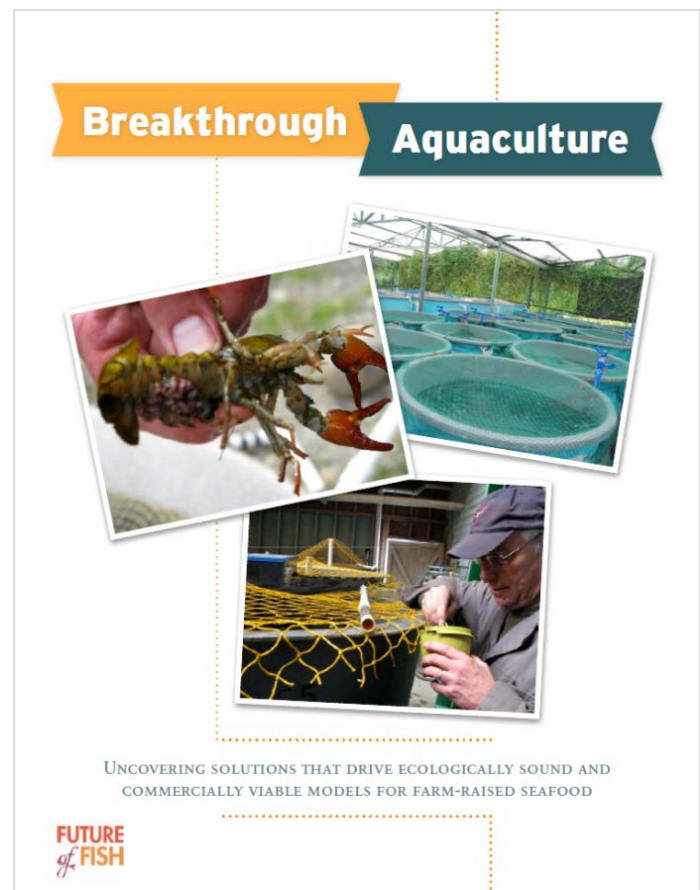
- 1) Hostile public and regulatory environment.
- 2) Chokehold on raw materials.
- 3) Lack of market differentiation.
- 4) Underdeveloped risk-mitigation strategies.
- 5) Immature operational models.

The five design principles identified were:

- 1) Focus on more than fish.
- 2) Draft off-aligned stakeholders.
- 3) Pioneer custom solutions.
- 4) Share responsibilities.
- 5) Mimic the ecosystem.

A set of five opportunity areas were identified for further exploration, as they could shift the aquaculture industry landscape towards less environmental impact, greater efficiency, lower risk, reduced costs and increased scalability:

- 1) Enabling businesses to share knowledge and information in order to lower the difficulty of farming and allowing time and attention for more creative and growth-oriented strategies.





- 2) Engaging the insurance and financial sectors to develop better strategies for risk mitigation and improved dialogue for how fish farming can lower its risk profile.
- 3) Beating the bad reputation of farmed fish.
- 4) Building distribution networks that help producers access bigger markets.
- 5) Developing secure pipelines for raw materials and operational know-how.

Interestingly, IMTA is present throughout this report and seems to come back as a Leitmotiv (in musicology, a short, constantly recurring musical phrase or guiding motif), both to exemplify challenges and solutions, a testimony to the validity of this concept still in full evolution.

In France, **Karine Le Loët**, Editor in Chief of the magazine **Terraeco**, published an article entitled “Pour laver sa réputation, le poisson d'élevage va devoir partager ses bassins”, based on interviews with **Thierry Chopin** (CIMTAN) and **Myriam Callier** (researcher at IFREMER in France).

<http://www.terraeco.net/Coquillages-algues-et-poisson-1,53328.html>

Terraeco is an independent magazine, humanistic and engaged, which explores transition leads towards a sustainable world.

In Canada, IMTA and kelps made it into the recent **New Brunswick Marine Bioscience brochure** developed by BIONB.

