

New Frontiers: Bridging Technology and Economic Growth

Nouvelles frontières : lier technologie et croissance économique

Program Guide / Guide de programme

Aquaculture Canada^{OM} 2012 Conference



**Charlottetown, Prince Edward Island, 27-30 May 2012
Charlottetown, Île-du-Prince-Édouard, 27-30 mai 2012**

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**Come help build New Frontiers for Students entering the
Aquaculture Industry**

Aquaculture Canada 2012 – Joe Brown BBQ & Silent Auction

(The primary fundraiser for the AAC Student Endowment Fund)

Food at ~ 6:30 pm

- **BBQ'ed Hotdogs and Hamburgers**
- **Salads and Desserts**

Drinks:

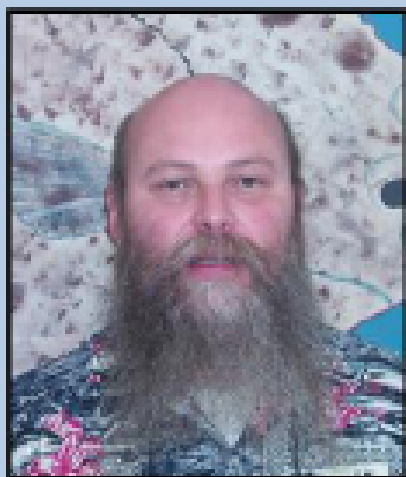
- **UPEI – Cash Bar**

Live Band:

**Robinson, Hendry and the
Vandellas**

50 / 50 draws

AVC tours (time TBD)



May 28th, 2012

6:00 – 10:00 pm

Entertainment:

Aquaculture themed games:

- **Each game play gives you a ticket for big end of night prizes,**
- **Play often, increase your chances to win!!**

Silent Auction:

The traditional Silent Auction is a great way to donate and get something in return!

Come support AAC student endowment fund!

W.A Murphy Student Centre

University of Prince Edward Island campus (Transport provided)

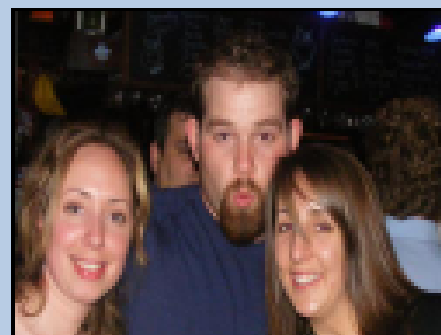
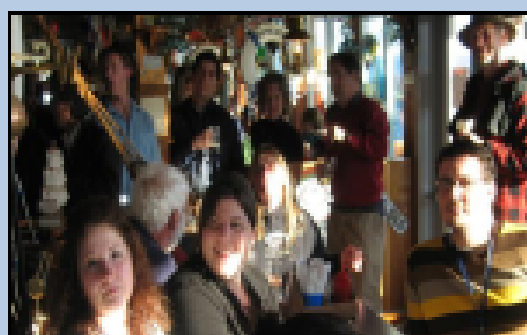


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Aquaculture Canada^{OM} 2012 Committees / Comités

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Matthew Liutkus – Canadian Food Inspection Agency
Karen Wortman – PEI Meetings and Conventions
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Aquaculture Canada^{OM} 2012

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Aquaculture Association of Canada
Prince Edward Island Department of Fisheries, Aquaculture and Rural Development
Atlantic Veterinary College, University of Prince Edward Island
Prince Edward Island Aquaculture Alliance
PEI BioAlliance

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- Prince Edward Island Department of Fisheries, Aquaculture and Rural Development
- Novartis Animal Health
- Genome Atlantic
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Gold Contributors / Commanditaires or (\$1000.00 +):

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| • Atlantic Veterinary College, UPEI | |

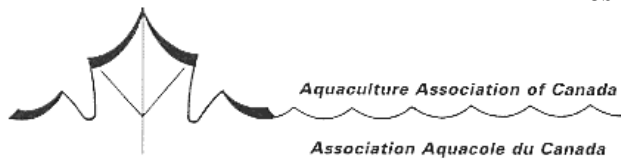
Silver Contributors / Commanditaires argent (\$300+)

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Aquaculture Association of Canada/ Association Aquacole du Canada
Welcome to Delegates / Mots de bienvenue aux délégués
President's Message



Welcome to Charlottetown, Prince Edward Island for Aquaculture Canada^{OM} 2012 – New Frontiers: Bridging Technology and Economic Growth. The PEI aquaculture industry and its life sciences cluster are intimately intertwined and perfect examples of our conference theme. An island that is known for Anne of Green Gables and potatoes is fast becoming as well known for cultured blue mussels, Canada's 2nd largest aquaculture product in both volume and value and whose production has quadrupled since the early '90s. PEI has also seen many partners collaborate towards the emergence of a biosciences cluster that's attracted early stage biotechs and multinationals. PEI is the embodiment of innovation driving economic growth.



In working with our conference co-hosts, the PEI Department of Fisheries, Aquaculture and Rural Development, the PEI Aquaculture Alliance, the Atlantic Veterinary College and the PEI BioAlliance, I believe our Program Committee has assembled a program that speaks directly to the theme and its relationship to aquaculture and once again presents Aquaculture Canada^{OM} as Canada's premiere aquaculture science and technology exchange event. Our keynote and plenary speakers will speak on the opportunity that Canada has to capitalize on its resources to grow our industry, on means to measure and mitigate against aquatic animal health issues to improve industry productivity, on the use of media and communications to gain public license for industry growth and, as part of the VetHealth Global program, how technology commercialization – towards improved productivity or new revenue generation – can be effectively executed. This year's conference sessions address the breadth of aquaculture R&D such as biological and ecological developments, culture methods, and market and financial issues. In addition, the conference is host to a number of special workshops and forums: VetHealth Global, the Environmental Monitoring Workshop, the Cultured Shellfish Forum, and the Sustainability Forum.

It's our sincere hope that this edition of Aquaculture Canada^{OM} will inspire you to help bridge the technological developments, such as those presented this week, with the economic potential of our Canadian aquaculture industry.

Enjoy Charlottetown and have a good conference!

Tim Jackson

President, Aquaculture Association of Canada

Aquaculture Canada^{OM} 2012, Charlottetown, PE

Bienvenue à Charlottetown, Île-du-Prince-Édouard pour Aquaculture Canada^{OM} 2012 – Nouvelles frontières : lier technologie et croissance économique. L'industrie aquacole à l'ÎPE et son pôle de compétitivité en sciences biologiques sont très interconnectés et représentent des exemples parfaits du thème de la conférence. Une île bien connue pour « Anne of Green Gables » et les pommes de terre devient également reconnue pour la moule cultivée, 2^e plus important produit cultivé au Canada en termes de volume et valeur commerciale et qui, depuis les années 90, a vu sa production quadrupler. L'ÎPE a aussi profité de la collaboration entre plusieurs partenaires pour soutenir l'émergence d'un pôle de compétitivité en biosciences qui a attiré de jeunes entreprises de biotechnologie et des multinationales. L'ÎPE représente bien le concept d'innovation soutenant la croissance économique.

De concert avec nos co-hôtes, le Département des pêches, aquaculture et développement rural de l'ÎPE, le PEI Aquaculture Alliance, le Collège vétérinaire atlantique et le PEI BioAlliance, notre comité de programme a mis en place une programmation qui s'insère directement dans le thème de la conférence et son lien avec l'aquaculture. Ce programme fait également la preuve qu'Aquaculture Canada^{OM} est le principal événement d'échanges scientifiques et technologiques au Canada dans ce domaine. Notre premier conférencier et les présentateurs d'assemblées plénières vont illustrer l'opportunité pour le Canada de capitaliser sur ses ressources pour faire croître l'industrie, sur les moyens pour mesurer et limiter les effets des maladies des animaux aquatiques pour améliorer la productivité industrielle, sur l'utilisation des médias et outils de communications pour gagner l'appui public nécessaire à notre croissance et, comme partie du programme VetHealth Global, comment la commercialisation technologique – vers amélioration de la productivité ou générer de nouveaux revenus – peut être accomplie de façon efficace. Les présentations de cette année vont toucher l'ensemble de la R&D aquacole tel que les développements biologiques et écologiques, les méthodes d'élevage et les questions de marché et de financement. De plus, la conférence présentera un certain nombre d'ateliers et forums : VetHealth Global, un atelier sur le suivi environnemental, un forum en conchyliculture et un forum en développement durable.

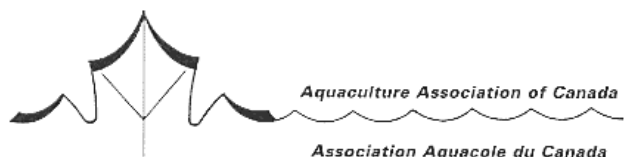
Nous espérons que cette édition d'Aquaculture Canada^{OM} vous incitera à miser sur les développements technologiques, comme ceux présentés cette semaine, pour accroître le potentiel économique de notre industrie aquacole canadienne.

Amusez-vous à Charlottetown et je vous souhaite une bonne conférence!

Tim Jackson

Président, Association aquacole du Canada

Aquaculture Association of Canada/ Association Aquacole du Canada
Welcome to Delegates / Mots de bienvenue aux délégués
Executive Director's Message



Welcome all to Aquaculture Canada^{OM} 2012, “*New Frontiers: Bridging Technology and Economic Growth*” and to the beautiful and historic city of Charlottetown, PEI. As your new Executive Director it will be my opportunity and pleasure to meet as many of you as possible and get your ideas and advice on how together, we can lead our industry forward.

This year's conference program will deliver a mix of technical sessions and opportunities to network with colleagues across the country. Topics this year include Fish Health and Nutrition, Integrated Pest Management, Genetics, Bio Economics, Shellfish Science, Coastal and Marine Spatial Planning and Reproductive Containment, among others. Our speakers will present the latest in aquaculture science and provide you with critical information that will be of benefit regardless of your role in the industry.

The AAC has a mandate and the commitment to foster the education and development of future industry leaders. Aquaculture Canada^{OM} 2012 features oral and poster competitions for students and our annual Joe Brown BBQ and Auction that will help raise funds for our Student Endowment Fund. This fund supports students through travel bursaries and scholarships.

This year we will also be recognizing a leader among us who has demonstrated outstanding contribution to the industry and to the AAC through the presentation of the AAC Lifetime Achievement Award.

Thank you for attending the conference this year. I am confident that you and I will both learn a lot and build new relationships that will endure for years to come. Enjoy!

Gail Ryan

Bienvenue à Aquaculture Canada^{OM} 2012, « *Nouvelles frontières : lier technologie et croissance économique* » et dans la belle et historique ville de Charlottetown, IPÉ. À titre de nouvelle directrice exécutive, j'aurai l'opportunité et le plaisir vous y rencontrer en grand nombre, de recueillir vos idées et avis sur comment, tous ensemble, nous pouvons aider notre industrie à continuer d'aller de l'avant.

Le comité de programme a mis en place un éventail de sessions techniques et d'opportunités de réseautage avec vos collègues de partout au pays. Les sujets abordés incluent, entre autres, la santé et

la nutrition des poissons, le contrôle intégré des espèces indésirables, la génétique, la bio-économie, la science des bivalves, la planification de l'utilisation des espaces côtiers et marins et le confinement de la reproduction. Nos conférenciers vous présenteront les derniers développements scientifiques dans le domaine de l'aquaculture ainsi qu'une information critique qui vous saura certainement vous être utile quelle que soit votre implication dans le domaine.

L'AAC a le mandat et l'engagement de promouvoir l'éducation et le développement des futurs meneurs de notre industrie. À ce titre, Aquaculture Canada^{OM} 2012 présentera les compétitions étudiantes pour les meilleures présentations orales et affiches, notre « Joe Brown BBQ » annuel et l'encan silencieux qui permet d'accumuler des fonds pour le « Student Endowment Fund ». Ce dernier nous permet de soutenir financièrement les dépenses de voyage et des bourses pour les étudiants.

Cette année nous soulignerons également le leadership de l'un de nos membres et la qualité de sa contribution à notre industrie par l'attribution de notre prix « AAC Lifetime Achievement Award ».

Merci de votre participation à notre conférence annuelle. J'ai confiance que vous et moi pourrons y apprendre beaucoup et que nous y forgerons de nouvelles relations qui sauront durer au cours des années à venir. Bon congrès!

Gail Ryan

Message from the Minister

On behalf of the Government of Prince Edward Island, I would like to welcome you to the Aquaculture Association of Canada 2012 annual conference. The Department of Fisheries, Aquaculture and Rural Development is pleased to partner in this year's meeting, *New Frontiers: Bridging Technology and Economic Growth*. We are excited to host discussions on aquaculture science and technology.

Aquaculture is a great success story for Prince Edward Island and a solid economic contributor to many rural communities. We produce over 80% of the mussels cultured in Canada. Our oyster, the "Malpeque" oyster, is world-renowned and offers great potential for expansion. Prince Edward Island also produces salmonid eggs and fingerlings in high-quality, disease-free groundwater. We are also working to grow the halibut industry. Our finfish products are closely linked to aquaculture operations in our neighbouring Atlantic provinces. Prince Edward Island is also known internationally for its high-quality research in many areas involving aquaculture.

Congratulations to the Aquaculture Association of Canada and our local hosts, the Prince Edward Island Aquaculture Alliance, the PEI BioAlliance and the Atlantic Veterinary College, University of Prince Edward Island, for organizing this event. While visiting Prince Edward Island, I hope you have the opportunity to take in some of the Island's beautiful scenery and to try some of our world-class seafood.

Sincerely,



Ron MacKinley, Minister
Fisheries, Aquaculture and
Rural Development



Ron MacKinley, Minister
Fisheries, Aquaculture and
Rural Development



Prince Edward Island Aquaculture Alliance
Welcome to Delegates / Mots de bienvenue aux délégués



On behalf of the PEI Aquaculture Alliance (PEIAA) I would like to welcome you to Aquaculture Canada 2012. The PEIAA is proud, along with our partners the Aquaculture Association of Canada (AAC), the Province of Prince Edward Island, the University of PEI (UPEI) and the PEI BioAlliance, to co-host this national event which will bring together researchers, regulators and growers to exchange ideas, review projects and discuss plans for developing all sectors of Canada's aquaculture industry.

PEI is **Canada's top producer and exporter** of rope cultured blue mussels, which have earned a reputation for great taste and high quality based on the diligence and pride of our growers and processors. Our famous Malpeque oysters have a world famous reputation for their supreme quality, great taste, and can be found in fine dining establishments, oyster bars, and kitchens across the world. Salmonids hatched in Island hatchery operations are exported to numerous other finfish aquaculture businesses in Atlantic Canada. Land based developments in atlantic halibut grow out are the newest addition to the Island's expanding finfish sector

The theme for the conference, "*New Frontiers: Bridging Technology and Economic Growth*", is definitely suitable for PEI. With world class biotechnology and fish health R&D facilities and growers with a demonstrated ability to meet challenges with innovation and creative thinking the Island's aquaculture industry, which generated over \$80 million in economic value in 2010, will continue to develop in the future.

Atlantic Veterinary College, University of Prince Edward Island Welcome to Delegates / Mots de bienvenue aux délégués



UPEI
UNIVERSITY
of Prince Edward
ISLAND



On behalf of the Atlantic Veterinary College, I welcome the delegates of Aquaculture Canada™ 2012 to the Atlantic Veterinary College at the University of Prince Edward Island.

Since it was established in 1986, the Atlantic Veterinary College has earned a global reputation for innovative and excellence in aquatic animal health. The research we do in this field is of regional, national and international significance and has anchored our efforts to become the world's leading academic-based aquatic health institution.

We continually seek to expand our knowledge base in the field of aquatic health. The College is home to an aquatic research cluster which includes several centres of excellence working for the benefit of the aquaculture industry. We are proud to host the prestigious Canada Excellence Research Chair in Aquatic Epidemiology which melds AVC's expertise in veterinary epidemiology and aquatic animal health, as well as several Canada Research Chairs and Industry Chairs who work in various areas of aquatic health.

The OIE Collaborating Centre for Epidemiology and Risk Assessment of Aquatic Animal Diseases, the AVC Shellfish Research Group, the Aquatic Virology Collaborating Centre (home of the OIE Reference Laboratory for Infectious Salmon Anaemia), the Centre for Veterinary Epidemiological Research, AVC Lobster Science Centre, and AVC Aquatic Diagnostic Services Laboratories are examples of our commitment to aquatic animal health. Complementing our research expertise is a state-of-the-art aquatic animal health facility that we are proud to show you when you visit the College.

In addition to carrying out research in aquatic health, we also train veterinary medicine students and graduate students in this field so they are prepared to respond to the needs of the aquaculture and wild fish industries. We provide regional veterinarians with access to continuing education and training in farmed and wild fish health. We work with industry, academia, and government partners to enhance the healthy development of aquatic species, contribute to the productivity of the aquaculture sector, and provide input into policy decisions affecting the industry.

With its strong focus on aquatic animal health, the Atlantic Veterinary College is well positioned to work with the aquaculture industry to ensure the safety, health and sustainability of the food it produces. I wish you all the best for a productive and successful conference.

Donald L. Reynolds, DVM, PhD, DACVM
Dean, Atlantic Veterinary College



Welcome Delegates Canadian Aquaculture Conference 2012



On behalf of the Prince Edward Island BioAlliance and the VetHealth Global steering committee, it's my pleasure to welcome all delegates to Prince Edward Island for Aquaculture Canada 2012. We are very pleased to have the opportunity to partner with the Aquaculture Association of Canada and other host organizations to present the VetHealth Global Aqua Health Sessions as a new addition to the Aquaculture Canada Conference Program.

The theme of this year's conference "New Frontiers: Bridging Technology and Economic Growth" speaks to the importance of understanding the challenges along the road from research to commercial success. We're excited to have a number of experienced industry representatives from around the world join us in Charlottetown to help us understand the pathway from discovery to commercial success for fish health and nutrition products. More than ever, Canadian researchers and businesses in the aquaculture sector must work together to be successful in developing new products, meeting regulatory requirements, and satisfying customer needs.

We hope that all Conference delegates will join us for our one-on-one business/research partnering program on Tuesday afternoon (May 29th 2:00 – 4:00 pm) where we will help connect you with other researchers, companies and commercialization experts. We applaud the efforts of the Aquaculture Canada 2012 organizing committee and wish all participants a productive and successful conference.

A handwritten signature in black ink that reads "Rory Francis".

Rory Francis, Executive Director, PEI BioAlliance & Chair, VetHealth Global

**Canadian Aquaculture Industry Alliance / Alliance de l'Industrie
Canadienne de l'Aquaculture
Welcome to Delegates / Mot de bienvenue aux délégués**



**CANADIAN
AQUACULTURE**
INDUSTRY ALLIANCE

ALLIANCE DE L'INDUSTRIE
**CANADIENNE DE
L'AQUACULTURE**



On behalf of the Canadian Aquaculture Industry Alliance (CAIA), I am very pleased to welcome all delegates to Aquaculture Canada 2012.

This year's conference theme, Bridging Technology and Economic Growth, asks us to explore the relationship between innovation and growth.

Canada's aquaculture industry demonstrates a history of technological progress that supports industry competitiveness while continually improving its ecological performance.

Today aquaculture is one of the most environmentally efficient ways to produce protein that our growing and urbanizing world population needs. It is the fastest growing food production sector in the world and demand for aquaculture production will most likely continue to grow with rapid pace.

Innovation, together with strengthened government policy and leadership must coalesce in order achieve sustainable growth in Canadian industry and to secure the opportunities through in the farmed seafood sector for economic activity and job creation.

The regulatory environment must also keep pace with industry development and through enabling policies, promote the conditions for national innovation, technology development and entrepreneurialism that will ultimately lead to industry competitiveness.

This year's Aquaculture Association of Canada (AAC) conference will showcase a variety of forward-thinking Canadian research and technologies. In doing so, it is calling upon participants from multiple stakeholder groups to collaborate and bring forward new information that will allow this industry to embrace technology as an engine for the economic and environmental sustainability and growth of Canadian aquaculture.

The CAIA Board of Directors applauds this goal, congratulates AAC for another job well done and wishes all participants a productive and successful conference.

Ruth Salmon
Executive Director
Canadian Aquaculture Industry Alliance

Greetings From Premier Ghiz



On behalf of the Province of Prince Edward Island I would like to extend warm greetings to all delegates, presenters and family members attending the Aquaculture Canada^{OM} 2012 being held in Charlottetown from May 27 - 30th at the Rodd Charlottetown Hotel.