<http://www2.unb.ca/chopinlab/articles/files/NB%20Marine%20Bioscience%20brochure%20ENG.pdf>

<http://www2.unb.ca/chopinlab/articles/files/NB%20Marine%20Bioscience%20brochure%20FR.pdf>

CIMTAN investigator **Jon Grant** has been appointed the **NSERC/Cooke Industrial Research Chair in Sustainable Aquaculture**, based in the Department of Oceanography at **Dalhousie University**. The Natural Sciences and Engineering Research Council of Canada (NSERC) Industrial Research Chair (IRC) program pairs university researchers with industry to provide technical and economic solutions to issues in production and operations. CIMTAN partner **Cooke Aquaculture Inc.** has long been committed to sustainable fish farming and will collaborate with Jon to focus on farming sites in Nova Scotia. A host of students and postdoctoral fellows will be trained through the program and an additional professor hired at Dalhousie University to collaborate with Jon. The result of a year-long planning process between Jon and Cooke Aquaculture Inc., an explicit research agenda has been vetted by NSERC and international experts. The



Left to right: Jeff Nickerson (Nova Scotia Saltwater Production Manager, Cooke Aquaculture Inc.), Michael Szemerda (VP Saltwater Operations, Cooke Aquaculture Inc.), Dr. Chris Moore (Dean of Science, Dalhousie University), Dr. Martha Crago (VP Research, Dalhousie University), Dr. Jon Grant (NSERC/Cooke IRC in Sustainable Aquaculture, Dalhousie University), Dr. Richard Isnor (Manager of the Atlantic Regional Office, NSERC), Nell Halse (VP Communications, Cooke Aquaculture Inc.), Andrew Lively (Director Marketing; Cooke Aquaculture Inc.) and Ross Butler (Senior VP, Cooke Aquaculture Inc.).



IRC will focus on:

- Simulation modelling for maintaining coastal ecosystem services.
- Integrity of cages and moorings for biosecurity.
- Waste management plans for environmental integrity.
- Assessment of sediment habitat health.
- Prevention of disease and management of fish health.
- Marine spatial planning of aquaculture and wild fisheries.

CIMTAN MSc student Stacy Murray wins the Aquaculture Association of Canada 30th Anniversary Graduate Student Essay Contest.

In celebration of the 30th Anniversary (2014) of the AAC, an Undergraduate and a Graduate Student Essay Contests were announced in 2013. Graduate students had to submit a 1000 word essay on the following subject: define sustainable aquaculture in a Canadian context and describe what is required to achieve this goal.



Stacy Murray, who is working on developing freshwater IMTA (FIMTA) under the supervision of **Thierry Chopin** (CIMTAN Scientific Director), wrote the winning essay below and will put the very generous prize of \$500 given by the AAC to good use. **Bravo, Stacy!**

Aquaculture is essential and Canada has the potential to be a world leader in production and sustainability. As the world population increases and wild fisheries continue to collapse the need for sustainable aquaculture is ever present. The Canadian aquaculture industry has seen a huge increase in production from its humble beginnings in the 1970's. This development

exceeded the required research which caused some negative perceptions of aquaculture and hindered its acceptability and its ability to be sustainable. One definition of sustainability is the capacity to endure or to be used without being devastated. In Canada, this is not only explicit to our beautiful natural resources but also to our jobs and well-being. To increase the development of aquaculture in a sustainable way there are aspects that require consideration: environmental, societal and economical. By addressing these three concerns Canada can be a leader in world aquaculture.

Canada has seen some controversy in the development of aquaculture and has been scrutinized by certain media and some of its residents. Some of these controversies include water usage issues, escapees, environmental degradation, fin fish feed resources and disease transmission. Publications and ad campaigns from anti-salmon farming groups have given the industry a bad reputation. These criticisms are more prevalent on the west coast and have caused destruction to farms ultimately making it unsafe for some farmers. This leads to the need to educate Canadian residents on the importance of aquaculture and just how critical it is for future generations. In comparison to other form of farmed animals, fish farming/domestication is still in its infancy. However it is one of the best protein sources in terms of resource efficiency. Canada has produced significant contributions in



aquaculture research. However, had the industry relied on research and then development, rather than development then research there may have been less criticism.

Environmental sustainability in aquaculture requires the most attention because the environment is essential for our existence. The maintenance of natural resources should be a priority of all Canadians. Some of the environmental problems caused by aquaculture include: water degradation, eutrophication, feed produced from wild fish, chemical/pharmaceutical usage and effects on wild fish populations. Fortunately, many of these concerns are being addressed. Feed formulations have changed dramatically over the years from less fish based feeds to more plant based feeds. There is also the practice of integrated multi-trophic aquaculture (including aquaponics and polyculture), where wastes produced from one organism is the nutrition for another. Also with increased recirculation technology the ability to move farms out of ocean net pens and on to contained land systems is possible. Having contained, recirculating, on-land farms using multi-trophic technology would be the best way to mitigate existing environmental issues. However the costs and capital investment are a huge constraint for new and existing farmers.