Your conference theme, "New Frontiers: Bridging Technology and Economic Growth" is indeed appropriate. Our Confederation Bridge keeps us linked to the mainland while your association supports the development and advancement of aquaculture in Canada.

Prince Edward Island is recognized as a leader in the area of research excellence and technology development. It is obvious your agenda is clearly focused in this direction as evidenced by the selection of your keynote speakers and thoughtful sessions. The information provided to you all this weekend is certain to prove beneficial as you encourage the teaching of all phases of aquaculture.

Good luck with your deliberations and enjoy your stay on Prince Edward Island!

A stylized, handwritten signature of Robert Ghiz in black ink.

Robert Ghiz
Premier of Prince Edward Island





GREETINGS FROM MAYOR CLIFFORD LEE MAYOR OF CHARLOTTETOWN

It is my pleasure to extend warm greetings to all delegates attending the 2012 Aquaculture Canada National meeting in beautiful Charlottetown, May 27 - 30, 2012. I want to thank you for once again selecting our City for your Annual Conference. The Aquaculture industry is so important to all Canadians and especially here on Prince Edward Island where it is a large contributor to our local economy.

Charlottetown is the Capital City of Prince Edward Island; a city with both history and charm. Tourism is a major industry with growth potential due to Charlottetown's historical significance. In 2005 Charlottetown was awarded the Prince of Wales Heritage Award. In 2011 Charlottetown was the International Large Category winner in the National Communities in Bloom competition and also received the Cultural Capital of Canada designation by Canadian Heritage. We are a city proud of our past and our community accomplishments and we encourage you to enjoy your time with us.

On behalf of Charlottetown City Council I extend warm greetings to you as you meet in beautiful Charlottetown. May all of you enjoy your Conference here in our City and please take the time to visit some of our most photographic sites during your time here ie our beautiful waterfront and Victoria Park Boardwalk,

Welcome to Charlottetown, "The Birthplace of Confederation".

Sincerely,

A handwritten signature in dark ink that reads "Clifford Lee". The signature is written in a cursive, flowing style.

*Clifford J. Lee
MAYOR*



A MESSAGE FROM CANADA'S MESSAGE DU MINISTRE DES PÊCHES

Welcome to Charlottetown for the Aquaculture Association of Canada's annual meeting.

This conference provides a valuable forum for the kind of collaboration that is essential in helping Canada's aquaculture sector succeed and reach its fullest potential.

Aquaculture is increasingly important to Canada's economy. Since 1996, production in Canada has more than doubled and its value has nearly tripled, to close to \$1 billion a year. It generates about 14,500 jobs in Canada.

Canada has excellent conditions for a successful aquaculture industry – an extensive coastline, healthy and productive waters, innovative technologies, a skilled labour force and, investments in scientific research and development.

The Government of Canada, in collaboration with provincial and territorial governments, is providing and applying world-class scientific aquaculture research, enforcing regulations and monitoring results to ensure the aquaculture sector continues to grow responsibly, bringing increased value to Canadians.

Aquaculture regulation and management is a shared responsibility among governments and industry. By working together, we ensure that management of the sector meets the high standards expected by Canadians and by markets for aquaculture products.

By working together government, industry and other stakeholders can ensure a thriving, responsible and sustainable aquaculture sector of which all Canadians can be proud.

Enjoy your stay in Charlottetown and best wishes for a successful conference.

*The Honourable Keith Ashfield, P.C., M.P.
Minister, Fisheries and Oceans Canada*



MINISTER OF FISHERIES AND ET DES OCÉANS DU CANADA OCEANS

Je vous souhaite la bienvenue à Charlottetown à l'occasion de la réunion annuelle de l'Association aquacole du Canada.

Cette conférence constitue une tribune de premier choix pour établir l'esprit de collaboration essentiel à la réussite du secteur aquacole canadien et à l'atteinte, par ce dernier, de son plein potentiel.

L'aquaculture occupe une place de plus en plus importante dans l'économie du Canada. Depuis 1996, la production aquacole au Canada a plus que doublé et sa valeur a presque triplé pour atteindre près d'un milliard de dollars par année. Elle produit quelque 14 500 emplois au Canada.

Le Canada bénéficie d'excellentes conditions pour assurer la prospérité de l'industrie aquacole : un vaste littoral, des eaux saines et productives, des technologies novatrices, une main-d'œuvre qualifiée, ainsi que des investissements dans la recherche et le développement scientifiques.

Le gouvernement du Canada, en collaboration avec les gouvernements provinciaux et territoriaux, offre des résultats de recherche en aquaculture de renommée internationale et en utilise, veille à l'application de la réglementation et surveille les résultats pour assurer une croissance continue et responsable du secteur aquacole, procurant ainsi une valeur ajoutée à la population canadienne.

La gestion et la réglementation de l'aquaculture sont une responsabilité commune des gouvernements et de l'industrie. En travaillant de concert, nous veillons à ce que le secteur aquacole soit géré selon les normes rigoureuses auxquelles s'attendent la population canadienne et les marchés en matière de produits aquacoles.

En unissant leurs forces, le gouvernement, l'industrie et les autres intervenants peuvent créer un secteur aquacole prospère, responsable et durable dont peut être fière la population canadienne.

Je vous souhaite un bon séjour à Charlottetown et une conférence des plus réussies.

*L'honorable Keith Ashfield, C.P., député
Ministre des Pêches et des Océans*

**Aquaculture Association of Canada – Lifetime Achievement Award /
Association Aquacole du Canada - Prix honorifique**

Tuesday, May 29, mardi 29 mai, 2012

7:30 pm (Gala Dinner)

Room/Salon: Victorian Room

Chair: Tim Jackson

Chris Frantsi, Ph. D.

Dr. Chris Frantsi has an extensive background in fisheries and aquaculture in both the public and private sectors.

He spent his early years in Ontario and eventually moved with his family to Nova Scotia. He completed his BSc at Acadia University with a focus on microbiology. He then attended the University of Guelph, Department of Microbiology where he completed a Masters with his research on mammalian virology. Following this he did his PhD at Guelph in the Ontario Veterinary College Department of Microbiology and Immunology with his thesis on the epidemiology of Infectious Pancreatic Necrosis virus.



He began his career as a student microbiologist with the Canada federal Fisheries Inspection Branch in Halifax and following completion of his Masters, he taught food microbiology for a semester at the University of Guelph.

From 1972 to 1975, working for DFO and stationed at Mactaquac Fish Hatchery near Fredericton, he was responsible for fish health in Atlantic Canada's then thirteen federal salmonid hatcheries. In 1975 he moved to St. Andrews and joined the Huntsman Marine Laboratory and the Atlantic Salmon Federation to assist in building and operating the North American Salmon Research Centre. In 1977 Dr. Frantsi moved to Ottawa for a year and assisted with the Introduction of Canada's Fish Health Protection Regulations.

From 1978 to 1985 he worked with the Huntsman and the New Brunswick Community College in establishing and teaching Canada's first Aquaculture Technician Training Program. During this period he also conducted research for government and private clients in both shellfish and finfish.

In 1985 Dr. Frantsi joined Connors Bros. Limited, later to become Heritage Salmon Limited, establishing the Aquaculture Division where he worked in senior management until 2004. He currently pursues a number of private interests under Chris Frantsi & Associates.

Dr. Frantsi has authored many scientific and technical papers on virology, microbiology and aquaculture, and has served as a member on various boards and as adjunct professor at a number of universities in both Canada and the USA. He is a Certified Fisheries Scientist with the American Fisheries Society and in 2000 was named “Aquaculturist of the Millennium”, a Canadian Farm Credit Corporation Award given by the Atlantic Aquaculture Exposition.

Dr. Frantsi currently serves on the Board of the Fundy Community Foundation, dedicated to serve community needs in Charlotte County New Brunswick and is Chair of the Atlantic Canada Opportunities Agency, Atlantic Innovation Fund Advisory Board.

Chris enjoys the good fortune of continuing to reside in St. Andrews and these days is usually found pursuing long neglected interests such as golfing, gardening, ATVing, hunting and fishing.

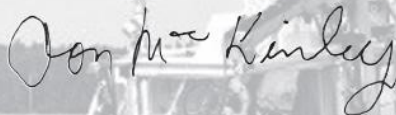
Welcome

Welcome to delegates attending Aquaculture Canada 2012.

I extend a warm welcome to you on behalf of Prince Edward Islanders. We are proud to host this year's conference and promote our beautiful province and our unique Island hospitality.

We are especially proud of our seafood products, known around the world for their high quality. Over the next few days there will be lots of opportunities to sample our delicious seafood - don't miss out.

Enjoy your stay. Best wishes for productive meetings.



Ron MacKinley, Minister
Fisheries, Aquaculture and
Rural Development



Ron MacKinley, Minister
Fisheries, Aquaculture and
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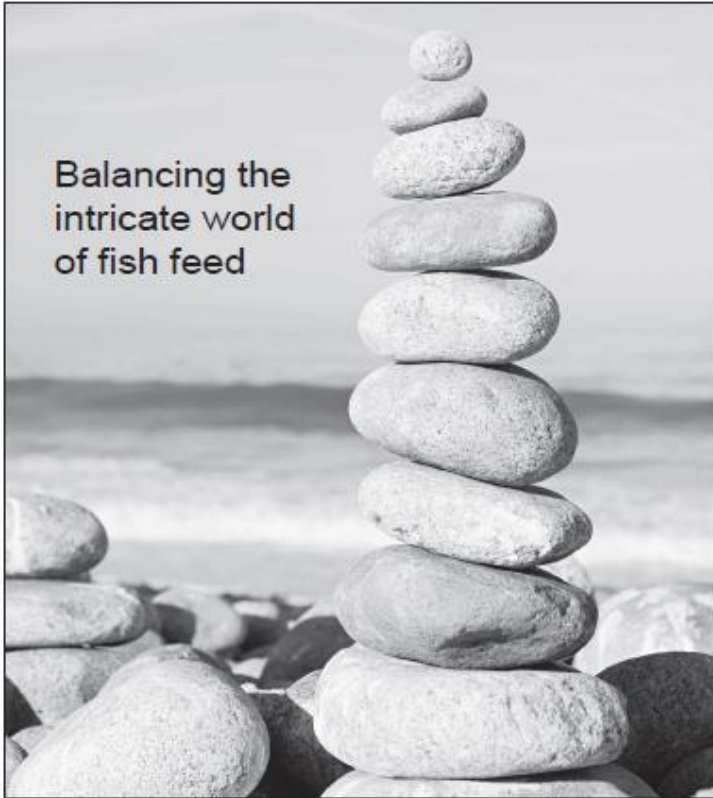


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Canada Research Chair in Integrated Health
Research for Sustainable Aquaculture



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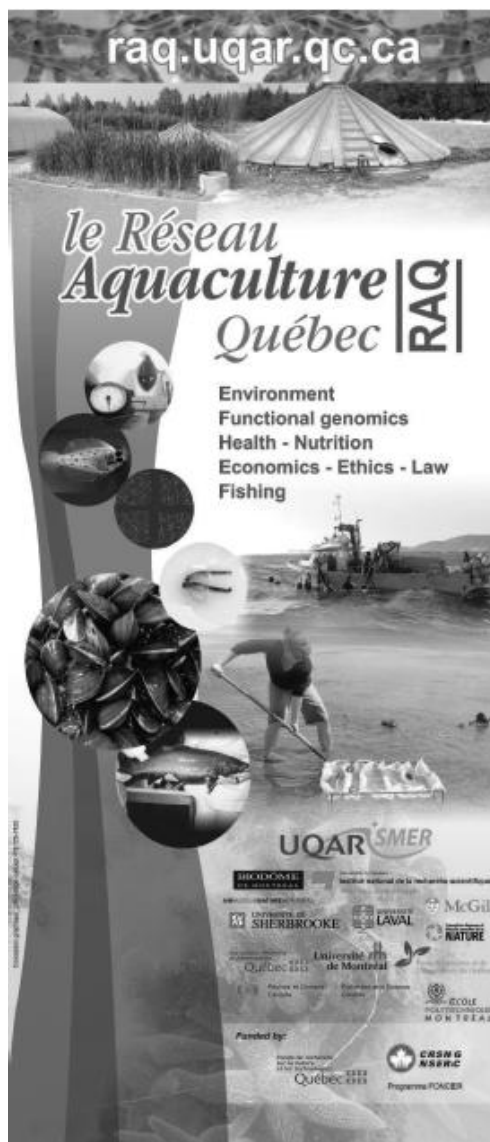


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Information / Informations

Registration / Inscription

Registration is located in the foyer of the main foyer of the Rodd Charlottetown and operates daily as follows:

L'inscription est dans l'entrée principale du Rodd Charlottetown et les heures d'opération sont :

- Sunday May 27th / dimanche 27 mai: 5:00 PM – 9:00 PM
- Monday May 28th / lundi 28 mai: 7:00 AM – 5:00 PM
- Tuesday May 29th / mardi 29 mai: 8:00 AM – 5:00 PM
- Wednesday May 30th / mercredi 30 mai: 8:00 AM – 12:00 PM

All function tickets must be obtained from the registration desk.

Vous devez obtenir les billets pour banquets, barbecue et AGA au bureau d'inscription.

Entrance to Sessions / Accès aux sessions

Entry to a session will not be permitted without your Aquaculture Canada^{OM} 2012 name tag.

Vous devez porter votre carte d'inscription pour avoir accès aux salles de conférence.

Program Notes for Speakers and Posters / Notes pour conférenciers et présentations d'affiches

Posters – Georgian Terrace, The Rodd Charlottetown: Set-up time is Sunday May 27th from 5:00 PM to 7:00 PM. Presenters are asked to be available at their poster during the Poster Session on Tuesday May 29th from 4:30 PM to 6:00 PM as well as during morning and afternoon breaks. Posters should be taken down by 7:00 PM on Tuesday May 29th.

Affiches – Georgian Terrace, the Rodd Charlottetown: Montage dimanche le 27 mai entre 17h00 et 19h00. Les présentateurs sont priés de se présenter dans le salon pour la session des affiches mardi 29 mai entre 16h30 et 18h00, et aussi durant les pauses-café. Les affiches doivent être enlever au délais le plus tard à 19h00 mardi le 29 mai.

Speakers: Oral presenters are asked to meet their session chair and AV personnel no less than 15 minutes prior to the start of the session. Should changes occur in the program, these will be announced at the beginning of each session and posted in the foyer next to each session room. Speakers and poster presenters are encouraged to submit extended abstracts by June 22, 2012 to Kathy.Brewer-Dalton@gnb.ca for publication of the proceedings in the AAC bulletin.

There will be a conference laptop available Sunday May 27th (5-7 pm) to test any presentations with video and to determine if a presenter will be required to bring their own laptop for their scheduled talk in the event that their presentation cannot be run on the laptops provided. A schedule will be developed for the test session.

Conférenciers : Ceux qui font des présentations orales doivent rencontrer le modérateur de la session et le personnel qui s'occupe du service audiovisuel au moins 15 minutes avant le début de la session. Si il y des changements dans le programme, ils seront annoncés au début de la session et montés près de la salle au début de la journée. Les présentateurs d'affiches et de présentations orales sont encouragés à soumettre des résumés prolongés avant le 22 juin, 2012 à Kathy.Brewer-Dalton@gnb.ca pour le compte rendu dans le Bulletin de l'AAC.

Il y aura un ordinateur disponible le dimanche 27 mai, de 17:00 à 19:00 pour vérifier les présentations incluant des documents vidéo et pour déterminer si les présentateurs devront utiliser leur propre ordinateur personnel si le document vidéo ne peut être présenté à partir des ordinateurs réservés pour les conférences. Un horaire sera établi pour cette session test.

Job Board / Annonces d'emploi et résumés

Notice boards are available for posting résumés and job notices near the poster session. Il y aura des tableaux disponibles pour les annonces près la session des affiches.

Refreshment Breaks / Pauses-santé

For your convenience, refreshment breaks will take place off the main foyer area in the Georgian Terrace.

Les pauses-santé auront lieu près du foyer dans la Georgian Terrace.

Refreshment breaks are / Pauses-santé:

Monday May 28th / lundi 28 mai: 10:00 AM – 10:30 AM and 4:05 PM – 4:30 PM

Tuesday May 29th / mardi 29 mai: 10:30 AM – 11:00 AM

Wednesday May 30th / mercredi 30 mai: 10:30 AM – 11:00 AM and 3:20 PM – 3:50 PM

Student Affairs and Events / Affaires étudiant(e)s

Student Awards: The AAC is pleased to have sponsored travel for 13 students to attend the conference. 34 students will compete for Best Oral and Best Poster presentations.

Prix étudiant(e)s : L'AAC est fière d'avoir commandité 13 étudiant(e)s avec des bourses de voyage pour participer à la conférence. 34 présentations par étudiant(e)s seront faites pendant la conférence.

AAC AGM / AGA de l'AAC

This will take place in the Rodd Charlottetown (room TBA) 12:30-14:00, Tuesday May 29th. All AAC members are encouraged to attend.

L'AGA de l'AAC se tiendra dans la salle Rodd Charlottetown (Salle à déterminer) 12h30-14h00, mardi le 29 mai. Les membres de l'AAC sont bienvenus de participer.

Social Functions / Événements Sociaux

We will once again be having a number of exciting social events featuring exceptional Canadian aquaculture products.

Il nous fait plaisir de vous offrir des événements sociaux mettant en oeuvre nos produits canadiens aquacoles de qualité exceptionnelle.

President's Reception / Réception du président

Sunday May 27th, Georgian Ballroom, Rodd Charlottetown, 7:00 – 9:00 PM. Cash bar.
Dimanche 27 mai, Georgian Ballroom, Rodd Charlottetown, 19:00 – 21:00. Bar payant.

Joe Brown BBQ for Student Endowment Fund / Barbecue aquacole Joe Brown pour fond des étudiant(e)s: The proceeds from the activities at the Joe Brown Student BBQ on Monday May 28th go towards the AAC Student Endowment Fund to support student scholarships and travel to Aquaculture Canada meetings. Students are especially encouraged to attend and participate in the evening's events.

Monday May 28th, UPEI Student Center, 6:00 PM – 11:00 PM with tours of the Atlantic Veterinary College. Tickets required in advance (includes bus cost to UPEI from Rodd Charlottetown and return).

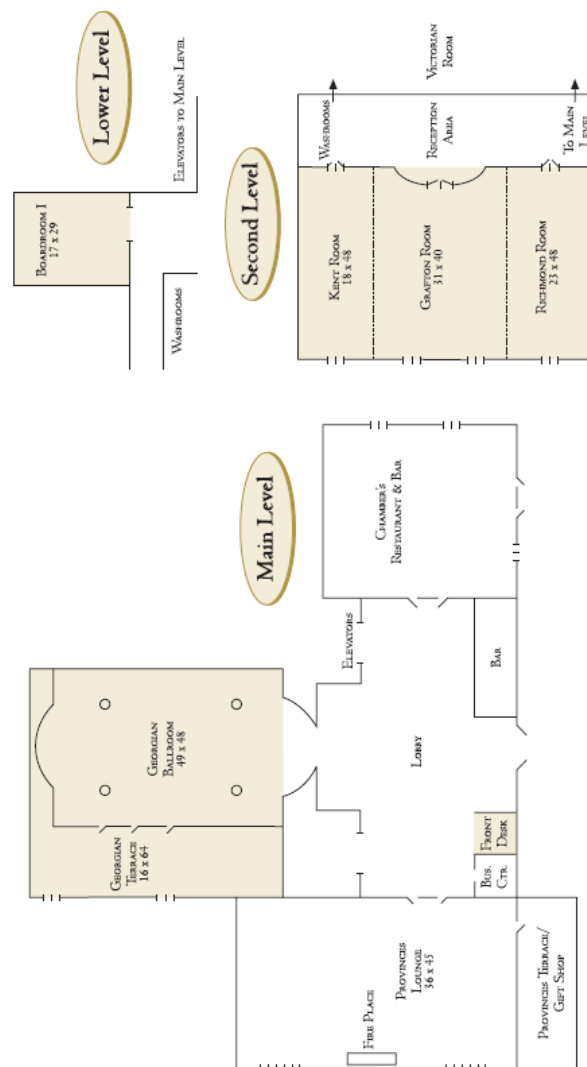
Barbecue Joe Brown pour le fond de support étudiant: Les profits des activités au barbecue aquacole lundi le 28 mai sont placés dans un fond de support en forme de bourses pour les étudiant(e)s. On encourage les étudiant(e)s de participer au barbecue lundi 28 mai, Student Center, UPEI, 18h00-23h00. Ceci inclus une visite des installations du collège vétérinaire des provinces atlantique. Billets requis (inclut le coût d'autobus à l'UPEI de Rodd Charlottetown et retour).