Societal sustainability in aquaculture can be obtained with improving the public perception of aquaculture. Most farms are located in rural coastal communities and can greatly improve the quality of life for these individuals by providing local food resources, jobs and community infrastructure. This is particularly important where wild fisheries are no longer able to sustain these communities.

Acceptance of aquaculture products will increase the quantity of products being sold allowing farmers to increase profits. This will also be an incentive for the development of new farms. The acceptance of aquaculture products requires science based education. The development of on-land grow-out farms will also increase the acceptance of aquaculture by decreasing multi-use conflicts of ocean sites. Many of the ideal ocean sites for fish farms are also used for fisheries, recreational use or can be eye-sores for residents. Aquaculture needs to not only be attractive to farmers, but also to Canadian residents, consumers and stakeholders.

Economic sustainability of aquaculture will inevitably develop as the other aspects are addressed. With an environmentally sustainable product, consumer demand will increase allowing for a cascade of positive outcomes. There is no reason for Canada to import fish for consumers. Canada has an abundant amount of resources and scientific knowledge to culture almost any fish species. With the required capital investment new farms can be developed to meet many of the diverse consumer aquatic species demanded. With an increase investment in Canadian aquaculture we could enhance our appeal to worldwide markets. This will increase jobs and profits for Canadians.

Sustainable aquaculture will not be achieved by fixing or improving just one aspect, but by combining as many aspects as manageable. There are improvements that can be made to environmental, societal and economical aspects. Some require initial capital investment allowing potential and current farmers to start up or improve operations in a sustainable way. These improvements include on land farms, multi-trophic farms and improvements in fish feed sources. This initial investment will not only help farmers but will improve resource usage, better the quality of life in rural communities, increase consumer acceptance and increase the market demand. There is a need for science based education and continued research. With our abundant resources, Canada should be a world leader in sustainable aquaculture.



CIMTAN held its **Fourth Technical Workshop** in Saint John, New Brunswick, on February 17-18, 2014, with 11 participants in attendance (investigators and HQP from CIMTAN, and 2 consultants from SIMCorp). The workshop focused on “**AquaModel – a modelling software for aquaculture operations**” and was delivered by its developers, Drs. **Jack Rensel** and **Dale Kiefer** (www.AquaModel.org). AquaModel is a computational tool for planning and evaluating aquaculture sites, acquiring permits and assessing investment risks and opportunities. It runs on a standard PC and provides a dynamic 4-dimensional display (3D plus time) of aquaculture and environmental processes and resides within the **EASy** geographic information system. Diverse types of environmental data can be imported, such as satellite imagery, current meter data, modelled 3D current data, bathymetry and coastlines, allowing site or regional-specific information to be incorporated. Graphical outputs map the distribution, over time, of key parameters including oxygen, particulate organic and dissolved nutrient wastes and dozens of other environmental and fish cultural/management parameters. AquaModel is currently being used in several locations in North America, Hawaii, Chile and the Arabian Sea.



AquaModel is also a simulation program that provides for assessment of both farm operations and their environmental effects on coastal or offshore waters. The model describes the nutrient transformation by fish farms of both dissolved and particulate nutrients in the water column and sea bottom. A system of equations describe fish growth and physiology that integrates with flow field data to transport waste from farms, assimilate dissolved nutrients by plankton, and simulate the sinking, deposition, resuspension and mineralization of fish feces and uneaten feed. A mathematical description of fish growth and metabolism consists of a nutrient budget for carbon, oxygen, and nitrogen as determined by the size of the fish, water temperature, oxygen concentration, swimming speed, feed rate and composition.

AquaModel has been used to simulate single (near field) and multiple (far field) fish farms for Atlantic salmon (*Salmo salar*), rainbow trout (*Oncorhynchus mykiss*), cobia (*Rachycentron canadum*), striped bass (*Morone saxatilis*) and moi (*Polydactylis sexfilis*). Models are under development for kampache (*Seriola rivoliana*), sea bream (*Sparus aurata*) and sablefish (*Anoplopoma fimbria*).

The purpose of this technical workshop was to get familiar with AquaModel and discuss its applicability to IMTA systems and combinations of co-cultivated species.



Following the AquaModel workshop, **CIMTAN** held its **Fifth Technical Workshop** in Saint John, New Brunswick, on February 19-20, 2014, with 27 participants from academia, government and industry in attendance. The theme of the workshop was “**IMTA Efficiencies**”.