Banquet – Victorian Ballroom, Rodd Charlottetown

Tuesday May 29th, 7:00 pm cash bar, 7:30 pm dinner . Presentations of AAC Lifetime Achievement Award and Science Atlantic 50th Anniversary Awards of Recognition. Entertainment by comedian Patrick Ledwell. Tickets required in advance.

Mardi 29 mai, 19 h bar payant, 19h30 dîner. Présentations du prix Honorifique de l'AAC et des prix reconnaissance 50e anniversaire de Science Atlantique. Divertissement par le comédien Patrick Ledwell. Billets requis à l'avance

Session Rooms / Salles de conférences



Program Outline / Sommaire du programme

DAY 1 – SUNDAY, MAY 27

JOUR 1 – DIMANCHE, 27 MAI

12:00 – 18:00	Golf, Glen Afton golf course
17:00 – 21:00	Registration Open / Inscription ouverte
17:00 – 19:00	Poster Set Up / montage des affiches
19:00 – 21:00	President's Reception / Réception du président Georgian Ballroom, Rodd Charlottetown

DAY 2 – MONDAY, MAY 28

JOUR 2 – LUNDI, 28 MAI

07:00 – 17:00	Registration Open / Inscription ouverte
10:00 – 16:00	Poster Session / Affiches
08:15 – 17:15	Opening Session, Keynote Speaker (9:00am - Dr. Brian Lee Crowley, MacDonald Laurier Institute), Plenary Speaker (2:00pm – Dr. Ian Gardner, Canada Excellence Research Chair in Aquatic Epidemiology, AVC), Technical Sessions / Allocutions d'ouverture, session plénière, sessions techniques
12:30 – 14:00	Lunch (on own) / lunch (à sois même)
18:00 – 23:00	AVC Tour and Joe Brown BBQ in Support of AAC Students /
Buses 17 :45	Barbecue Joe Brown – AVC and UPEI Student Centre (tickets required / billets requis)

DAY 3 – TUESDAY, MAY 29

JOUR 3 – MARDI, 29 MAI

08:00 – 17:00	Registration Open / Inscription ouverte
10:00 – 18:00	Poster Session / Affiches Authors in attendance 16:30 - 18:00 / Auteurs présents 17:00-18:30 (finger food and cash bar)
08:15 – 16:30	Plenary Speaker (9:45am – Dr. George Gunn, Chief Executive Officer Novartis Animal Health Division and Head of Corporate Social Responsibility), Technical Sessions / Session plénière, sessions techniques
12:30 – 14:00	AAC AGM Luncheon (members only) (tickets required) / AGA de l'AAC Room TBA / Salle à venir
12:30 – 14:00	Lunch (on own) / lunch (à sois même)
14:00 – 16:00	PEI BioAlliance Partnering Event, Richmond Room, Rodd Charlottetown
19:30 – 22:30 (cash bar 19:00, dinner 19:30)	Gala Dinner with AAC Lifetime Achievement Award and Science Atlantic 50 th Anniversary Recognition Awards. Entertainment by comedian Patrick Ledwell, Victorian Room, Rodd Charlottetown (tickets required/ billets requis)

DAY 4 – WEDNESDAY, MAY 30

JOUR 4 – MERCREDI, 30 MAI

08:00 – 12:00	Registration Open / Inscription ouverte
08:15 – 17:20	Plenary Speaker (9:45am – Dr. Gary Marty, Fish Pathologist. Animal Health Centre. BC Ministry of Agriculture), Technical Sessions / Session plénière, sessions techniques
12:20 – 14:00	Lunch (on own) / lunch (à sois même)
17:20	STUDENT AWARDS PRESENTATION

DAY 5 – THURSDAY, MAY 31

JOUR 5 – JEUDI, 31 MAI

09:00-17:00	CREATE Student Workshop, Atlantic Veterinary College Room 287N
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Outline of Presentations / Résumés des présentations

POSTER PRESENTERS / PRÉSENTATIONS D’AFFICHES:

Set up Sunday May 27 (5-7PM), take down Tuesday May 29 (7:00PM)
Montage dimanche 27 mai (17h00-19h00), en lever mardi 27 mai (19h00)

PRESIDENT’S RECEPTION / RÉCEPTION DU PRÉSIDENT:

Sunday May 27 (7-9 PM) / Dimanche 27 mai (19h00-21h00): (Georgian Ballroom)

MONDAY, MAY 28, Morning

LUNDI 28 MAI, matin

07:00 - 17:00	Registration / Inscription		
08:15 - 09:00	Opening session / Allocutions d’ouverture (Victorian Room): Tim Jackson, President, Aquaculture Association of Canada Gail Ryan, Executive Director, Aquaculture Association of Canada Honourable Ron MacKinley, Minister of PEI Dept of Fisheries, Aquaculture and Rural Development Dr. Don Reynolds, Dean, AVC-UPEI Anne Worth, Executive Director, PEI Aquaculture Alliance Rory Francis, Executive Director, PEI BioAlliance Ruth Salmon, Executive Director, Canadian Aquaculture Industry Alliance Fisheries and Oceans Representative		
09:00 - 10:00	Conference Keynote / Session plénière: Dr. Brian Lee Crowley MacDonald Laurier Institute: "Canada: Food Superpower or Also-Ran?" (Victorian Room)		
09:00 - 17:00	Posters up for viewing		
10:00 - 10:30	BREAK / PAUSE		
	Victorian Room	Georgian Ballroom	Provinces Lounge
	Fish Health (Sea Lice)	Coastal and Marine Spatial Planning	Reproductive Containment and Genetics and Selective Breeding
10:30 – 10:50	L. Braden: Development of a skin injection model for studying local and systemic responses to <i>Lepeophtheirus salmonis</i> in salmon	J. Dupuis: Replacement class screening report for oyster aquaculture activities in eastern New Brunswick	T.J. Benfey: The use of female triploidy for reproductive containment of farmed Atlantic cod
10:50 - 11:10	S. Fordham: Sea Lice Library: Production of sea lice for research purposes	R. Filgueira: Paving the way for the integration of ecosystem modelling into marine spatial planning	D.A. Plouffe: Reproductive confinement for the safe cultivation of genetically improved lines of Atlantic salmon

11:10 - 11:30	O. Igboeli: Involvement of P-glycoprotein in reduced efficacy of emamectin benzoate (SLICE®) in sea lice, <i>Lepeophtheirus salmonis</i>	M. Ouellette: Ecosystem-based risk management applied in coastal spatial planning	S. Tibbetts: An overview of a collaborative project to develop optimized diets for culture of triploid growth-hormone transgenic Atlantic salmon (<i>Salmo salar</i>)
		Bioeconomics	
11:30 - 11:50	J.A. Cooper: Dose-responses for non-target crustaceans based on semi-natural laboratory and field-based mesocosm exposures to chemo-therapeutants.	J.D.P. Davidson: The efficacy and bio-economics of various high pressure water treatment regimes on mussel productivity	Q. Xu: Family-specific differences in growth rate and hepatic gene expression in triploid growth hormone (GH) transgenic Atlantic salmon (<i>Salmo salar</i>)
11:50 - 12:10	D. Lewis: Effects of <i>Lepeophtheirus salmonis</i> secretions on salmon macrophages	S. Cross:	C.Y. Feng: Family differences in growth hormone transgenic Atlantic salmon hepatic transcriptome responses to triploidization
12:10 -12:30	L. Hammell: Supporting sea lice treatment monitoring: Decision support system, sea lice count training, and independent audit programs in New Brunswick	G. Flimlin: Investigating alternative markets for cultured shellfish	T.S. Hori: Immunogenomics research and Mx1 transcript expression analyses in spleen of diploid and triploid growth hormone transgenic Atlantic salmon
12:30 - 14:00	LUNCH ON OWN / DÉJEUNER LIBRE		

MONDAY, MAY 28, Afternoon

LUNDI 28 MAI, après-midi

14:00 - 14:40	Conference Plenary / Session plénière: Dr. Ian Gardner (Canada Excellence Research Chair in Aquatic Epidemiology-AVC. Standards for the design and reporting of validation studies for diagnostic assays used for detection of aquatic animal pathogens: are they needed? (Victorian Room)		
	Victorian Room	Georgian Ballroom	Provinces Lounge
	Fish Health Cont'd	Integrated Multi- Trophic Aquaculture	Reproductive Containment and Genetics and Selective Breeding Con't

14:45 - 15:05	S.M.C. Robinson: Studying the early life-history of sea lice in the Bay of Fundy for the purpose of developing alternative strategies to reduce epidemic-level infestations	C. Chianale: The red alga, <i>Palmaria palmata</i> , as a summer/fall candidate for increased biomitigative performance of the Integrated Multi-Trophic Aquaculture (IMTA) system in the Bay of Fundy, Canada	D. Runighan: Generation of tetraploid broodstock to enable reproductive confinement of salmonids
15:05 - 15:25	C. Novak: <i>Lepeophtheirus salmonis</i> (Caligidae) as a vector of <i>Aeromonas salmonicida</i>	H. Khoda Bakhsh: A variation on the IMTA theme for land-based, freshwater aquaculture operations: aquaponics	A. Garber: Atlantic Salmon performance selection and broodstock development program for use in commercial saltwater aquaculture production on the East Coast of Canada
15:25 - 15:45	E. Rees: Spatio-temporal analysis of sea lice infection in wild salmon, British Columbia, Canada	L. Orr: Quantifying the capture and conversion efficiencies of species being considered for organic extraction in open-water IMTA systems on the West Coast	B. Swift: Development and integration of selective breeding programs for two commercial salmon aquaculture operations in British Columbia
15:45-16:05	M. Laflamme: Transcriptional response of Atlantic salmon after primary versus secondary exposure to infectious salmon anemia virus	D. Morse: A pilot project to stimulate seaweed production on mussel farms in Maine.	A. Garber: Ceres: A relational broodstock database program
16:05 – 16:30	BREAK / PAUSE		
	Victorian Room	Georgian Ballroom	Provinces Lounge
	Fish/Shellfish Health Cont'd	IMTA Cont'd	Contributed Papers
16:30 - 16:50	T. Renault: Increased mortality outbreaks of French Pacific oysters <i>Crassostrea gigas</i> since 2008 in Europe: pathogen detection, control measures and mitigation	S.M.C. Robinson: Seasonal trends in blue mussel (<i>Mytilus edulis</i>) somatic composition as a reflection of quality and traceability in Integrated Multi Trophic Aquaculture (IMTA) systems	H.M. Murray: Histology and mucous histochemistry of the integument and body wall of a marine polychaete worm, <i>Ophryotrocha n. sp.</i> (Annelida: Dorvilleidae) associated with Steelhead trout cage sites on the south coast of Newfoundland
16:50 - 17:10	D. Huyben: The evaluation of submerged membrane filtration as an alternative to UV disinfection and its ability to remove <i>Flavobacterium psychrophilum</i> from recirculation aquaculture systems	J.A. Manriquez-Hernandez: Effect of light intensity on performance of red seaweed cultivated at high stocking density	C. Stephen: Policy and legislation gap assessment for the sustainable development of freshwater ornamental fish aquaculture in Sri Lanka

17:10 - 17:30	T.T. George: An unprecedented Incidence of tilapia mass mortality due to Streptococcus inae infection in the White Nile at Jebel Aulia Dam Reservoir, Khartoum, Sudan.	J. Day: Establishing relationships to investigate the far-field effects on wild species of aquaculture nutrient plumes using biological and biochemical indicators.	W. Kader-Bathia: Ornamental fish as complementary species in aquaponics
18:30 - 23:00	Joe Brown Student BBQ: UPEI Student Centre/ Tours of AVC (buses depart hotel at 17:45)		

TUESDAY, MAY 29, Morning

MARDI 29 MAI, matin

08:00 - 17:00	Registration / Inscription		
09:00 - 18:00	Posters up for viewing		
	Victorian Room	Georgian Ballroom	Provinces Lounge
	Vet Health Global	Shellfish Carrying Capacity	Contributed Papers
08:15 - 08:35	Slice- The story of a market leader	C. W. McKindsey: In-situ mesocosms to evaluate dose-response effects of farmed mussel biodeposition on the benthic environment	M. Klaver: British Columbia Aquaculture Regulatory Program
08:35 - 08:55	New diagnostic tools for the shellfish industry	M. Fréchette: A model of clearance rate regulation in mussels	C. Edwards: Improving environmental performance in salmon aquaculture: a study of alternative cage materials and coatings in coastal British Columbia
08:55 - 09:15	M.P. Estrada: Vaccines against sea lice: first steps toward a deeper understanding	A. Gangnery: Carrying capacity of the shellfish ecosystem of the Baie des Veys (Normandy, France): in situ measurements and hydrobiological modelling	C. Stephen: Scoping review of literature to identify factors associated with positive human development outcomes associated with aquaculture development
09:15 - 09:35	The Fish Health and Nutrition Challenges for Global Aquaculture	C. Bacher: Combining ecophysiological model and satellite-derived environmental data to assess the potential of bivalve aquaculture	N. Hagen: Assessing the assessment: effect of bibliometric bias on the ranking of Canadian aquaculture researchers' publication performance
09:45 - 10:30	Conference Plenary / Session plénière: Dr. George Gunn, Novartis : Success at the Interface: Creating Effective Relationships Between Academic Institutions and the Private Sector (Victorian Room)		
10:30 - 11:00	BREAK		

	Victorian Room	Georgian Ballroom	Provinces Lounge
	Vet Health Global	Shellfish Carrying Capacity Cont'd	Environmental Monitoring
11:00 - 11:20	R. Finlay: Understanding the commercialization pathway	R. Rosland: Effects of stimulated upwelling on phytoplankton production and mussel growth in a Norwegian fjord system	A.T. Bennett: The New Brunswick environmental management framework for marine finfish aquaculture: A brief history with an eye to the future
11:20 - 11:40	J. Raoul: Patenting and licencing strategies	T. Guyondet: Diagnostic method for assessing the shellfish culture potential of a coastal system	T. Balch: The Nova Scotia environmental monitoring program; past, present and future
11:40 - 12:00	D. A. Plouffe: Executing regulatory-compliant studies in support of aquaculture applications	J. Grant: The role of assimilative capacity in concepts of carrying capacity	B. Sweeney: The need for aquaculture environmental assessment & monitoring research
12:00 - 12:20	B. Green: Investing in New Technologies	R. Filgueira: Bivalve condition index as an indicator of aquaculture intensity	B.D. Chang: Recent research on environmental monitoring of salmon farms in Southwestern New Brunswick
12:20 - 14:00	LUNCH ON OWN / DÉJEUNER LIBRE		
12:30 - 14:00	AAC AGM (membres seulement) – Room TBA		

TUESDAY, MAY 29, Afternoon
MARDI 29 MAI, après-midi

	Victorian Room	Georgian Ballroom	Provinces Lounge
	Pest and Predator Control	ACAIRDN Session	Environmental Monitoring Cont'd
14:00 - 14:20	C. Webster: Integrated pest management plan for sea lice in New Brunswick	S. Thériault: Three Oaks Innovation	D. Drover: Exploration of a visual based approach to benthic environmental monitoring of finfish cage culture sites in Southern Newfoundland.
14:20 - 14:40	Y. Leclerc: Integrated pest management in the potato industry – The IPM survey and other McCain Foods initiatives	R. Isnor: Maximizing the potential for university-college-industry research collaborations in Atlantic Canada	J. Grant: Near-field and far-field perspectives on aquaculture monitoring: implications for models and measurements used in management

14:40 - 15:00	S. Stewart-Clark: Detecting future invaders: The use of molecular assays in invasive species monitoring in aquaculture regions.	J. Parsons: Fisheries and Oceans Canada - Aquaculture Science Research Funding Programs	D. Hamoutene: The use of bacterial mats (<i>Beggiatoa spp.</i>) and opportunistic polychaete complex as potential indicators of habitat alteration around finfish aquaculture sites over hard bottom
15:00 - 15:20	A. Garber: The ECO Bath System: A paradigm shift for Atlantic salmon sea lice management	S. Vatcher: National Research Council Canada - Industry Research Assistance Program	G. Mabrouk: Validation of the DEPOMOD for estimating desposition from fish farms on the South Coast of Newfoundland
15:20 - 15:40	K. Robertson: Development of shark and predator resistant aquaculture containment nets	G. Falk: Aquaculture Innovation and Market Access Program (AIMAP)	C. Salvador: Marine finfish aquaculture hard seabed monitoring in British Columbia
15:40 - 16:00	T. Landry: Tunicate infestation in Prince Edward Island Canada: development of an integrated management approach.	D. Green: A strategy for targeted aquaculture research in Newfoundland and Labradore (STAR-NL)	Facilitated Panel Session: Sharon McGladdery
16:00 - 16:20	B. Vercaemer: <i>Ciona intestinalis</i> environmental control points? Field and laboratory investigations	B. Harnish: A high level overview of the Scientific Research and Experimental Development (SR&ED) Tax Incentive Program at the Canadian Revenue Agency	
14:00-16:00	Business Partnering: PEI BioAlliance (Richmond Room at Rodd Charlottetown)		
16:30 - 18:00	Poster session, authors in attendance (cash bar) / Session d'affiche, auteurs présents (bar payant), Georgian Terrace		
19:30-22:30	GALA Dinner (Cocktails at 19:00) – Presentations of the AAC Lifetime Achievement Award and Science Atlantic 50 th Anniversary Recognition Awards. Entertainment by comedian Patrick Ledwell Victorian Room		

WEDNESDAY, MAY 30, Morning
MERCREDI 30 MAI, matin

08:00 - 12:00	Registration / Inscription		
	Victorian Room	Georgian Ballroom	Provinces Lounge
	Cultured Shellfish Forum	Contributed Papers	Sustainability Forum

8:15-8:35	L. Duncan: Marketing to food service	G.K. Reid: Using image analysis software and the Archimedes Principle to determine the submersed weight supported by a buoy	C. Roper: Building a supply chain business case For aquaculture certification schemes
8:35-8:55	D. Tillapaugh: The Vancouver Island University Deep Bay Marine Field Station –leadership in design and innovation	D.W. Fredriksson: Development of an aquaculture net finite element modeling technique with laboratory bench-top measurement validation	
8:55-9:15	C. Hendry: Innovation in Newfoundland shellfish aquaculture	C. Uhlig: An integrated concept for land-based mariculture with particular emphasis on microalgae based biofilter in Norway	W. More: Best aquaculture practices - An update on sustainable production and certification
9:15-9:35	F. Bourque: Various Technological Developments in the Québec Aquaculture Industry	G. Mabrouk: Characterization of the oceanographic conditions in the South Coast of Newfoundland in support of aquaculture	
09:45-10:30	Conference Plenary / Session plénière: Dr. Gary Marty: Communicating Science – The Pitfalls and Need for Transparency (Victorian Room)		
10:30-11:00	BREAK		
	Victorian Room	Georgian Ballroom	Provinces Lounge
	Cultured Shellfish Forum Cont'd	Advances in Fish Nutrition	Sustainability Forum Cont'd
11:00-11:20	C. Gionet: Wild spat collection at Little Shemogue Oyster Company	N. Boudreau: Preparation and investigation of experimental feeds for American lobster (<i>Homarus americanus</i>) larvae	R. Salmon: Providing options for Canadian farmed seafood suppliers - Canadian organic farmed aquaculture standards and FAO-based certification option

11:20-11:40	L.A. Davidson: Culturing oysters glued to strings in an exposed site vs. a sheltered site in Baie des Chaleurs, NB	C. Bullerwell: Performance of rainbow trout (<i>Oncorhynchus mykiss</i>) fed <i>Camelina sativa</i> seeds and high oil residue meal	J. Smith: The aquaculture sustainability reporting initiative – reaching out to Canadians
11:40-12:00	D. Méthé: Oyster nursery in low salinity sites: effect on productivity and physiology	R. Yossa: The effects of dietary biotin on zebrafish <i>Danio rerio</i> reproduction	G. Marty: A fish pathologist's view of science communication
12:00-12:20	L. Hiemstra: Overview of new scalable hatchery developed for increasing the production of <i>Mytilus</i> seed for BC aquaculture	J. Fraser: Digestibility of <i>Camelina sativa</i> seed and its by-products by Atlantic cod (<i>Gadus morhua</i>), rainbow trout (<i>Oncorhynchus mykiss</i>), and Atlantic salmon (<i>Salmo salar</i>)	DFO Science Communications
12:20 -12:40			Discussion Panel
12:20 - 14:00	LUNCH ON OWN / DÉJEUNER LIBRE		
12:20 - 14:00	AAC Board of Directors / Conseil d'administration - Room TBA		

WEDNESDAY, MAY 30, Afternoon
MERCREDI 30 MAI, après-midi

	Victorian Room	Georgian Ballroom	Provinces Lounge
	Cultured Shellfish Forum Cont'd	Advances in Fish Nutrition Cont'd	Advances in Land Based Aquaculture
14:00-14:20	J. Wyatt: The effect of extended holding time on the condition, physiology and stress response of cultured blue mussels (<i>Mytilus edulis</i> L. 1758) following commercial harvest in northeastern Newfoundland	S. Granier: Nutritional protein and lipid levels on growth of young-of-the-year Arctic charr (<i>Salvelinus alpinus</i>)	A. Desbarats: Advances in recirculating aquaculture technologies
14:20-14:40	J. Willis: <i>Cryptosporidium</i> and <i>Giardia</i> in contaminated American Oysters from Prince Edward Island: Current knowledge and ongoing efforts to distinguish human pathogenicity of biased samples	X. Xue: Gene expression analyses of skeletal muscle and liver tissues of Atlantic cod (<i>Gadus morhua</i>) fed diets containing <i>Camelina sativa</i> meal or oil	J. Duston: Integrating red macroalgae into land-based finfish mariculture
14:40-15:00	D. Gallardi: Evaluation of long-term live holding in blue mussels: changes in condition, lipid profile and organoleptic testing	S. Plante: New natural ingredient for growth and flesh pigmentation in Atlantic salmon (<i>Salmo salar</i>)	J. Carr: Virginia Freshwater Institute: Land based research

15:00-15:20	L. Gilmore Soloman: Oyster production in hanging structures suspended from mussels long lines in Magdalen Islands, why not?	N. LeFrançois: Genetic and nutritional approach to improve omega-3 content of two <i>Salvelinus</i> sp. and reciprocal hybrids	G. Johnson: Land based Atlantic Halibut Farm on Prince Edward Island
15:20 – 15:50	BREAK / PAUSE		
	Victorian Room	Georgian Ballroom	Provinces Lounge
	Cultured Shellfish Forum Cont'd	Advances in Fish Nutrition Cont'd	Advances in Land Based Aquaculture Cont'd
15:50-16:10	C. Gionet: Next steps towards the development of the American oyster (<i>Crassostrea virginica</i>) breeding program in New Brunswick	M.H. Deschamps: The effects of dietary P level on bone metabolism in rainbow trout (<i>Oncorhynchus mykiss</i>): development of new indicators to prevent vertebral abnormalities in fish farms.	D. Moran: Carbon dioxide and its implications in land-based aquaculture
16:10-16:30	S. Backman: Improve production efficiency of scallop aquaculture by integrating HDPE salmon cage technology with existing lantern net culture methods and the addition of communal species.	T. Huynh Thanh: Effects of sucrose addition on Artemia biomass production	P. Nickerson: An overview of heating and cooling process water in land-based aquaculture: best practices, & two case studies
16:30-16:50	Discussion Panel	A.Y. El-Dakar: Use of black pepper seeds as a growth enhancer for juvenile of Florida Hybrid Red Tilapia, <i>Oreochromis niloticus</i> (Linnaeus) X <i>Oreochromis mosambicus</i> (Peters)	T. Lyons: Development of a renewed land based aquaculture environmental management program for New Brunswick
16:50 - 17:10		TBD	
17:20	STUDENT AWARDS PRESENTATION		

Posters (Georgian Terrace), Authors in attendance: Tuesday, May 29, 2012 (4:30-6:00 PM)
Affiches (Georgian Terrace), Auteurs présents: Mardi 29 mai, 2011 (16h30-18h00)

- Anderson, D.** Nutrient digestibility of honeybees (*Apis mellifera*), house crickets (*Acheta domesticus*) and kelp meal fed to rainbow trout (*Oncorhynchus mykiss*).
- Chen, Z.** Digestibility of enzyme treated pre-pressed solvent extracted camelina meals by rainbow trout (*Oncorhynchus mykiss*).
- Comeau, L.** Winter quiescence and spring awakening of the Eastern oyster *Crassostrea virginica* at its northernmost distribution range.
- Del Bel Belluz, J.** Spatial and temporal optical characterization of the particulate plume dispersing from the fed components at an Integrated Multi-Trophic Aquaculture (IMTA) system in Kyuquot Sound, British Columbia

<u>Deschamps, M.H</u>	The effects of dietary P level on bone metabolism in rainbow trout (<i>Oncorhynchus mykiss</i>): development of new indicators to prevent vertebral abnormalities in fish farms.
<u>Diessner, C</u>	Practical use of google earth and landsat thematic mapper to detect and evaluate aquaculture change over time.
<u>Dubé, A.</u>	Characterization of waste generated by trout fed commercial feed currently used in Canada.
<u>Ellis, L.</u>	The effect of dissolved oxygen concentration on critical thermal maximum in triploid brook charr, <i>Salvelinus fontinalis</i> .
<u>Frederiksson, D.</u>	The potential for controlled harvest aquaculture of <i>Crassostrea virginica</i> in the Chesapeake Bay using an in-situ technique.
<u>Fry, J.</u>	Determination of safe doses of ozone to use for fish egg disinfection: the case of Atlantic cod (<i>Gadus morhua</i>).
<u>Lachance, A.</u>	Development of a new approach for holding farmed sea scallops in closed-system tanks.
<u>Le Luyer, J.</u>	Monitoring bone tissue specific whole-genome response to P-deprivation in rainbow trout (<i>Oncorhynchus mykiss</i>) vertebrae.
<u>Leavitt, N</u>	Metabolic response and scope for growth of the green sea urchin, <i>Strongylocentrotus droebachiensis</i> , fed Atlantic salmon faeces: inputs for modelling the deposit feeder niche in Integrated Multi-Trophic Aquaculture (IMTA) systems.
<u>McConnachie, S.</u>	Loma salmonae interactions between Blue Mussels (<i>Mytilus edulis</i>) and Rainbow Trout (<i>Oncorhynchus mykiss</i>) within Integrated Multitrophic Aquaculture Systems.
<u>Mohagheghi Samarin, A.</u>	<i>In vivo</i> and <i>in vitro</i> storage of Kutum, <i>Rutilus frisii kutum</i> eggs at various temperatures.
<u>Pace, S.</u>	The effect of temperature and feed ration on the apparent digestibility of sablefish (<i>Anoplopoma fimbria</i>) faeces.
<u>Power, J.</u>	Fisheries and Oceans Canada - Aquaculture Collaborative Research and Development Program.
<u>Poirier Stewart, N.</u>	Evolution of the mineralization of bone tissues in juvenile rainbow trout (<i>Oncorhynchus mykiss</i>).
<u>Rochus, C.</u>	Detecting family differences associated with resistance to the salmon louse (<i>Lepeophtheirus salmonis</i>) in Atlantic salmon.
<u>Sheibani, M.T.</u>	Development of pylorus and pyloric caecum in larval stages of <i>Acipenser stellatus</i> .

- Sheibani, M. T.** Microscopic structures of liver and pancreas in *Acipenser persicus*
- Sonier, R.** Fluorescence characterization of water entering and exiting a blue mussel (*Mytilus edulis*) aquaculture estuary.
- Vercaemer, B.** Monitoring for invasive tunicates and European green crab in Nova Scotia: 2010-2011.
- Wyatt, J.** The effect of extended holding time on the condition, physiology and stress response of cultured blue mussels (*Mytilus edulis* L. 1758) following commercial harvest during in northeastern Newfoundland

Opening and Welcome / Allocutions d'ouverture et de bienvenue
Monday May 28, 2012 – lundi 28 mai, 2012

8:00 AM – 9:15 AM

Location: Victorian Room

Chair: Tim Jackson, President, Aquaculture Association of Canada

Tim Jackson, President, Aquaculture Association of Canada

Gail Ryan, Executive Director, Aquaculture Association of Canada

Honourable Ron MacKinley, Minister of PEI Dept of Fisheries, Aquaculture and Rural Development

Dr. Don Reynolds, Atlantic Veterinary College, University of Prince Edward Island

Ms. Ann Worth, Executive Director, PEI Aquaculture Alliance

Mr. Rory Francis, Executive Director, PEI BioAlliance

Ms. Ruth Salmon, Executive Director, Canadian Aquaculture Industry Alliance

Fisheries and Oceans Canada representative

Keynote Speaker Session

Monday May 28, 2012 – lundi 28 mai, 2012

9:00 AM – 10:00 AM

Location: Victorian Room

Chair: Tim Jackson

Keynote Speaker: Dr. Brian Lee Crowley, Managing Director,
Macdonald-Laurier Institute



Presentation: Canada: Food Superpower or Also-Ran

Biography: Brian Lee Crowley has headed up the Macdonald-Laurier Institute (MLI) in Ottawa since its inception in March of 2010, and he has a long and distinguished record in the think tank world. He was the founder of the Atlantic Institute for Market Studies (AIMS) in Halifax, one of the country's leading regional think tanks. He is a former Salvatori Fellow at the Heritage Foundation in Washington DC and is a Senior Fellow at the Galen Institute in Washington. In addition, he advises several think tanks in Canada, France and Nigeria. Crowley has published numerous books, including two bestsellers: *Fearful Symmetry: the fall and rise of Canada's founding values* (2009) and MLI's first book, *The Canadian Century; Moving Out of America's Shadow*, which he co-authored with Jason Clemens and Niels Veldhuis.

Crowley has twice won the Sir Antony Fisher Award for excellence in think tank publications for his health care work and in 2011 accepted the award for a third time for MLI's book, *The Canadian Century*.

From 2006-08 Crowley was the Clifford Clark Visiting Economist with the federal Department of Finance. He has also headed the Atlantic Provinces Economic Council (APEC), and has taught politics, economics and philosophy at various universities in Canada and Europe.

Crowley is a frequent commentator on political and economic issues across all media. He holds degrees from McGill and the London School of Economics, including a doctorate in political economy from the latter.

Abstract: The agriculture and food sector (including aquaculture) is a potential economic powerhouse for Canada. More food will be consumed in the next fifty years than in the rest of human history. World food demand, population and incomes are all rising.

Yet the world's ability to respond to that growing demand is uncertain. If the planet cannot rise to this challenge, major food shortages and humanitarian disasters loom.

Canada has everything it needs to fill a major share of this food supply gap. And yet Canada is not merely failing to take advantage of these propitious circumstances, our ability to supply world markets is declining and our productivity on the farm is falling far behind that of our peers. In aquaculture other countries have often proven themselves more able to take advantage of our ideas than we have.

Look no further than outmoded government policy based on dated views of the agriculture/aquaculture/food industry for the chief explanation of this signal failure of imagination and energy.

The government that gets this will preside over a rural renaissance, an expansion of well-paying jobs, a rise in productivity and a transformation of the industry from dependent to wealth generator.

Plenary Session I / Session plénière

Monday, May 28, 2012 - lundi 28 mai 2012

2:00 PM – 2:40 PM

Location: Victorian Room

Chair: Larry Hammell

Speaker: Dr. Ian Gardner, Canada Excellence Research Chair (CERC) - Aquatic Epidemiology

Presentation: Standards for the design and reporting of validation studies for diagnostic assays used for detection of aquatic animal pathogens: are they needed?



Biography: Dr. Ian Gardner is the Canada Excellence Research Chair (CERC) in Aquatic Epidemiology, a position awarded by the Canadian Government to the University of Prince Edward Island (UPEI). The goal of the CERC program is to make UPEI and Canada the global leader in applied aquatic epidemiology research (with an ecosystem health focus). Dr. Gardner is part of a multi-disciplinary team of epidemiologists, statisticians, finfish, crustacean and mollusc clinicians, ecosystem health and regulatory veterinary medicine specialists whose work focuses on holistic approaches to assist the Canadian and international aquaculture industries improve the productivity, sustainability and health of farmed fish stocks. Prior to moving to Canada, Dr. Gardner was a Professor of Epidemiology at the University of California, Davis for 23 years. His research interests are diagnostic test evaluation, risk analysis and methods for certification of disease freedom. He has authored more than 200 peer-reviewed scientific publications and reports, many of which are focused on the evaluation and application of diagnostic tests for

animal diseases. Dr. Gardner obtained his veterinary degree at the University of Sydney in 1975 and completed post-graduate training (Master of Preventive Veterinary Medicine and PhD) at the University of California, Davis in 1988

Abstract: Accurate diagnostic tests are central to the detection, control and prevention of spread of pathogens in aquaculture, yet few tests have been adequately validated for routine diagnostic use. The World Organisation for Animal Health (OIE) specifies that tests in terrestrial and aquatic species should be validated as "fit for the intended purpose(s)". To support this recommendation, the OIE publishes guidance for researchers, diagnosticians and test-kit manufacturers interested in validating existing or novel tests with varying levels of scientific rigor. Estimation of diagnostic sensitivity and specificity based on field samples (with or without a reference standard) is a critical component of the validation pathway. Guidelines for diagnostic validation of quantitative PCR have recently been published (Purcell et al., J. Aq. Anim. Health 2011; 23: 148-161) for aquatic pathogens based on OIE principles. These guidelines are not overly prescriptive since multiple designs may be appropriate for the same intended purpose. The guidelines are readily adaptable to other organism and antibody detection tests.

Test kit manufacturers may also apply for OIE certification of tests by providing a dossier for review by a scientific panel. One test for white spot syndrome virus (IQ 2000 TM WSSV Detection & Prevention System, GeneReach Biotechnology Corp) in shrimp is certified (http://web.oie.int/VCDA/eng/en_vcda_registre.htm) but interestingly, no tests are certified for the 3 OIE-listed viral diseases of salmon (infectious salmon anemia (ISA), infectious haemopoietic necrosis, and viral haemorrhagic septicemia) or the other 6 listed diseases (epizootic haematopoietic necrosis, epizootic ulcerative syndrome, spring viraemia of carp, red sea bream iridoviral disease, koi herpes virus, and *Gyrodactylus salaris* infection).

The Standards for Reporting of Diagnostic Accuracy (STARD) statement (www.stard-statement.org) was published to encourage complete and transparent reporting of key elements of test accuracy studies in human medicine. The statement was motivated by widespread evidence of bias in test accuracy studies and the finding that incomplete or absence of reporting of items in the STARD checklist was associated with overly optimistic estimates of diagnostic sensitivity and specificity. The pragmatic goal of STARD is to avoid use of tests that don't improve health outcomes. Although STARD principles apply broadly to test validation studies in all species, specific guidelines do not exist to account for unique considerations in aquaculture such as cage/site tests based on multiple individual animals, potential use of experimental challenge studies, a diverse group of testing purposes and sampling designs, and the widespread lack of an ante-mortem reference standard with high sensitivity and specificity.

To assess how well tests have been validated for important fish diseases, recent validation studies published in peer-reviewed journals were evaluated according to the STARD 25-item check list for reporting quality and for design deficiencies that may have led to

overly optimistic estimates of test accuracy. Based on a Pubmed search of papers published in the last 5 years, 11 studies (9 for viral infections and 2 for parasitic infections) were identified that included validation involving field samples. Important deficiencies in reporting/design included failure to describe the purpose of the test, presentation of sensitivity and specificity estimates without confidence intervals, use of samples for validation that were unrepresentative of populations in which the tests are likely to be applied, and lack of head-to-head comparison of multiple tests for the same infectious agent using a common set of samples.

In conclusion, guidelines for reporting are needed to facilitate critical evaluation of the quality of primary test accuracy studies and ultimately meta-analysis. These guidelines would be helpful for authors submitting papers, and for reviewers and journal editors during the review process. This concept is novel even for terrestrial animal pathogens and to this author's knowledge, the only published guidelines paper involves tests for paratuberculosis (*Mycobacterium avium* subsp. *paratuberculosis*)

Plenary Session II / Session plénière

Tuesday, May 29, 2012 - mardi 29 mai 2012

9:45 AM – 10:30 AM

Location: Victorian Room

Chair: Rory Francis

Speaker: Dr. George Gunn, Chief Executive Officer Novartis Animal Health Division and Head of Corporate Social Responsibility, Novartis Corporation
Member of the Executive Committee of Novartis



Presentation:

Biography: George Gunn is Chief Executive Officer of Novartis Animal Health and Head of Corporate Social Responsibility for the Novartis Corporation, a role he took in April 2011. Prior to that he was Chief Executive Officer of the Novartis Consumer Health Division with responsibility for Novartis Animal Health, Novartis OTC (Over the Counter) and Ciba Vision. He took on the NCH role in 2008 and prior to that he held the role of Chief Executive Officer Novartis Animal Health, which he took on in 2004. He joined the company as Head of Novartis Animal Health US, Inc., and Region Head North America in 2003.

A veterinarian by education, Mr. Gunn has spent more than 25 years in Animal Health Industry. Prior to joining Novartis, he spent 3 years as President of Pharmacia Animal Health, Pharmacia Corporation's global animal health business.

Mr. Gunn joined Johnson & Johnson in 1986 and worked there until he moved to Pharmacia in 2000. Gunn began his career with Johnson & Johnson as Technical Manager Animal Health in the UK and went on to hold senior commercial positions in UK and Europe for Janssen Animal Health. He moved within Johnson & Johnson to work in senior management roles in Human Pharmaceuticals (Janssen and Janssen-Cilag), Consumer Health (Janssen, Janssen-Cilag), and Consumer Nutritionals (McNeil).

Prior to joining the industry, Mr. Gunn worked for 3 years as a veterinarian in General Practice and for 6 years as field veterinarian for UK Ministry of Agriculture.

Mr Gunn received the Pharmacia Chairman's Leadership award in 2002 and the Novartis Excellence award for Talent Development in 2007

Mr. Gunn holds the degree of Bachelor of Veterinary Medicine and Surgery and a Post Graduate Diploma in Veterinary State Medicine, both from the Royal Dick School of Veterinary Studies in Edinburgh, UK. He is also a Member of the Royal College of Veterinary Surgeons in the UK.

In 2008 Mr. Gunn received the Honorary Degree of Doctor of Veterinary Medicine and Surgery from the University of Edinburgh.

Plenary Session III / Session plénière

Wednesday, May 30, 2012 - mercredi 30 mai 2012

09:45 AM – 10:30 AM

Location: Victorian Room

Chair: Cyr Couturier

Speaker: Dr. Gary D. Marty, Fish Pathologist. Animal Health Centre. BC Ministry of Agriculture

Presentation: Communicating science – the pitfalls and need for transparency



Biography: Dr. Gary D. Marty is a board-certified veterinary pathologist with a master's degree in fisheries biology and a PhD. in comparative pathology. With nearly 50

publications in the peer-reviewed scientific literature, he has been researching the relation of disease and fish population health since the 1989 *Exxon Valdez* Oil Spill. Since 2004 he has served as the fish pathologist for the provincial veterinary diagnostic laboratory operated by the British Columbia Ministry of Agriculture, where he conducts disease investigations on farmed and wild fish species. Beginning in December 2010 with publication of a contrarian sea lice paper in the Proceedings of the National Academy of Sciences (PNAS), Dr. Marty has educated the public about current fish health issues using multiple media forms, including press releases, letters to the editor, written commentary, e-mail replies to direct enquiries (which often get posted on the Internet), and interviews for newspaper, radio, and television stories. Dr. Marty also has appointments as a research associate at the University of California, Davis, and as an affiliate professor at the School of Fisheries & Ocean Sciences, University of Alaska, Fairbanks.

Abstract: Most Canadian aquaculture occurs in public waters where shared use creates conflict. Aquaculture opponents effectively use science to exploit the public's fear of disease and population collapse in wild fish. However, the aquaculture industry can employ several strategies to decrease the problem of negative images of aquaculture. First, transparency overcomes fear of the unknown. Fear is a strong motivating emotion, but knowledge is power. When "Science" published that sea lice from fish farms would cause certain pink salmon population extinction, much of the public's fear was overcome when all farm sea lice data for the Broughton Archipelago were published with medical and mathematical analysis in PNAS. Second, avoid pitfalls by understanding and respecting the capability of your adversary. When the PCR-positive results for infectious salmon anaemia virus in wild sockeye salmon were announced in British Columbia, the "cataclysmic biological threat to life" was picked up by more than 300 media outlets, and concern about this "disease emergency" reached the U.S. Senate. And finally, communicate science by working in teams. Use all the resources you have. Public relations people benefit from help in explaining scientific details, while scientists and medical experts benefit from help to effectively communicate those details to the public.