The objective was to discuss the efficiency of the different components of the IMTA system with respect to recycling and mitigation, and, to a lesser extent, their economic and societal efficiencies. This included the extractive efficiency of seaweeds, invertebrates and finfish to capture and convert inorganic and organic material into bio-deposits or marketable biomass, the relative efficiencies of the different taxonomic groups, the advantages of various feeding types such as suspension and deposit feeders, possible disease mitigation by filter feeders, the role of the microbial community, etc. Interactions between targeted species placed on site and non-target mobile or settling communities were also addressed. Estimates of these different efficiencies will be used in the modelling of open water IMTA systems as we move towards the end of CIMTAN.

Presentations from two guest speakers, as well as from various CIMTAN investigators and students (12 presentations from 11 presenters in all), and two discussion periods allowed for a better understanding of IMTA efficiencies. The guest speakers were Dr. **Paul Wills** (Florida Atlantic University/Harbor Branch Oceanographic Institute, Vero Beach, Florida), who gave a presentation entitled “Forays into land-based Integrated Multi-Trophic Aquaculture: evolution from open ocean ancestors”, and Dr. **Jack Rensel** (Rensel Associates Aquatic Sciences, Arlington, Washington State), who gave a presentation entitled “Ocean acidification refugia: fish, shellfish and seaweed Integrated Multi-Trophic Aquaculture on the US west coast”.

The end of each day of the workshop was dedicated to a discussion period. On day 1, the discussion centered on “What can we conclude about organism efficiency? Are there any guidelines we could use for general concepts and what appear to be the unique aspects that are species specific?”. On day 2, the discussion centered on “What can we conclude about demands for modelling IMTA efficiency and what implications do they have for the aquaculture industry and management? Where do we go from here?”.

We hope to synthesize the information gathered in these workshop presentations and discussions into a perspective paper published in a review journal.

The end of the workshop coincided with the end of the third period of the gold medal game in women's hockey at the Sochi Olympic Games: a classic Canada/USA final. Tension was high... at 56 minutes and 34 seconds, it was 2:0 for the USA; at 59 minutes and 5 seconds, it was 2:2 and we had to go to overtime; at 8 minutes and 10 seconds, it was over with a final score of 3:2 for Canada! Three days later, the men's team got the gold medal for Canada, beating Sweden 3:0 ... who says that hockey is not Canada's game?!







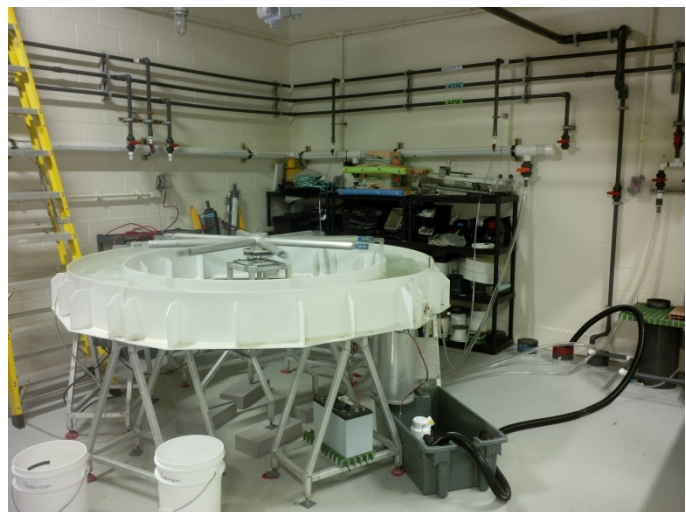
Kurt Simmons loading a sample for analysis using a Beckman Coulter Multisizer. This technique provides size distribution and quantification of particulates in a water sample, allowing for changes in particulate concentrations to be tracked as sea cucumbers feed (photo credit: Jeff Clements).

Kurt Simmons obtained his Bachelor degree in Biology from Cape Breton University in 2012. After working toward the development of a sustainable whelk fishery in Cape Breton, he became interested in the future of seafood production. Following his graduation, he moved to Saint John, New Brunswick, to pursue a MSc degree in the Department of Biology at the University of New Brunswick. Under the supervision of Drs. Bruce MacDonald and Shawn Robinson, his project focuses on the potential integration of the orange-footed sea cucumber, *Cucumaria frondosa*, into East Coast IMTA systems. This organism may be an effective IMTA species due to its potential as an organic extractive species coupled with its lucrative market value. As a benthic suspension feeder, this species of sea cucumber has the potential to help clear the water of large