Sessions and Abstracts – Aquaculture Canada^{OM} 2012

Fish Health

Monday, May 28, 2012 – lundi 28 mai, 2012

10:30 AM – 12:30 PM

Location: Victorian Room

Chairs: Jeff Davidson and Larry Hammell

10:30 L. Braden

Development of a skin injection model for studying local and systemic responses to *Lepeophtheirus salmonis* in salmon

10:50 S. Fordham

Sea Lice Library: Production of sea lice for research purposes

11:10 O. Igboeli

Involvement of P-glycoprotein in reduced efficacy of emamectin benzoate (SLICE®) in sea lice, *Lepeophtheirus salmonis*

11:30 J.A. Cooper

Dose-responses for non-target crustaceans based on semi-natural laboratory and field-based mesocosm exposures to chemo-therapeutants

11:50 D. Lewis

Effects of *Lepeophtheirus salmonis* secretions on salmon macrophages

12:10 L. Hammell

Supporting sea lice treatment monitoring: Decision support system, sea lice count training, and independent audit programs in New Brunswick

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

Development of a skin injection model for studying local and systemic responses to *Lepeophtheirus salmonis* in salmon

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Responses elicited in salmon skin during infection with *L. salmonis* result from attachment and feeding activities, including the secretion of compounds with anti-inflammatory properties. Our research explores host-specificity to *L. salmonis* by characterizing species-specific differences in skin responses. We have shown differential expression of defense-related genes in skin of resistant (pink salmon, *Oncorhynchus gorbuscha*) and susceptible hosts (chum salmon, *O. keta*; Atlantic salmon, *Salmo salar*) during infection with adult copepods¹. This report describes the development and feasibility of an injection model of *L. salmonis* infection. Local and systemic expression of genes was monitored following intradermal delivery of Atlantic salmon with dopamine-elicited *L. salmonis* secretions (SEP). Treatment groups included <3kDa, >3kDa, <300kDa and >300kDa SEP fractions, unfractionated SEPs, and an injection control. After 12, 24 and 48 hrs, injection site and non-injection site skin was sampled for RT-qPCR and histological assessments. Quantitative expression analysis was performed on genes associated with pathways of pro-inflammatory cytokines, arachidonic acid metabolism, tissue remodeling and acute-phase proteins (APPs). Utility of the intradermal injection model as a tool for understanding the salmonid response to *L. salmonis* infection will be discussed.

1. Braden, L.M., Barker, D.E., Koop, B.F., Jones, S.R.M. (2012). Comparative defense-associated responses in salmon skin elicited by the ectoparasite *Lepeophtheirus salmonis*. Comp. Biochem. Phys. D. doi: 10.1016/j.cbd.2011.12.002.

Sea Lice Library: Production of sea lice for research purposes

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Sea lice (*Lepeophtheirus salmonis*) is a copepodid ectoparasite of significant economic concern to the Atlantic salmon (*Salmon salar*) aquaculture sector in Canada. Sea lice are used in controlled laboratory settings to conduct research and have traditionally been obtained on a per experiment basis from marine aquaculture sites experiencing sea lice infestations. Obtaining suitable sea lice populations may be difficult as: 1) sea lice should

be obtained from marine sites where salmon have not been recently medicated or where adjacent marine sites have not been treated; 2) sea lice populations from a collection site may be tolerant to a specific type of treatment and this may affect results of laboratory testing; 3) access to a marine site on a timely basis for collection is sometimes problematic as a result of commercial workloads and activities; and 4) inclement weather conditions can result in difficulty obtaining sea lice which may increase the mortality of sea lice. The Huntsman Marine Science Centre is producing sea lice populations originating from various marine aquaculture sites under controlled laboratory conditions to increase access to sea lice populations for industry-wide experimentation. Results from the Sea Lice Library (comparison of infection rates and infection conditions) will be discussed.

Involvement of P-glycoprotein in reduced efficacy of emamectin benzoate (SLICE®) in sea lice, *Lepeophtheirus salmonis*

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Lepeophtheirus salmonis control in salmon farms relies heavily on chemotherapeutants and this has led to widespread resistance development. There are reports of reduced sensitivity to the macrocyclic lactone (ML) emamectin benzoate (EMB; SLICE®), a major sea lice therapeutant. P-glycoprotein (P-gp), a multidrug transporter, has been linked to ML resistance in arthropods and nematodes. The present study investigated interaction of EMB with P-gp, effect of increasing EMB concentrations on P-gp mRNA expression in sea lice from salmon farms in New Brunswick, as well as changes in the mRNA expression of the transporter in archived adult female *L. salmonis*. Analysis of bioassay results indicated a 4 to 26 fold higher EMB EC₅₀ for samples collected in 2011 compared to a similar study done between 2002 and 2004. An assay for ATPase activity as well as a competitive inhibition test showed that EMB interacts with the transporter. Emamectin benzoate had a significant concentration-dependent effect on P-gp mRNA expression in the parasite. There was increasing expression of P-gp mRNA in sea lice samples collected from 2002 to 2011. Our results suggest that EMB is a substrate for P-gp and that the transporter could be involved in reduced efficacy of the parasiticide in *L. salmonis*.

Dose-responses for non-target crustaceans based on semi-natural laboratory and field-based mesocosm exposures to chemo-therapeutants.

J.A. Cooper¹, L. Burrige¹, and S. Robinson¹

¹. St. Andrews Biological Station, Fisheries and Oceans Canada, St. Andrews, NB E5B 2L9

Population explosions of parasitic sea louse, *Lepeophtheirus salmonis*, around salmon farms in the Bay of Fundy have resulted in huge economic losses for the salmon industry and a response which has involved the release of chemical pesticides into the ecosystem. However, the effects of such therapeutants are not species specific and both lethal and sublethal effects are possible on non-target crustacean species. One of the major technical problems in understanding the risk to the natural ecosystem is that environmental conditions may alter our understanding of pesticide lethality which is normally measured under highly controlled laboratory conditions. Availability and lethality to non-target organisms based on various substrates and water conditions is not well understood and may obscure our interpretation of the lab-based exposure concentrations. A mesocosm approach to investigating this potential effect aims to refine our traditional methods of ecotoxicological risk assessment. This project is designed to measure the effects of natural sea water and sediments on the dose-response in non-target crustaceans such as lobster and mysid shrimp. This approach can compare laboratory against *in situ* exposures so as to offer an improved understanding of the risks to non-target species in the natural environment.

Effects of *Lepeophtheirus salmonis* secretions on salmon macrophages

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It has been shown that the salmon louse, *Lepeophtheirus salmonis*, produces secretions that contain pharmacologically active substances (i.e. prostaglandin E₂ and trypsin-like proteases) while feeding on a salmon host. The presence of these substances has been shown to impair the genetic expression of inflammatory mediators in the salmon head kidney cell line (SHK-1); however, any effect on the functionality of those cells was not explored. Salmon species (*Oncorhynchus* spp. and *Salmo salar*) exhibit differences in *L. salmonis* infection rates and threshold tolerances, which is partially related to the development of an inflammatory response. The aim of this research is to determine if the presence of secretions isolated from *L. salmonis* impair the cellular immune response in salmonid hosts. First, using SHK-1 cells, phagocytosis assays were performed with the

bacterial pathogen *Aeromonas salmonicida* in the presence/absence of *L. salmonis* secretions. Second, these assays were repeated using macrophages isolated from several salmon species. Initial results suggest that *L. salmonis* secretions increase the association of *A. salmonicida* with SHK-1 cells. Additionally, effects on phagocytosis were more significant when cells were exposed to non-viable bacteria in the presence of secretions. Modification of the cellular immune response by *L. salmonis* secretions implies that the copepod has the potential to serve as a vector of pathogenic bacteria.

Supporting sea lice treatment monitoring: Decision support system, sea lice count training, and independent audit programs in New Brunswick

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As resistance emerged to emamectin benzoate, the New Brunswick salmon farming industry needed to access other treatment options. Permission to use these products has obligatory reporting requirements that include on-going summaries describing historical and recent treatment events and their impacts on sea lice trends. To facilitate the assimilation of data in a credible fashion, a third-party, independent system (referred to as the Decision Support System, DSS) was established to accept data inputted by the farmers on a weekly (routine lice counts) or event (treatment applications) basis and generate standardized summaries of lice burdens across all sites and regions of New Brunswick and to evaluate responses to bath treatments. Training sessions were provided to site workers to improve the precision of their counts that were being submitted to the DSS. In addition, third-party audits were performed at 70% of active sites to evaluate the agreement between an independent lice count and the site lice count. General trends in treatment responses, lice dynamics, and audit performance will be discussed.

Coastal and Marine Spatial Planning

AND

Bio Economics

Monday, May 28, 2012 – lundi 28 mai, 2012

10:30 AM – 12:30 PM

Location: Georgian Ballroom

Chairs: Marc Ouellette and Thomas Landry

10:30 J. Dupuis

Replacement class screening report for oyster aquaculture activities in eastern New Brunswick

10:50 R. Filgueira

Paving the way for the integration of ecosystem modelling into marine spatial planning

11:10 M. Ouellette

Ecosystem-based risk management applied in coastal spatial planning

11:30 J.D.P. Davidson

The efficacy and bio-economics of various high pressure water treatment regimes on mussel productivity

11:50 S. Cross

12:10 G. Flimlin

Investigating alternative markets for cultured shellfish

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

Replacement class screening report for oyster aquaculture activities in eastern New Brunswick

J. Dupuis*¹

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Any “work” built or placed in any navigable waterway in Canada requires a *Navigable Waters Protection Act* (NWPA) authorization. Growing structures used on aquaculture sites are considered “works” under the NWPA. The NWPA is included on the *Law List Regulations* of the *Canadian Environmental Assessment Act*; therefore, an environmental assessment is required before Transport Canada (TC) can approve the proposed site under the NWPA.

Previously, each application was subject to a separate EA. In order to facilitate the assessment of the applications for oyster culture and over-wintering sites, TC in collaboration with DFO, and the New Brunswick Department of Agriculture, Aquaculture and Fisheries, has developed two Replacement Class Screening Reports (RCSR).

A RCSR consists of a report that defines the class of projects and describes the associated environmental effects, design standards, and mitigation measures. It includes a conclusion of the significance of the environmental effects of all projects assessed by the RCSR. No project-specific information or further EA is required for projects in the class, provided that the design standards and mitigation measures described in the RCSR are implemented. The two existing RCSRs are currently being reviewed and they will be merged into one report in the fall of 2012.

Paving the way for the integration of ecosystem modelling into marine spatial planning

R. Filgueira and J. Grant

The production of food at aquaculture sites is a valuable ecosystem service provided by coastal zones. The pressure of this activity can compromise the sustainability of the ecosystem and consequently the production of ecosystem services. Maintenance of ecosystem functioning to provide the services humans want and need is the goal of Ecosystem-Based Management (EBM). A practical tool towards EBM in coastal zones is Coastal and Marine Spatial Planning (CMSP). CMSP requires understanding of coastal ecosystems and their interaction with the socio-economic system. This task can be addressed with ecosystem models, which can simulate system organization, function and change. The possibility of modelling alternative aquaculture scenarios constitutes a

critical aspect for management purposes. Therefore, ecosystem modelling can generate understanding, evaluate and propose different management strategies that can feed CMSP processes. However, the integration of ecosystem modelling into CMSP is not a straightforward process and the following challenges must be solved:

- *Which spatial scale and resolution are most appropriate?*
- *How can dynamic information be integrated into static layers?*
- *What is the compromise between complexity and uncertainty?*

The need to incorporate scientific knowledge into policy-making and management calls for a smooth integration of ecosystem modelling into CMSP.

Ecosystem-based risk management applied in coastal spatial planning

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The coastal zone is an area of high ecological complexity and productivity given its intrinsic connectivity between habitats and processes of terrestrial, freshwater and marine ecosystems. It is also an area of complex anthropogenic interactions with variable social, economical and cultural values. Furthermore, it is often where aquatic ecosystems are the most vulnerable to cumulative environmental effects caused by human activities, of various types and intensity, and where management lies within a complex jurisdictional backdrop. The sustainability of coastal aquaculture and fishing activities requires that we succeed in considering all these elements. Given this context, the task seems formidable, but it is possible and it is critical that we do it strategically and efficiently.

Fisheries and Oceans Canada is currently in the process of developing an ecosystem-based risk management approach, in relation to cumulative environmental effects, to assist decision-making processes. By incorporating the risk analysis principles to marine spatial planning, it becomes possible to operationalize ecosystem-based management that finds space for both ecosystem integrity conservation and sustainable economic development in aquatic environments. A case study will be presented in the context of shellfish aquaculture in order to demonstrate the use of this approach in promoting efficient Integrated Coastal Zone Management.

The efficacy and bio-economics of various high pressure water treatment regimes on mussel productivity

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Successful management of aquatic invasive tunicates has become a critical component in the maintenance of mussel aquaculture. Over the past thirteen years, four exotic tunicate species (*Styela clava*, *Botryllus schlosseri*, *Botrylloides violaceus*, and *Ciona intestinalis*) have been detected in the waters surrounding Prince Edward Island, Canada. The species have rapidly become invasive and are now considered serious nuisance species by acting as fouling organisms. The mussel aquaculture industry has been the most significantly affected by *C. intestinalis*. Working with industry we conducted a clinical field trial to determine the optimal regime to treat mussel socks with high pressure water, the treatment of choice for mitigating *C. intestinalis* on Prince Edward Island. Biologically, the optimal regime results in the greatest reduction of *C.intestinalis* and the highest yield of mussels on the socks. A cost-benefit analysis was conducted on each treatment regime to determine the most economical treatment regime for the mussel industry.

Key Words: *Ciona intestinalis*, tunicates, treatment regimes, mussels, economics

Investigating alternative markets for cultured shellfish

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As shellfish aquaculture grows along the coastal regions, often overshadowing wild harvests, the markets for these cultured clams, oysters and mussels can become quite competitive. Analyzing the issues that impede increased prices and market expansion is a process that can be undertaken to clarify what specific roadblocks exist. Often the impediments are clear, but finding solutions to these may be the crucial point. Most often local growers see each other as the competition, but in most cases the real competition comes from growers or product from other places, as well as other center of the plate protein sources.

Evaluating all the problems, grouping them into similar issues, then building a problem statement is the start of defining how to address those issues.

Potential alternatives for markets may be product branding, value added processing, local direct distribution, farmers' markets, Community Supported Agricultural farms or Community Supported Fisheries, or the formation of growers' cooperatives. All function differently but can be used to expand current markets.

Reproductive Containment and Genetics and Selective Breeding

Monday, May 28, 2012 – lundi 28 mai, 2012

10:30 AM – 12:30 PM

Location: Provinces Lounge

Chairs: Tillmann Benfey and Steve Armstrong

10:30 T.J. Benfey

The use of female triploidy for reproductive containment of farmed Atlantic cod

10:50 D.A. Plouffe

Reproductive confinement for the safe cultivation of genetically improved lines of Atlantic salmon

11:10 S. Tibbetts

An overview of a collaborative project to develop optimized diets for culture of triploid growth-hormone transgenic Atlantic salmon (*Salmo salar*)

11:30 Q. Xu

Family-specific differences in growth rate and hepatic gene expression in triploid growth hormone (GH) transgenic Atlantic salmon (*Salmo salar*)

11:50 C.Y. Feng

Family differences in growth hormone transgenic Atlantic salmon hepatic transcriptome responses to triploidization

12:10 T.S. Hori

Immunogenomics research and Mx1 transcript expression analyses in spleen of diploid and triploid growth hormone transgenic Atlantic salmon

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

The use of female triploidy for reproductive containment of farmed Atlantic cod

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High rates of pre-harvest sexual maturation and a propensity for within-cage spawning point to a need for preventing sexual maturation of farmed cod. This has been achieved in other species by using female triploids. This presentation will summarize two parallel projects that focused on (1) developing cod broodstock capable of generating all-female offspring and (2) evaluating female triploidy as a tool for ensuring reproductive sterility in this species. Diploid gynogens (i.e., fish having solely maternal inheritance) were invariably female, demonstrating female homogamety and meaning that all-female populations can be produced by crossing normal females with functionally masculinized females ('neomales'). All-male populations were produced by feeding androgen during early sexual differentiation; these fish are currently being reared to maturity in order to determine which ones are normal males and which are neomales. Triploid cod were produced by subjected eggs to pressure treatment following normal fertilization. Triploid males produced functional sperm and were able to fertilize eggs both *in vitro* and *in vivo*. Triploid females, on the other hand, had greatly diminished ovarian growth up to and beyond the age and size of sexual maturity in diploids. This confirms female triploidy as an effective tool for eliminating sexual maturation in farmed cod.

Reproductive confinement for the safe cultivation of genetically improved lines of Atlantic Salmon

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Growth performance is an important factor in determining the economic success of aquaculture operations. Because of their economic value as an aquaculture species, Atlantic salmon have been the subject of genetic improvement programs, including traditional phenotypic selection as well as modern genetic approaches such transgenesis. Since the improved strains have a unique phenotype/genotype relative to the wild-type strains from which they are derived, there is keen interest in employing reproductive sterility as a form of biological containment. In salmon, induction of triploidy is currently the most effective way to achieve sterility on a commercial scale; however, reports on the

performance of triploid salmon have been variable and therefore it has not been widely adopted by the industry. AquaBounty has undertaken a comprehensive project that aims to generate technology and lines of salmon allowing the culture of triploid, reproductively sterile Atlantic salmon with performance equivalent to, or better than, fertile diploid siblings. Preliminary project results evaluating commercially improved and growth-hormone transgenic lines of Atlantic salmon suggest a family response to triploidy in which some families are predisposed to better performance in culture. These early data support the re-evaluation and optimization of the use of triploid fish for the salmon aquaculture industry.

An overview of a collaborative project to develop optimized diets for culture of triploid growth-hormone transgenic Atlantic salmon (*Salmo salar*)

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³Centre for Aquaculture Technologies, San Diego, CA, USA

There is growing interest in growth-hormone transgenesis (TG) and triploidy (TRIP) in salmon aquaculture to shorten production cycles using fast-growing, reproductively sterile animals. Since triploidy alters physiology of fish and TG salmon have significantly enhanced growth rates, it is likely that feed formulations for conventional non-transgenic (NTG), diploid (DIP) culture may not be suitable. It is possible that traditional formulations may not provide TG/TRIP fish with sufficient macronutrients to sustain rapid growth and dietary micronutrient levels may require adjustment to reduce possible skeletal irregularities associated with triploidy. Evidence suggests that TG/TRIP fish may utilize dietary nutrients more efficiently, providing an opportunity to reduce feedcosts and improve the economics and ecological sustainability of salmon culture. This presentation will review a collaborative project conducted between industry and government to characterize and improve growth performance and nutrient utilization of TG and NTG TRIP salmon. Several studies are in various stages of completion focussing on several life stages; including first-feeding fry (<30 g), juveniles (30-300g) and large fish (up to 1 kg). These studies will provide information to help determine if diets for conventional NTG/DIP salmon are suitable for reproductively sterile fish and where further improvements may be required. Preliminary results will be presented.

Family-specific differences in growth rate and hepatic gene expression in triploid growth hormone (GH) transgenic Atlantic salmon (*Salmo salar*)

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Growth hormone transgenic Atlantic salmon (GHTg) have enhanced growth when compared to their non-transgenic counterparts; a trait that is beneficial for aquaculture production. Biological containment of GHTg can be achieved by inducing triploidy (3nGHTg). However, little is known about the growth performance of triploid salmon relative to their diploid siblings and the growth rates of 3nGHTg Atlantic salmon was found to vary between families in a breeding program. To identify correlates of enhanced growth in 3nGHTg salmon we used microarrays and QPCR to identify and validate liver transcripts that were reproducibly differentially expressed between two fast-growing 3nGHTg families (AS11 and AS26) and one slow-growing 3nGHTg family (AS25). Of 687 informative microarray features identified, 40 (39 associated with fast growth and 1 associated with slow growth) were present in both AS11 vs. AS25 and AS26 vs. AS25 comparisons. QPCR results validated the microarray results for 12 of 15 growth-associated transcripts, including APOAI, APOAIV, B2M, D5DP, and GAPDH; all having functional annotations related to metabolism and immune- or stress-related responses. We have identified candidate genes and pathways associated with enhanced growth that may lead to the development of molecular markers for the selection of GHTg broodstock producing rapidly growing 3nGHTg families.

Family differences in growth hormone transgenic Atlantic salmon hepatic transcriptome responses to triploidization

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Triploidization is an effective measure to ensure biological containment of genetically improved aquaculture species. We used 3 diploid families (AS11, AS25, and AS29) of growth hormone (GH) transgenic Atlantic salmon and their triploid counterparts to study the effects of triploidization on somatic growth rate and the constitutive hepatic transcriptome. The analysis of growth performance data revealed distinct, family-specific phenotypic responses to triploidization; we detected enhanced (family AS11), depressed

(family AS29), or unaffected (family AS25) growth-rate in triploid (3n) individuals from specific families when compared to their diploid (2n) siblings. The family-specific, hepatic transcriptome responses to triploidization in these fish were studied using the 32K cGRASP cDNA microarray and QPCR. Based on the triploidization-responsive features identified by family-specific microarray comparisons, different hepatic transcriptome responses were evident in AS29 (566 informative features greater than 2-fold differentially expressed between 2n and 3n), AS11 (131 informative features), and AS25 (35 informative features). The QPCR analysis confirmed the microarray results (in at least direction of change) for 19 of 23 microarray-identified transcripts (including APOAI, B2M, and VTG) using individual samples as template. For the first time in vertebrates, our functional genomics results demonstrated variable transcriptomic response to polyploidy in different families.

Immunogenomics research and Mx1 transcript expression analyses in spleen of diploid and triploid growth hormone transgenic Atlantic salmon

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Induction of triploidy to achieve reproductive sterilization is a viable way of achieving biological containment of Atlantic salmon with improved genetics. However, it is not clear how triploidization may impact the ability of the animals to mount an effective immune response. Here we report on a functional genomics approach, involving the use of 4 X 44K Atlantic salmon oligonucleotide microarrays, to characterize the spleen transcriptome response of growth hormone transgenic (GHTg) diploid (2n) and triploid (3n) Atlantic salmon to intraperitoneal (IP) injection with the viral mimic polyriboinosinic polyribocytidylic (pIC). The microarray results showed that Mx1 mRNA was highly responsive to pIC at 24 hours post-injection in both 2n and 3n fish; therefore, Mx1 was selected for subsequent QPCR-based analysis. We used QPCR to study Mx1 transcript expression in nine families of 2n GHTg salmon and their 3n counterparts before, and 24 h after, IP injection with pIC. We found no significant overall or family-specific impacts of triploidization on Mx1 mRNA expression following pIC injection. These results suggest that, at the level of Mx1 transcription, there is no significant depression of the innate anti-viral immune response in the spleen of 3n GHTg Atlantic salmon when compared to their diploid full siblings.

Fish Health (continued)

Monday, May 28, 2012 – lundi 28 mai, 2012

14:45 PM – 17:30 PM

Location: Victorian Room

Chairs: Jeff Davidson and Larry Hammell

14:45 S.M.C. Robinson

Studying the early life-history of sea lice in the Bay of Fundy for the purpose of developing alternative strategies to reduce epidemic-level infestations

15:05 C. Novak

Lepeophtheirus salmonis (Caligidae) as a vector of *Aeromonas salmonicida*

15:25 E. Rees

Spatio-temporal analysis of sea lice infection in wild salmon, British Columbia, Canada

15:45 M. Laflamme

Transcriptional response of Atlantic salmon after primary versus secondary exposure to infectious salmon anemia virus

16:05 HEALTH BREAK

16:30 T. Renault

Increased mortality outbreaks of French Pacific oysters *Crassostrea gigas* since 2008 in Europe: pathogen detection, control measures and mitigation

16:50 D. Huyben

The evaluation of submerged membrane filtration as an alternative to UV disinfection and its ability to remove *Flavobacterium psychrophilum* from recirculation aquaculture systems

17:10 T.T. George

An unprecedented Incidence of tilapia mass mortality due to *Streptococcus inae* infection in the White Nile at Jebel Aulia Dam Reservoir, Khartoum, Sudan.

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

Studying the early life-history of sea lice in the Bay of Fundy for the purpose of developing alternative strategies to reduce epidemic-level infestations

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The amplification of sea lice (*Lepeophtheirus salmonis*) in conjunction with Atlantic salmon farming has been a continuing international problem. Our program is investigating the early life history characteristics of sea lice in the Bay of Fundy to find potential stages where the lifecycle may be short-circuited to reduce population numbers. Results in the early fall indicated that significantly more sea lice larvae were found near active farm sites than reference areas. Trends during the day show these larvae were distributed in both the top and bottom waters around a shallow water (30 m) salmon site. Experiments in the lab using a 2 m settling column indicated that individual egg strings settled at a rate of 1.0 cm/s while egg strings attached to dead gravid females settled at a velocity of 1.9 cm/s. The eggs were observed to successfully hatch in lab conditions on muddy sediments. Based on typical inshore depths and currents where fish farming occurred and the 2 settling velocities, we estimated egg dispersal distances of 160-300 m. Observed swimming speeds suggested the larvae could swim to the surface within 1 to 3 hours. The implications of this research suggest there may be an infection cycle created within the near-field regions of the site itself and therefore, solutions may be devised to work within that spatial scale.

Lepeophtheirus salmonis* (Caligidae) as a vector of *Aeromonas salmonicida

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The sea louse, *Lepeophtheirus salmonis*, has been hypothesized to be a vector of fish pathogens. Previous studies have isolated bacterial pathogens (*Tenacibaculum maritimum* and *Aeromonas salmonicida*) from *L. salmonis* parasitizing clinically diseased fish. Two fish disease challenges tested whether *L. salmonis* could be a vector of *A. salmonicida* to naïve Atlantic salmon (*Salmo salar*). In the challenges, bacteria-contaminated sea lice obtained from *A. salmonicida*-injected salmon were allocated among naïve salmon for 14

days. Two hypotheses were examined: (i) *L. salmonis* can transfer *A. salmonicida* from ip-injected salmon to naïve salmon and (ii) *L. salmonis* and *A. salmonicida* synergistically impact fish health (measured via condition factor). Challenge 1 (~44g fish) demonstrated a successful vector (sea lice) to host (salmon) bacterial transfer with 71% fish infection and 54% fish mortality. Conversely, challenge 2 (~155g fish) showed no vector transfer. Furthermore, the mean fish condition factor in both challenges decreased after sea lice carrying *A. salmonicida* were introduced, but it was only in challenge 1 that a significant decrease ($t=4.12$, $df=23$, $P<0.001$) was observed. Thus, *L. salmonis* can act as a vector of *A. salmonicida* and infect young Atlantic salmon post-smolts (~44g) leading to significantly reduced fish health and mortalities within 14 days.

Spatio-temporal analysis of sea lice infection in wild salmon, British Columbia, Canada

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British Columbia is one of few places in the world where Atlantic salmon are farmed in waters that provide habitat for large populations of wild salmon. Both the wild and farmed populations in this region are susceptible to infection by sea lice. Given the decline in wild populations over the last few decades in other regions, an active area of research is in assessing whether sea lice infestation on farmed salmon negatively impact wild salmon populations. This paper presents a spatio-temporal analysis of an unprecedented wild salmon dataset. Over 140,000 wild salmon were captured by beach seine net in the Broughton Archipelago during the spring and summer of 2003 to 2009 and assessed for characteristics of salmon and sea lice. We used a multivariable regression analysis to determine spatio-temporal factors affecting the proportion of wild salmon infected with sea lice, per sampling instance, given salmon species and size, and sampling date and location. Our results indicate that the proportion of fish infected with sea lice was greater in catches with a higher proportion of chum salmon. Sea lice infection was greater in 2004, and when fish were sampled in late spring. Furthermore, there were strong spatial trends in the data indicating that fish sampled in some sites were more likely to be infected than in other sites. This work provides a baseline for identifying spatio-temporal patterns in this historic data, which will support more comprehensive analyses of associated risk factors.

Transcriptional response of Atlantic salmon after primary versus secondary exposure to infectious salmon anemia virus

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Following an infection with a specific pathogen, the acquired immune system in many organisms retains a specific memory of the infectious agent, and thus protects itself from subsequent infections. For example, Atlantic salmon that have survived an infection with a low-virulence infectious salmon anemia virus (ISAV) isolate are less susceptible to subsequent ISAV infections. A greater understanding of the mechanisms and immunological components involved in this acquired protection against ISAV is fundamental for the development of efficacious vaccines and treatments against this pathogen. To better understand the components involved in this phenomenon, we have used an Atlantic salmon DNA microarray to study the global gene expression responses of Atlantic salmon that had survived an infection with a low-virulence ISAV isolate, during the course of a secondary infection, 18 months later, with a high-virulence ISAV isolate. Our results show a clear reduction of ISAV viral loads in head-kidney of secondarily infected fish compared to primary infected fish. Further, we note a lower-expression of many antiviral innate immunity genes in the secondarily infected fish, suggesting that the acquired system was immediately activated. These results provide great insight into immunity components involved during primary and secondary ISAV infection.

Increased mortality outbreaks of French Pacific oysters *Crassostrea gigas* since 2008 in Europe: pathogen detection, control measures and mitigation

T. Renault

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Increased mortality outbreaks occurred in the majority of Pacific cupped oyster (*Crassostrea gigas*) producing areas in France since 2008. These outbreaks were usually sudden and severe (40 to 80%) and affected essentially spat (oysters less than 1 year-old) and juveniles (12 to 18 month-old oysters). *Crassostrea gigas* was the single affected species. Mortality outbreaks were first observed in April/May. All oyster production sites

were affected. Increased mortality outbreaks among *C. gigas* spat were also reported in Ireland and UK.

Reported cases of increased mortality have been investigated with to check the presence of notifiable diseases, endemic pathogens or emerging ones. Results of diagnostic tests in France as those obtained in other Members States indicated that (1) there was no officially notifiable pathogen involved, (2) OsHV-1 was detected in most of samples especially in moribund oysters, (3) bacteria belonging to the *Vibrio splendidus* group were also detected in affected oysters.

As a main result, it appears that mortality events in France, the Republic of Ireland and the UK reported since 2008 were associated with OsHV-1 DNA detection. Moreover, increased mortality outbreaks were associated with the detection of a particular genotype called OsHV-1 μ Var. Several differences in ORF4 and ORF43 are characteristic of this variant when compared with the reference OsHV-1 genome (GenBank accession n° AY509523). Although both OsHV-1 genotypes were detected in association with mortality outbreaks in 2008 in France, OsHV-1 μ Var was mainly detected in since 2009. These results raise questions about the emergence and the virulence of OsHV-1 μ Var genotype.

In Pacific cupped oysters most of the infectious diseases are not currently notifiable diseases subjected to specific control measures under EU or WOAHP legislation. However, in the context of recently reported increased mortalities in *Crassostrea gigas* oysters, the European Commission assumed that Members States were facing an emerging disease situation and that measures to control this emerging disease situation should not only be taken by the Member States currently affected by the increased mortalities, but opportunities should also be provided for to allow other Member States not affected to protect their population of *C. gigas* oysters. The European Commission decided thus to implement the Council Directive 2006/88/EC through a commission regulation (Regulation EU N°175/2010) consisting of specific measures to control increased mortality in *C. gigas* oysters in connection with the detection of OsHV-1 μ Var.

In addition to surveillance and transfer controls, oyster farmers are seeking practical measures which they can rely upon and adopt. Selective breeding of oysters stocks less susceptible to massive mortality outbreaks appears to be one of the most promising approaches. In France, different ways have been tested. As the first emergency solution, families of Pacific oysters produced during the course of a previous research programme (MOREST, 2001-2006) and less susceptible to summer mortality outbreaks have been used to produce spat of interest (Plan de sauvegarde). Commercial hatcheries have also undertaken breeding programmes in order to produce more resistant animals. Finally, a project mainly funded by the French ministry of agriculture (SCORE) aims to place resistant strains in strategic locations in the field in order to promote resistance in the wild populations.

The evaluation of submerged membrane filtration as an alternative to UV disinfection and its ability to remove *Flavobacterium psychrophilum* from recirculation aquaculture systems

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Recirculation aquaculture systems (RAS) utilize wastewater disinfection treatments, such as UV, to reduce the amount of pathogens to which cultured fish are exposed. However, *Flavobacterium psychrophilum*, the causative agent of bacterial cold water disease (BCWD), is able to tolerate UV doses commonly used in aquaculture. Membrane filtration is a common solids and pathogen removal treatment in many industries and may be an alternative technology to UV disinfection. Membrane filtration was evaluated for 30 days in parallel with UV treatment within a RAS rearing Nile tilapia (*Oreochromis niloticus*) at the Alma Aquaculture Research Station. Its performance was evaluated on the basis of membrane fouling rate and removal efficiencies of total aerobic bacteria, total suspended solids (TSS), and other wastewater parameters. The results showed that the membrane filter exhibited low rates of fouling and removed 95.4% of TSS. The bacteria removal efficiency between the two systems was very similar, achieving 98.6% removal for membrane filtration compared to 99.6% for UV. In addition, a challenge test was performed on the membrane filtration system to determine its removal efficiency of *F. psychrophilum*. Thus, based on this study, membrane filtration represents an effective alternate to UV disinfection and could be used for the specific removal of *F. psychrophilum* from RAS.

An unprecedented Incidence of tilapia mass mortality due to *Streptococcus iniae* infection in the White Nile at Jebel Aulia Dam Reservoir, Khartoum, Sudan.

T.T. George

Global Aquaculture Consultants, Toronto, Canada / Al Neelain University, Khartoum, Sudan. (email: profttg@yahoo.ca)

Mass mortality of only tilapia species (25-700 grams) occurred in the reservoir and beyond the Jebel Aulia Dam for 40 km, a week after 60,000 live tilapia fingerlings, crowded in fibreglass tanks, were transported and released at Jebel Aulia Dam Reservoir without following the technological procedures of transporting live fish. Laboratory analysis and examination showed no harmful effects due to pesticides or heavy metals but, high levels of bacteria. This paper reports the details of this unprecedented incidence and what should be undertaken to avoid such ecological catastrophe in the future.

Integrated Multi - Trophic Aquaculture

Monday, May 28, 2012 – lundi 28 mai, 2012

14:45 PM – 17:30 PM

Location: Georgian Ballroom

Chair: Gregor Reid

14:45 C. Chianale

The red alga, *Palmaria palmata*, as a summer/fall candidate for increased biomitigative performance of the Integrated Multi-Trophic Aquaculture (IMTA) system in the Bay of Fundy, Canada

15:05 **H. Khoda Bakhsh**

A variation on the IMTA theme for land-based, freshwater aquaculture operations: aquaponics

15:25 L. Orr

Quantifying the capture and conversion efficiencies of species being considered for organic extraction in open-water IMTA systems on the West Coast

15:45 **D. Morse**

A pilot project to stimulate seaweed production on mussel farms in Maine.

16:05 **HEALTH BREAK**

16:30 **S.M.C. Robinson**

Seasonal trends in blue mussel (*Mytilus edulis*) somatic composition as a reflection of quality and traceability in Integrated Multi Trophic Aquaculture (IMTA) systems

16:50 J.A. Manriquez-Hernandez

Effect of light intensity on performance of red seaweed cultivated at high stocking density

17:10 J. Day

Establishing relationships to investigate the far-field effects on wild species of aquaculture nutrient plumes using biological and biochemical indicators.

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

The red alga, *Palmaria palmata*, as a summer/fall candidate for increased biomitigative performance of the Integrated Multi-Trophic Aquaculture (IMTA) system in the Bay of Fundy, Canada.

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The inorganic extractive component of the Integrated Multi-Trophic Aquaculture (IMTA) system in the Bay of Fundy has, so far, been two kelps, *Saccharina latissima* and *Alaria esculenta*, cultivated at the sites from late fall to early summer. For year round inorganic biomitigation, a different species, which grows well during summer/fall, is needed. The selected candidate is *Palmaria palmata* (dulse), naturally abundant during the summer and already having a market as an edible seaweed. Its life cycle is complicated (dwarf female gametophytes) and, despite the ancestral use of this seaweed, it was, paradoxically, only elucidated recently (1980); little is known about the occurrence of its different phases in nature, especially during fall and winter. Recruitment has been monitored on the shore with twines mounted on frames as substrates. Cross sections of tissues, holdfasts and sori were made to identify reproductive stages. The timing of the occurrence of male gametophytes and tetrasporophytes has been recorded. By varying desiccation time, darkness and seawater temperature, massive release of spermatia and tetraspores have been obtained; however, success has a seasonality component. We are presently defining the laboratory culture conditions and methods for the different phases of *P. palmata* before their transfer to IMTA sites.

A variation on the IMTA theme for land-based, freshwater aquaculture operations: aquaponics

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The concept of Integrated Multi-Trophic Aquaculture (IMTA) can be applied to open-water or land-based, marine or freshwater, and temperate or tropical systems. One of its variations is aquaponics, which is the combination of animal aquaculture with plant

hydroponic cultivation. In such systems, effluents become nutrients for the plants instead of accumulating and becoming toxic for the fish or being released downstream from the operation. An innovative tank design, combined with Nutrient Film Technique (NFT), was used to investigate the effects of feed pellets, enriched with an organic-inorganic mixture, on the growth performance of tilapia (*Oreochromis* sp.) and lettuce (*Lactuca sativa*) raised in a tropical environment in Malaysia. At the end of the experiment, the most efficient formulated diet, for both fish and plants, was the diet containing 30% of the organic-inorganic mixture. We are now investigating the potential for developing aquaponic systems for the salmon (*Salmo salar*) land-based, freshwater hatcheries operated in New Brunswick by Cooke Aquaculture Inc. Both flow-through and recirculating facilities are being assessed to design the most appropriate aquaponic systems based on water quality and flow, nutrient concentrations and bioavailability, temperature, light, plant candidates, space availability and economic viability

Quantifying the capture and conversion efficiencies of species being considered for organic extraction in open-water IMTA systems on the West Coast

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One advantage of IMTA is the potential for bioremediation by organic-extractive organisms. In British Columbia, a number of marine invertebrate species are being considered for use in open-water IMTA with sablefish (*Anoplopoma fimbria*). These include both filter-feeding bivalves (*e.g.* cockles, mussels) which would consume the finer suspended particulates from the finfish culture component and deposit/detrital feeders (*e.g.* sea cucumbers, sea urchins, prawns) which would feed on the heavier-settleable solids. We tested the following candidate species in laboratory feeding trials for their ability to consume sablefish faeces and uneaten sablefish feed: basket cockle (*Clinocardium nuttallii*), blue mussel (*Mytilus edulis*), California sea cucumber (*Parastichopus californicus*), green sea urchin (*Strongylocentrotus droebachiensis*), and Pacific prawn (*Pandalus platyceros*). We measured ingestion rate and absorption efficiency in candidate species fed a diet of sablefish waste relative to those fed a “natural” control diet, in order to estimate their potential to remove organic wastes from the system. Egestion rates in candidate species from both treatments were also quantified, as well as the shape, size, and settling velocity of fecal pellets, in order to

estimate the dispersal potential of undigested material. Preliminary results confirm that candidate species are capable of consuming and digesting the wastes from sablefish aquaculture.

A pilot project to stimulate seaweed production on mussel farms in Maine

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⁷ Pemaquid Mussel Company, 6 Pasture Way, Lamoine, ME 04605

⁸ Wild Ocean Aquaculture, 9 Carver Road, Hampden, ME 04444

⁹ Pemaquid Mussel Company, PO Box 1255, Damariscotta, ME 04543

^{10,11} Oceanville Seafood, and Long Cove Oyster Company, 534 Oceanville Road, Stonington, ME 04681

¹² Ocean Approved, 188 Presumpscot St., Portland, ME 04103

¹³ Blue Hill Bay Mussels, 346 Old Rt. 1, Hancock, ME 04640

The Food and Agriculture Organization of the United Nations reports that globally, seaweed products have a global value of approximately \$6 billion USD, and yet farming of marine macroalgae in the US has only just begun, with one new commercial operation, based in Maine. Therefore, a pilot-scale effort is bringing macroalgal culture to shellfish growers in Maine, as a mechanism to diversify aquaculture production, to build expertise in the techniques for algal culture, to optimize site characteristics, and to foster discussion between growers and buyers. Ocean Approved, of Portland, Maine, provided nursery lines seeded with juvenile sugar kelp (*Saccharina latissima*) to growers on seven sites in coastal Maine waters between December 2011 and February 2012. Kelp lines were deployed at 1m and 1.2m depths. Data are being recorded on growth, yield, temperature, salinity, and dissolved ammonia and nitrate. Harvests are expected to occur between April and June of 2012. The results will inform discussions of the opportunities and obstacles for increased production of macroalgae in Maine.