particulates beneath salmon cages. However, sea cucumbers are not well studied and the quantity of particulates they are able to clear is unknown. It is, therefore, not known whether sea cucumbers will be beneficial to IMTA systems when kept in commercial densities. Sea cucumbers have a unique feeding behaviour, making conventional ways of measuring particle ingestion inappropriate. Kurt's aim is to find a better way to measure the ingestion rates of these unusual creatures. Last summer, field work was conducted wherein sea cucumbers were contained in tubes which allowed for the collection of natural settled material and biodeposits. When compared to the concentration of particulates in the water column, this allows for an indirect measure of ingestion by sea cucumbers. Currently, Kurt is conducting laboratory experiments in which sea cucumbers are allowed to feed in a flume tank in which particulate concentrations are monitored intermittently.

First CIMTAN member quote of the month:

"What I enjoy most about CIMTAN is the scope and interconnections of its topics – how collecting waste may lead to a novel method to sustainably culture and harvest a species and lead to a new market. It's really "number 1" in the "number 2" business." (Kurt Simmons, CIMTAN MSc candidate).



A laboratory experiment in which sea cucumbers are allowed to feed in an annular flume, with changes in particulate size distributions monitored over time (photo credit: Kurt Simmons).



Erin Latham holding a geoduck while on a field trip at the Deep Bay Marine Research Station on Vancouver Island (photo credit: Courtney Edwards).

Erin Latham joined CIMTAN in January 2013, and is a PhD candidate in the Geography Department at the University of Victoria, British Columbia (BC). Erin is originally from Vancouver and, while growing up in BC, developed a keen interest in biology. She studied wildlife ecology and her work experience took her from the Rocky Mountains of Canada and the United States to the biodiversity hotspot of the Russian Far East. After completing a Master degree in geographic information systems (GIS) at the University of Calgary, she returned to the University of Victoria to continue her graduate studies with Dr. Stephen Cross. In fact, she met Dr. Cross several years before while taking an undergraduate course with Dr. Mark Flaherty, and expressed a strong interest in the emerging technology of IMTA in BC. Over the years, Erin realized she was more interested in aquaculture

management and community engagement in its governance. While her research is in its early stages, she aims to work with First Nations and explore their interests, goals, and barriers as they engage with aquaculture governance and its various courses of development, including IMTA. In the last two years, Erin has been building her own capacity towards understanding First Nations contemporary issues in resource development. She recently moved to northern Vancouver Island, one of the major epicentres of the aquaculture industry in BC, and she has started to engage with communities at the local level, as she seeks a long-term working partnership to achieve the in-depth understanding of the industry through the perspective of First Nations. Overall, Erin is enjoying the change of pace from the Victoria "metropolitan". When she's not working, she may be found on the forest trails with her new dog Bodhi (aka Sneaky Pete), a ball- and food-obsessed labradoodle, or she may be at the beach swimming in her wetsuit and keeping a watchful eye for transient killer whales.

Second CIMTAN member quote of the month:

"CIMTAN grounds my research with First Nations in a way that asks not what aquaculture is or has been, but what aquaculture can become." (Erin Latham, CIMTAN PhD candidate).



Marine fisheries and resources remain highly important to First Nations communities as they pursue aquaculture development on the coast of British Columbia (BC). Left: Keith Gladstone and his recent halibut catch, Bella Bella, BC. Top right: clam digging with the Kyuquot First Nation, Kyuquot, BC. Bottom right: the collection of seaweeds, locally known as 'black gold' (nori or *Porphyra*, which is now called *Pyropia*), is dried in the summer sun and stored to be eaten as a salty snack or as soup seasoning, Bella Bella, BC (photo credits: Erin Latham).



Farewell Meryl! Meryl Coes came back from maternity leave at the beginning of January, but left us at the end of February... The Town of Quispamsis, just east of Saint John, offered her a permanent position, closer to home and she could not pass up the opportunity for her and her new family. We will miss Meryl at CIMTAN Central and her efficiency at organizing annual general meetings and technical workshops, always with a smile... Adrian will now have to be the one checking that we continue to have our smoothies during our nutritious breaks!

Good luck Meryl and we hope the new opportunity provides both challenge and growth potential for you. All the best, and a big THANK YOU for all you have done for the Network.



Constanza Chianale, Adrian Hamer, Meryl Coes and Stacy Murray at the Farewell Party for Meryl Coes (photo credit: Thierry Chopin).

200 Words a Day! Learn Spanish Course 2 (for Intermediate Learners)

las algas = seaweed