Seasonal trends in blue mussel (*Mytilus edulis*) somatic composition as a reflection of quality and traceability in Integrated Multi Trophic Aquaculture (IMTA) systems

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Growth and biochemical composition of mussels (*Mytilus edulis*) will vary throughout the year in response to both external factors such as the amount and type of food available, as well as internal physiological cycles such as reproduction. Understanding the seasonal cycles of growth and biochemical change is essential for comparisons of product quality based on biochemical composition as well as assessing how changes in external factors can affect composition. This study followed the seasonal changes over 18 months in blue mussels grown on two integrated multi trophic aquaculture (IMTA) salmon sites versus a reference site in the Bay of Fundy with regard to shell and tissue growth, lipid content, fatty acid profiles, glycogen content, and stable isotope signatures. Seasonal trends were apparent in all of the measurements. The implications of the seasonal cycles found and their relative levels will be discussed in terms of product marketing strategies as well as reference points for environmental assessment.

Effect of light intensity on performance of red seaweed cultivated at high stocking density

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The integrated culture of seaweed and fish is an ecological way to treat the land-based aquaculture effluents. For this bioremediation to be practical, seaweed stocking density needs to be maximized. However, high density results in self-shading, thus a higher light intensity may be needed to sustain the photosynthetic activity. Dulse (*Palmaria palmata*) and Irish moss (*Chondrus crispus*) were cultured in 1L-glass flasks at low and high density (2 vs. 10g/L) in a greenhouse with controlled temperature (10°C) under 20, 50 and 100% of natural light in summer-fall (daily mean 50, 140 and 280 $\mu\text{mol}/\text{m}^2/\text{s}$, respectively). Growth rate of dulse was 100% greater than Irish moss at 2g/L and 90% greater at 10g/L. Irish moss culture in the same vessels, densities, temperature and photoperiod but under six levels of artificial light (50 to 500 $\mu\text{mol}/\text{m}^2/\text{s}$) showed a light saturation point for growth at 400 and 300 $\mu\text{mol}/\text{m}^2/\text{s}$ at low and high density, respectively. No significant difference was found in growth between natural (280

$\mu\text{mol}/\text{m}^2/\text{s}$) and artificial light ($300 \mu\text{mol}/\text{m}^2/\text{s}$). By comparison, Irish moss showed no saturation point up to $400 \mu\text{mol}/\text{m}^2/\text{s}$ under artificial light in 50L-tanks at high density ($10\text{g}/\text{L}$) using flow through effluent from Atlantic halibut with natural temperature, mean 17°C .

Establishing relationships to investigate the far-field effects on wild species of aquaculture nutrient plumes using biological and biochemical indicators

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The far field effects of aquaculture-based nutrients on wild species are not well understood. Quantifying this effect is an important step to establish performance measures for integrated multi-trophic aquaculture (IMTA) with an objective to reduce the amount of nutrients lost to the environment by incorporating extractive species within a site design.

Over the past two years we have deployed and examined passive collector plates at varying distances around several commercial aquaculture sites. From this, we have determined that aquaculture nutrient plumes can potentially cause differential colonization rates (fouling) in native wild species depending on proximity to cage sites and depth. Although we assume that this is partially influenced by nutrient availability, more work is needed to determine to what extent growth rates of wild species collected are influenced by actively feeding fin-fish operations.

Over the next year we will investigate more robust techniques to measure the impact of organic un-dissolved particulates on tunicate and hydrozoan colonization. The relationship between biomass accumulation and instantaneous growth rates will be examined under controlled laboratory conditions and *in-situ* in order to establish a baseline for future performance measurements.

Reproductive Containment and Genetics and Selective Breeding (continued)

Monday, May 28, 2012 – lundi 28 mai, 2012

14:45 PM – 16:05 PM

Location: Provinces Lounge

Chairs: Tillmann Benfey and Steve Armstrong

14:45 D. Runighan

Generation of tetraploid broodstock to enable reproductive confinement of salmonids

15:05 A. Garber

Atlantic Salmon performance selection and broodstock development program for use in commercial saltwater aquaculture production on the East Coast of Canada

15:25 B. Swift

Development and integration of selective breeding programs for two commercial salmon aquaculture operations in British Columbia

15:45 A. Garber

Ceres: A relational broodstock database program

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

Generation of tetraploid broodstock to enable reproductive confinement of salmonids

D. Runighan^{*1}, J.R. Veinot¹, D.A Plouffe¹, and J.T. Buchanan²

¹AquaBounty Canada Inc., PE, Canada

²AquaBounty Technologies, CA, USA

The successful generation of tetraploid broodstock provides an alternative method for production of triploid salmonids at a commercial scale, with a theoretical efficiency of 100%. This process involves interploid mating in which gametes from tetraploid broodstock (2n) of one sex are mixed with the gametes from diploid broodstock (1n) of the other sex. At AquaBounty, the successful production of tetraploid Atlantic salmon and rainbow trout has been achieved by using hydrostatic pressure treatment to inhibit the first mitotic division of the zygote. Survival rates following the induction process are extremely low (0-7.9%), and the efficiency of induction can vary greatly between females. The tetraploid Atlantic salmon produced were the first reported for this species. To date, no tetraploid Atlantic salmon have reached sexual maturation. Using tetraploid rainbow trout broodstock, we have confirmed previous reports of successful interploid matings producing triploid offspring. We have also confirmed that second generation tetraploids can be created by applying hydrostatic pressure to diploid eggs, fertilized with milt from tetraploid males, to induce retention of the second polar body during meiosis II. Tetraploid Atlantic salmon broodstock produced in 2010 are expected to mature in the fall of 2012, and the production of triploid progeny and second generation tetraploids from interploid mating will be investigated.

Atlantic Salmon performance selection and broodstock development program for use in commercial saltwater aquaculture production on the East Coast of Canada

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The Atlantic Salmon Performance Selection and Broodstock Development Program is a multi-element, science/industry collaboration whose two general objectives are: 1) to examine genetic variability of traits chosen by industry that will improve commercial viability and select individuals displaying improvement in those traits, and 2) to establish

a pedigreed line of Atlantic salmon specifically selected for farming within commercial conditions employed by three Atlantic Canadian fish farming companies. Genetic variation and heritability for bacterial kidney disease, sea lice, growth, fillet yield and deformities will be studied. This will be completed by tagging individual fish and conducting challenges; tagging individual fish to create two breeding nuclei that will result in the future broodstock for industry partners; and, communal rearing of families in commercial sea cages on farms in New Brunswick and Newfoundland & Labrador for harvest assessment of growth, fillet yield, and incidence of deformities (fish will be assigned parentage by using microsatellite markers). This program will further increase the potential for traceability by allowing identification of fish from 'egg to plate'. To date, families have been created for the first two year classes and salmon progeny have been PIT tagged from the first year class of production.

Development and integration of selective breeding programs for two commercial salmon aquaculture operations in British Columbia

Swift, B. *

Tri-Gen Fish Improvement Ltd., Box 8, Site 17, RR3, Ponoka, AB. Canada. T4J 1R3

Tri-Gen Fish Improvement Ltd. has been providing technical support for two major selective breeding (SB) programs in B.C. since 1995. This presentation will explain the development of this SB programs for Chinook and Atlantic salmon. We will outline advancements made within these programs, including the use of tools such as PIT tags, DNA genotyping, Animal Model-Blup, SNP data, sexing (ultrasound) and cryopreservation.

Ceres: A relational broodstock database program

A. F. Garber

Huntsman Marine Science Centre, 1 Lower Campus Road, St. Andrews, NB E5B 2L7

Ceres is a computerized broodstock data management system created for use in a breeding program.

Ceres has six key features:

1. Provides both real time and disconnected collection of data.
2. Allows importing/exporting data from/to other formats (e.g., data stored in an Excel file).
3. Stores data in a secure, reliable and highly performant centralized relational database.
4. Offers rich data retrieval, searching, analysis and reporting features.
5. Supports signing of datasets, quality control, quality assurance and auditing.

6. Provides good laboratory practice (GLP) compliance.

Ceres allows for secure data entry into forms customized to specific tasks (e.g., family/tank, individual, challenge, spawning) and also allows importation of archived data (archived in a data format such as Excel). In addition to serving as a relational database, Ceres also allows the user to perform basic analyses (e.g., graphing family means). Ceres has ad hoc exporting capability important for applications such as estimating breeding values in programs such as ASReml. Ceres can import and manipulate data generated by external programs. Ceres also supports custom fields, allows users to work while offline (not connected to the database), generates pedigree reports and is GLP compliant.

Contributed Papers

Monday, May 28, 2012 – lundi 28 mai, 2012

16:30 PM – 17:30 PM

Location: Provinces Lounge

Chair: Kathy Brewer-Dalton

16:30 H.M. Murray

Histology and mucous histochemistry of the integument and body wall of a marine polychaete worm, *Ophryotrocha n. sp.* (Annelida: Dorvilleidae) associated with Steelhead trout cage sites on the south coast of Newfoundland

16:50 C. Stephen

Policy and legislation gap assessment for the sustainable development of freshwater ornamental fish aquaculture in Sri Lanka

17:10 W. Kader-Bathia

Ornamental fish as complementary species in aquaponics

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

Histology and Mucous histochemistry of the integument and body wall of a marine polychaete worm, *Ophryotrocha n. sp.* (Annelida: Dorvilleidae) associated with Steelhead trout cage sites on the south coast of Newfoundland

H.M. Murray^{*1}, D. Gallardi^{1,2}, Y.S. Gidge^{1,3}, and G.L. Sheppard¹

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A new species of polychaete (*Ophryotrocha n. sp.* (Annelida: Dorvilleidae)) was identified from opportunistic polychaete complexes (OPCs) associated with sediment below Steelhead trout aquaculture cages on the south coast of Newfoundland, Canada. The organisms were observed to produce a mucus network in which groups of individuals would reside. In order to answer questions regarding the nature and cellular source of the mucus, samples of worms were taken from below cages and transported to the laboratory where individuals were fixed for investigation of the histology of the epidermis and cuticle with associated mucus histochemistry. The body wall of the worms was organized into segments with an outer cuticle that stained strongly for acid mucopolysaccharides. The epidermis was thin and supported by a loose fibrous connective tissue layer. Channels separating individual segments were lined with cells staining slightly positive for Alcian blue. Muroid cellular secretions appeared thick and viscous, strongly staining with Alcian blue and Periodic Acid Schiff Reagent. It was also noted that lateral channels were connected via secondary channels running through the anterior/posterior axis. The role of these worms as part of the benthos below cages and the importance of mucus secretion with reference to other polychaete species is discussed.

Policy and legislation gap assessment for the sustainable development of freshwater ornamental fish aquaculture in Sri Lanka

J.A. Dawson¹, C. Stephen^{1,2*}, J. Wade³, A. Dale⁴

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4. Royal Roads University, Victoria, British Columbia, Canada V9B 5Y2

A set of guiding questions was developed from available literature and used to assess how sustainable development has been integrated into policy, strategy and action plans for freshwater ornamental finfish aquaculture in Sri Lanka. Sri Lanka's Fisheries and Aquatic Resources Act and the Ministry of Fisheries and Aquatic Resources' National Fisheries and Aquatic Resources Policy provide for the conservation and development of fisheries and aquaculture, and seek to ensure sustainable development in principle. However, the Act and Policy fail to address issues and/or impacts that are specific to the development of the ornamental fish sector, and do not successfully identify goals that represent how the issues and/or problems might be solved or mitigated. While existing legislation embraced the concept of sustainable development, there were significant gaps in details on specific policies and actions for the aquaculture sector and for the implementation and monitoring of sustainable development of ornamental finfish aquaculture. Recommendations are provided to assist Sri Lankan policy makers to develop and implement policies to realize the implementation of sustainable freshwater ornamental finfish aquaculture.

Ornamental fish as complementary species in aquaponics

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Running costs of aquaponic systems are much higher in temperate regions due to supplementary greenhouse heating and lighting during certain periods of the year. Finding routes to maximize profit would be critical for good business operations. Ornamental fish production is a highly lucrative sector and profitability (profitm⁻³ culture water) is very high. The aim of this study was to investigate the possibility of using two small ornamental fish species, namely platy (*Xiphophorus maculatus*) and goldfish (*Carassius auratus*), as sole major nutrient sources for three species of plants in aquaponic culture, under greenhouse conditions. No significant differences ($p > 0.05$) were observed regarding fish growth parameters (sex-wise) for platies across treatments. Productivity of basil with goldfish was higher compared to platies ($p < 0.05$) as the goldfish treatment had a higher nutrient input and build-up. Being a low nutrient-requirement and temperature tolerant plant, watercress showed better growth than basil and spinach. But, nutrient profiles remained low overall to sustain good plant production. Other limitations were the lack of supplementary heating and lighting. It was concluded that small ornamental fish alone would not be suitable for commercial plant production.

They can however be a very good value-addition in aquaponic systems in temperate regions.

VetHealth Global – New Technologies for Fish Health and Nutrition

Tuesday, May 29, 2012 – mardi 29 mai, 2012

08:15 AM – 09:35 AM

Location: Victorian Room

Chairs: Rory Francis and Rose FitzPatrick

08:15 Slice- The story of a market leader

08:35 New diagnostic tools for the shellfish industry

08:55 **M.P. Estrada**

Vaccines against sea lice: first steps toward a deeper understanding

09:15 The Fish Health and Nutrition Challenges for Global Aquaculture

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

Vaccines against sea lice: first steps toward a deeper understanding

Y. Carpio¹, L. Basabe¹, J. Acosta¹, J.M. Lugo¹, C. García¹, E.M. González¹, R. Morales¹, F.Herrera¹, A. Morales¹, C. Borroto¹, MP Estrada (*)¹

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Vaccines against sea lice have the potential to be a cost-effective means of controlling the infestation and avoid many of the disadvantages of medicine treatments but there are no commercial vaccines available against these parasites. Following the experience with terrestrial parasites, we have developing novel approaches to solve this problem. Candidate antigens produced in *E. coli* had been investigated. Other novel approaches such as antimicrobial peptides as molecular adjuvants had been tested in animal models combined with these antigens. The results suggest that akirins or ribosomal proteins-based peptides from sea lice may be used as targets for vaccine development to control sea lice infestations in fish. On the other hand, taking into account the dissimilar results obtained with vaccines in aquaculture, we have studied booster administration or other molecules that could improve the effectiveness of the fish response to vaccination, activating specific and non-specific immune response. One of the molecules studied was PACAP. This peptide was able to trigger different molecular defenses mechanisms including IgM, suggesting its potential. These findings are the first steps towards an integrate approach in the development of an effective vaccine against sea lice.

Shellfish Carrying Capacity

Tuesday, May 29, 2012 – mardi 29 mai, 2012

08:15 AM – 09:35 AM

Location: Georgian Ballroom

Chair: Luc Comeau

08:15 C. W. McKindsey

In-situ mesocosms to evaluate dose-response effects of farmed mussel biodeposition on the benthic environment

08:35 M. Fréchette

A model of clearance rate regulation in mussels

08:55 A. Gangnery

Carrying capacity of the shellfish ecosystem of the Baie des Veys (Normandy, France): in situ measurements and hydrobiological modelling

09:15 C. Bacher

Combining ecophysiological model and satellite-derived environmental data to assess the potential of bivalve aquaculture

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

In-situ mesocosms to evaluate dose-response effects of farmed mussel biodeposition on the benthic environment

C. W. McKindsey^{1,*}, A. M. Weise¹

¹Fisheries and Oceans Canada, PO Box 1000, Mont-Joli, QC, Canada, G5H 3Z4

Much work has examined the influence of biodeposition from bivalves in suspended culture on the benthic environment. However, much of this work has been comparative in nature and little effort has been directed at determining the dose-dependent effects of biodeposition on the benthic environment. This study evaluated the dose-dependent response of benthic communities to varying levels of biodeposition using benthic mesocosms in the Magdalen Islands, eastern Canada. Mesocosms (60 cm diameter) were placed in situ (i.e., in the natural muddy sand sea bottom adjacent to an existing mussel farm) and received biodeposition from known densities of mussels (0 to 500 mesocosm⁻¹) which were placed in cages overlying mesocosms. Samples were collected from each mesocosm and control areas (i.e., without mesocosms) following 75 days incubation to examine benthic infaunal communities and various sediment biogeochemical parameters and the experiment halted. There were clear visual effects from biodeposition and, overall, benthic communities and biogeochemical parameters responded as predicted a priori to organic enrichment due to biodeposition. Although there was an immediate effect of the experimental protocol, all parameters responded dramatically past a certain level of biodeposition. Results are discussed with respect to their importance to predictive ecological modelling for sustainable bivalve aquaculture.

A model of clearance rate regulation in mussels

M. Fréchette¹

¹ Ministère des Pêches et des Océans, Institut Maurice-Lamontagne, 850 Route de la Mer, Mont-Joli, Québec, CP. 1000, G5H 3Z4.

Clearance rate regulation has been modelled as an instantaneous response to food availability, independent of the internal state of the animals. This view is incompatible with latent effects during ontogeny and phenotypic plasticity in clearance rate. Internal-state regulation of clearance rate is required to account for these patterns. I develop an analytical model of internal-state based regulation of clearance rate. External factors such as suspended sediments are included in the model. To assess the relative merits of instantaneous regulation and internal-state regulation, I compare two DEB models that differ only with respect to their feeding module. In the standard DEB model, feeding is governed by a Holling's Type II response to food concentration. In the internal-state DEB feeding module, gill ciliary activity and thus clearance rate are driven by internal reserves level. Suspended sediments are not included in the simulations. The two DEB models

were compared on the basis of their ability to capture the impact of latent effects, of environmental heterogeneity in food abundance and of physiological plasticity on clearance rate and individual growth. The standard DEB model was unable to capture the effect of any of these sources of variability without recalibration, while the internal-state DEB model did.

Carrying capacity of the shellfish ecosystem of the Baie des Veys (Normandy, France): *in situ* measurements and hydrobiological modelling

A. Gangnery*¹, P. Cugier², R. Le Gendre¹, F. Maheux¹ and B. Simon¹

¹Ifremer, Laboratoire Environnement Ressources de Normandie, 14520 Port-En-Bessin, France.

²Ifremer, Dynamique de l'Environnement Côtier, 29280, Plouzané, France.

The Baie des Veys, located on the French coast of the Eastern English Channel is an open intertidal estuary (37 km²) hosting an important oyster farming activity. In this area, the standing stock of the Pacific oyster, *Crassostrea gigas*, is about 10 200 tons. This ecosystem is strongly influenced by four rivers draining an important catchment basin (3 500 km²). The productive carrying capacity of the ecosystem regarding the sustainability of shellfish culture was investigated through different approaches: 1) *in situ* measurements and 2) development of a three-dimensional ecosystem model. *In situ* measurements were dedicated to detect a potential and recurrent depletion of phytoplankton related to the consumption by oysters. In this context, an 'EasyFish' underwater towed vehicle equipped with a multi-sensor CTD was used to investigate spatial and temporal variations of different parameters including chlorophyll-*a* concentration inside and outside the shellfish culture area. The ecosystem model coupled hydrodynamics, biogeochemical and oyster ecophysiological processes. It was implemented to explore different scenarios regarding the ecosystem functioning in response to modifications of watershed inputs, oyster density and rearrangements of the shellfish area. All results indicate that the present oyster standing stock has a strong influence on the ecosystem.

Combining ecophysiological model and satellite-derived environmental data to assess the potential of bivalve aquaculture

C. Bacher¹, Y. Thomas, M. Alunno-Bruscia, J. Mazurié

Ifremer, BP 70, 29280 Plouzané, France

The advent of remote sensing in biological oceanography in the 1990s offers a very powerful tool able to capture temporal and spatial changes of chlorophyll-*a* concentration

and temperature at several temporal scales (decadal, inter annual and seasonal), and at local as well as at the oceanic scale. Such data have the advantage over traditional measurements of being inexpensive, spatially extensive, automatically repeated in time and validated. They have been very useful for phytoplankton monitoring in relation to eutrophication in coastal waters and the number of applications in the field of coastal zone management is growing. We present here a real case application to shellfish aquaculture. We assessed the potential for mussel aquaculture in Mont Saint Michel bay by combining satellite images and an individual growth model. The model was applied to simulate annual growth of mussel over nine years with a resolution of 1 km² over the entire bay. Results show that a strong spatial growth gradient is expected and that some locations are more suitable for mussel aquaculture when individual growth is considered. Such an approach to physiological responses can be extended to assess filter-feeders productivity in coastal areas. Perspectives of new applications will be briefly presented.

Contributed Papers

Tuesday, May 29, 2012 – mardi 29 mai, 2012

08:15 AM – 09:35 AM

Location: Provinces Lounge

Chair:

08:15 M. Klaver

British Columbia Aquaculture Regulatory Program

08:35 C. Edwards

Improving environmental performance in salmon aquaculture: a study of alternative cage materials and coatings in coastal British Columbia

08:55 C. Stephen:

Scoping review of literature to identify factors associated with positive human development outcomes associated with aquaculture development

09:15 N. Hagen

Assessing the assessment: effect of bibliometric bias on the ranking of Canadian aquaculture researchers' publication performance

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

British Columbia Aquaculture Regulatory Program

M. Klaver

Fisheries and Oceans Canada, Aquaculture Resource Management, 1965 Island Diesel Way, Nanaimo BC V9S 5W8

This presentation summarizes the implementation of the regulatory transition from provincial to federal control for the management of aquaculture in British Columbia. In December 2010, DFO took over the responsibility for regulating the BC aquaculture industry under the authority of the *Pacific Aquaculture Regulations*. This responsibility includes the issuance of aquaculture licences, developing the policy framework and implementation of Integrated Management of Aquaculture Plans. External consultation on the management of aquaculture is facilitated through an Integrated Management of Aquaculture Plan (IMAP) process as well as a harmonized provincial federal process both of which are under development. Federal commitments for the transition also included increased enforcement and improved transparency through public reporting.

Improving environmental performance in salmon aquaculture: a study of alternative cage materials and coatings in coastal British Columbia

C. Edwards*¹, S.F. Cross²

^{1,2} Coastal Aquaculture Research and Training (CART) Network. Department of Geography, University of Victoria, PO Box 3060 STN CSC, Victoria, BC, Canada V8W 3R4

Biofouling in salmon aquaculture is an expensive problem, both environmentally and economically. The accumulation of fouling organisms negatively impacts fish by occluding net openings which reduces water flow and the associated nutrient and oxygen exchange. It also physically damages nets and infrastructure. It is typically managed by toxic coatings and manual cleaning. The application of an effective, alternative antifoulant coating will contribute to the overall sustainability of the industry by reducing copper pollution and maintenance requirements.

This study describes the effectiveness of 7 alternative netting treatments and two copper based treatments as compared to an untreated nylon net. Following 8 months immersion, results indicate that there are significant differences between some treatments based on species percent cover, biomass and percent net occlusion. Findings also show that copper based treatments are highly effective antifoulants.

This research demonstrates that the alternative treatments that were tested are unable to meet the performance standards set by industry, that more research is needed into alternative antifoulant coatings for aquaculture, and that the effectiveness of copper based treatments will continue to be a barrier to the development and implementation of alternative antifouling coatings.

Scoping review of literature to identify factors associated with positive human development outcomes associated with aquaculture development

T. Burns¹, C. Stephen^{1*}, J. Wade², J. Dawson¹.

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² Fundy Aqua Services. 1859 Delanice Way, Nanoose Bay, BC Canada V9P 9B3

Aquaculture is often cited as a key strategy to reduce poverty and improve food security in developing countries. However, it is also cited as a cause of resource conflict and increased economic inequality. We reviewed the literature on aquaculture and human development to assess its current state and identify actions to make it more effective. The initial literature search of 4 databases (CAB, PAIS, Agricola and Medline) returned 2014 peer reviewed articles. One hundred ninety six were original studies that focussed on our outcomes of interest; food security and sustainability, poverty reduction and human welfare. Reports of negative outcomes (17/38) were twice as common in shrimp aquaculture as positive outcomes (9/38). The reverse was true for freshwater finfish aquaculture where positive outcomes (46/70) were seven times more common than negative outcomes (6/70). This presentation will discuss variables associated with negative and positive development effects from aquaculture and their implication for promotion of sustainable food production that helps develop human welfare and equity.

Assessing the assessment: effect of bibliometric bias on the ranking of Canadian aquaculture researchers' publication performance

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In a bibliometric analysis submitted to Fisheries and Oceans Canada on March 31, 2010 by Science-Metrix, the leading aquaculture researchers in Canada were identified and ranked according to the total number of relevant papers they had published between 1996 and 2008. Both this ranking, as well as an earlier one by Sylvain (1993), are, however, biased by several systematic sources of error in data acquisition and analysis. Here I provide examples of how subjective subfield delineation, and subjective source data selection, introduce acquisition errors affecting the outcome of the rankings. I also

examine the analytical consequences of correcting for equalizing and inflationary bibliometric bias in the source data. Equalizing bias is generated by allocating equal authorship credit to coauthors who have not contributed equally to a multiauthored paper, while inflationary bias is generated by allocating one full authorship credit repeatedly to all coauthors. Re-ranking publication performance with de-biased authorship credit scores resolved ties and rearranged both the Science-Metrix and the Sylvain rankings. In conclusion, the results suggest that current bibliometric methods have several severe drawbacks and limitations that combine to produce unreliable rankings.

VetHealth Global – Navigating the Shoals: Taking New Fish Health Products to the Market

Tuesday, May 29, 2012 – mardi 29 mai, 2012

11:00 AM – 12:20 PM

Location: Victorian Room

Chairs: Rory Francis and Rose FitzPatrick

11:00 R. Finlay

Understanding the commercialization pathway

11:20 J. Raoul

Patenting and licencing strategies

11:40 D. A. Plouffe

Executing regulatory-compliant studies in support of aquaculture applications

12:00 B. Green

Investing in New Technologies

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

Executing regulatory-compliant studies in support of aquaculture applications

D.A. Plouffe^{*1} and J.T. Buchanan²

¹ The Center for Aquaculture Technologies Canada, PE, Canada

² The Center for Aquaculture Technologies, San Diego, CA, USA

The Center for Aquaculture Technologies Canada is a contract research organization (CRO) providing support for R&D and commercialization activities in the aquaculture industry, with particular expertise in GxP-compliant research. Conduct of studies with a high level of care and accuracy is required to ensure the quality and validity of the test data. There are specific requirements for the conduct of regulatory studies including those related to facilities, equipment, operations, and personnel; all are reviewed by an independent quality assurance unit. Execution of controlled pre- and post-market studies/monitoring to GLP/GCP standards may include the development of study protocols, study specific standard operating procedures (SOPs), and completion of final study reports including a description of deviations from the original protocol. CROs typically work closely with research sponsors in developing strategies for achieving the collection of quality data and records required in support of regulatory applications.

Shellfish Carrying Capacity (continued)

Tuesday, May 29, 2012 – mardi 29 mai, 2012

11:00 AM – 12:20 PM

Location: Georgian Terrace

Chair: Luc Comeau

11:00 R. Rosland

Effects of stimulated upwelling on phytoplankton production and mussel growth in a Norwegian fjord system

11:20 T. Guyondet

Diagnostic method for assessing the shellfish culture potential of a coastal system

11:40 J. Grant

The role of assimilative capacity in concepts of carrying capacity

12:00 R. Filgueira

Bivalve condition index as an indicator of aquaculture intensity

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

Effects of stimulated upwelling on phytoplankton production and mussel growth in a Norwegian fjord system

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The pycnocline establishing during spring and summer in Norwegian fjords limits primary production, which is an important food source for mussels in these systems. An upwelling experiment, by means of dived river water, was conducted in Lysefjorden in 2010-2011 to study how elevation of nutrient rich deep water affected primary production and mussel growth of different mussel cohorts (m08, m09, m10) compared to control stations. Four growth experiments spanned both years 2010-2011, while four experiments spanned 2011 only. The effects of chl *a* and temperature on mussel growth were analysed by a DEB-model.

Temperatures at the upwelling station were lower (-7.3 pct. [-11.0, -1.6]) than the control station (value represents the average between growth experiments [minimum and maximum in brackets]), while chl *a* (69 pct. [61, 82]), shell length (3.0 pct. [-1.3, 8.2]) and mussel dry flesh mass (16.6 pct. [6.7, 39.5]) were higher. Mussel growth increased modestly compared to chl *a* at the upwelling station. Mussel feeding responses reconstructed from growth in shell length corresponded well with chl *a* concentrations which indicate that phytoplankton is an important food source for mussels in this fjord. Model simulations suggest that lower temperatures at the upwelling station dampen the growth stimulating effects from elevated food concentrations.

Diagnostic method for assessing the shellfish culture potential of a coastal system

T. Guyondet^{1*}, L. Comeau¹, R. Sonier¹, T. Landry¹, J. Davidson²

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In the context of resource management and spatial planning, tools are needed to help decision makers assess the potential of coastal areas for various activities. Among these,

shellfish culture presents the particularity of exploiting natural resources as well as producing goods and services. Numerical modelling is a powerful tool that is well suited for examining the role played by cultured bivalves in coastal ecosystems. However, the massive amounts of input data required to run the models and the complexity of the analyses, particularly with respect to ecosystem modelling, often dissuade stakeholders from embracing modelling in their decision making process. Here we present a simpler method based exclusively on hydrodynamic modelling. Results are used to describe the transport of a tracer mimicking shellfish food (i.e., phytoplankton), with its own rate of production and rate of removal by the cultured organisms in the farm areas. We applied this diagnostic method in two coastal systems to demonstrate its suitability for informing spatial planning processes.

The role of assimilative capacity in concepts of carrying capacity

J. Grant* and R. Filgueira

Department of Oceanography, Dalhousie University, Halifax, NS B3H 4R2

The concept of carrying capacity (CC) is well entrenched in bivalve aquaculture, most recently highlighted as ecological CC, based on depletion of chlorophyll and its implications for ecosystem resilience. This concept has been applied largely in the pelagic realm, and the mixing characteristics of small estuaries make it applicable at the ecosystem scale. In contrast, there is lesser application of this concept in the benthos, despite the fact that benthic impacts are of great concern to regulators. The most common benthic impact is eutrophication, which pushes sediments to a suboxic state. The state variable of concern here is oxygen, where sediment oxygen demand is fueled by sedimenting organic matter. Assimilative capacity is the ability of sediments to consume organic matter relative to its input. In practical terms for an oxic benthos, oxygen demand must not exceed the renewal of sediment oxygen via advection/diffusion. The implementation of this approach is hindered by the complexity of the required sediment diagenesis models. However, simpler approaches may still produce useful estimates of assimilative capacity that complement other measurements of resilience with respect to aquaculture impacts. Methods for approaching this problem are discussed and initial results presented relative to data requirements and model development.

Bivalve condition index as an indicator of aquaculture intensity

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¹Department of Oceanography, Dalhousie University, Halifax, NS B3H 4R2.

²Aquaculture and Coastal Ecosystems, DFO Gulf, Moncton, NB E1C 9B6.

The bivalve condition index (CI) is attractive in many ways: it integrates the effect of changing trophic conditions over time, is easy to measure and is widely available in government and industry databases. Using a meta-analysis approach, we investigated whether the CI of *Mytilus edulis* and *Crassostrea virginica* is related to aquaculture development in Prince Edward Island and New Brunswick. Our underlying premise was that overstocking bivalves leads to increased competition for food resources and ultimately to a reduction in CI values. For *C. virginica*, a General Additive Model (GAM) provided a regression that included the initial dry meat weight as a linear term, and the lease area as a smooth term. The model explained a total deviance of 59.9%. The GAM for *M. edulis* included only smooth terms, lease coverage (lease area/bay area) and lease area. This model explained a total deviance of 61.0%. The good relationships between the CI and aquaculture intensity constitutes the scientific framework for its use as an ecological indicator of carrying capacity.

Environmental Monitoring

Tuesday, May 29, 2012 – mardi 29 mai, 2012

11:00 AM – 12:20 PM

Location: Provinces Lounge

Chair: Karen Coombs

11:00 A.T. Bennett

The New Brunswick environmental management framework for marine finfish aquaculture: A brief history with an eye to the future

11:20 T. Balch

The Nova Scotia environmental monitoring program; past, present and future

11:40 B. Sweeney

The need for aquaculture environmental assessment & monitoring research

12:00 B.D. Chang

Recent research on environmental monitoring of salmon farms in Southwestern New Brunswick

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

The New Brunswick environmental management framework for marine finfish aquaculture: A brief history with an eye to the future

A.T. Bennett^{*1} and T.A. Lyons²

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²Department of Environment and Local Government, PO Box 6000, Fredericton, NB E3A 5T8

The New Brunswick Department of Environment and Local Government (DELG) has been responsible for the environmental management of marine finfish aquaculture since 2002. Since that time all marine finfish cage aquaculture sites are required to hold a valid Certificate of Approval to Operate issued by DELG. An integral component of the management framework is the annual benthic monitoring program. The monitoring program has evolved over time in response to changes in science and industry practices and continues to provide regulators with accurate assessments of the condition of the marine sediments. Currently the program uses sediment sulfide as the threshold indicator, recognizing the Oxic site classification as the Marine Environmental Quality Objective (MEQO). This data is used in a performance based standards approach to regulation allowing for maximum environmental protection and operational flexibility within the industry. This talk will give a summary of environmental performance (based on annual benthic monitoring) in the Bay of Fundy, an overview of how the program has changed since its inception and highlight recent collaborative research that will lay the groundwork for future change.

The Nova Scotia Environmental Monitoring Program; past, present and future

T. Balch*

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balchto@gov.ns.ca

Nova Scotia Fisheries and Aquaculture's Environmental Monitoring Program (EMP) studies the relationship between aquaculture and the marine environment. Based on a protocol established by government, academia and industry, monitoring is conducted on both aquaculture leases and at reference stations in the surrounding bay. Monitoring consists of collecting qualitative (video) and quantitative (sediment and water analysis) elements from coastal areas throughout Nova Scotia.

The EMP follows a risk-based approach that recognizes increased risk requires increased monitoring. All marine sites, both finfish and shellfish, currently in production are targeted and those that are larger or more intensive are given higher priority. Those sites

of potential concern are subject to repeat sampling and, if required, remediation action is implemented.

The EMP is also working on a variety of related projects with both regulatory and scientific partners to continue to expand the knowledge base of the potential environmental impacts of aquaculture on our coastal ecosystems. As part of this continued development of the program, a variety of methods and techniques have been employed to assess potential impact and the evolution of the program continues.

The need for aquaculture environmental assessment & monitoring research

B.Sweeney*¹

¹Sweeney International Marine Corp. SIMCorp Marine Environmental Inc.

An Atlantic Provinces' Memorandum of Understanding for the Development of the Aquaculture Sector dated January 18, 2008 set the course for an increased level of cooperation amongst the Atlantic Provinces who agreed to partner on mutually beneficial initiatives that promote sustainable aquaculture development in Atlantic Canada. The first area of cooperation and support stated that..."2.1 *The Parties agree to work towards a harmonized regulatory and policy environment, to the extent that is possible, in areas such as leasing and licensing programs, environmental monitoring, introductions and transfers, aquaculture statistics, and aquatic animal health*". This presentation will examine the level of success achieved on the course leading towards harmonization of aquaculture environmental monitoring, the challenges facing industry as well as the regulatory agencies towards achieving that goal and will look at some of the research needed to bring both industry and the regulatory agencies to a mutually agreed upon level of harmonization in Atlantic Canada. As marine finfish aquaculture environmental assessments and, in particular, the monitoring research moves forward, priority considerations need to address the differences between soft bottom and hard bottom or high energy sites. In doing so research to advance the development of an appropriate benthic quality index for visual imaging is felt to be at the top of the list for the SIMCorp Biologists. SIMCorp has been conducting marine baseline environmental assessments and monitoring for the finfish aquaculture sectors in New Brunswick, Nova Scotia and Newfoundland for the past ten (10) years and as such brings a wealth of experience from across the Atlantic Region.

Recent research on environmental monitoring of salmon farms in southwestern New Brunswick

B.D. Chang*¹ and F.H. Page¹

¹ St. Andrews Biological Station, Fisheries and Oceans Canada, St. Andrews, NB E5B 2L9

Research on environmental impacts of salmon farming in southwestern New Brunswick (SWNB) has been conducted since 1985. This presentation reviews recent research conducted at the St. Andrews Biological Station. Spatially intensive sediment sulfide sampling was conducted at 6 farms in 2005-2007. Impacts were mostly confined within the cage array area and small-scale patchiness was observed. Weekly or biweekly sampling was conducted during the autumn in 2008 and 2009 at two farms and a control site. Sediment sulfide concentrations remained low at the control site; at the farm sites, sulfide concentrations increased during the first autumn, but increased and then fell during the second autumn due to harvesting. Sediment infaunal biodiversity was examined in October 2008 at the same two farms and control site. Biodiversity remained high at the control site and decreased at farm sampling stations where sediment sulfide concentrations were high. Another project examined factors influencing the Tier 1 monitoring results in southwestern New Brunswick. A recent study examined the use of the DEPOMOD model in New Brunswick and compared model predictions with sediment sulfide measurements. In general, where the model predicted low impacts, the sediment measurements also showed low impacts, but where the model predicted high impacts, there was a wide variation in observed sulfide concentrations. Future research plans will be discussed.

Pest and Predator Control

Tuesday, May 29, 2012 – mardi 29 mai, 2012

14:00 PM – 16:20 PM

Location: Victorian Room

Chair: Kathy Brewer- Dalton

14:00 C. Webster

Integrated pest management plan for sea lice in New Brunswick

14:20 Y. LeClerc

Integrated pest management in the potato industry – The IPM survey and other McCain Foods initiatives

14:40 S. Stewart-Clark

Detecting future invaders: The use of molecular assays in invasive species monitoring in aquaculture regions.

15:00 A. Garber

The ECO Bath System: A paradigm shift for Atlantic salmon sea lice management

15:20 K. Robertson

Development of shark and predator resistant aquaculture containment nets

15:40 T. Landry

Tunicate infestation in Prince Edward Island Canada: development of an integrated management approach

16:00 B. Vercaemer

Ciona intestinalis environmental control points? Field and laboratory investigations

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

Integrated pest management plan for sea lice in New Brunswick

C. Webster *¹, K.E.B Dalton²

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Dartmouth, NS, B2Y 1J3

²New Brunswick Department of Agriculture, Aquaculture and Fisheries, Resource
Management and Fish Health, 850 Lincoln Road, Fredericton, NB, E3B 5H1

Over the last thirty years the aquaculture industry has responded to a number of fish health challenges, including Infectious Salmon Anemia (ISA), Bacterial Kidney Disease (BKD) and the control and management of sea lice. Sea lice are parasitic copepods of salmon and other fish species that are naturally present in the marine environment. If sea lice are not effectively managed, the economic impact to salmon aquaculture can be significant. Impacts include lack of growth, and suppression of the immune system, which can result in other diseases and/or mortality. The New Brunswick Integrated Pest Management Plan (IPMP) for Sea Lice provides a comprehensive, strategic framework that promotes the health and welfare of cultured Atlantic salmon, while minimizing potential impacts to wild aquatic resources in the surrounding environment. This plan can be used by other jurisdictions as a framework for other IPMP's across Canada. This presentation will highlight the components of the NB IPMP including prevention, research, monitoring (observation), and chemotheraputant and non-chemotheraputant control measures (intervention), as well as identifying the need for green technologies and developing novel techniques for managing sea lice.

Integrated pest management in the potato industry – The IPM survey and other McCain Foods initiatives

Y. Leclerc*¹, E. Ritchie¹

8800 Main Street, Florenceville-Bristol, New Brunswick, E7L 1B2

In response to request from the marketplace, several organizations including McCain Foods cooperated to develop a Potato Integrated Pest Management Survey for the North American potato industry. The internet application is free to all growers, requires once yearly reporting and involves an extensive set of questions about best IPM practices. Each practice is categorized as a Basic, Steward, Expert, or Master. This tiered approach allows for practice reporting by low-management to high-management IPM. By participation in this survey growers are able to report their level of IPM adoption to customers. Various reports allow growers to 1) compare their farm performance, practice-by-practice, to the average for the country, region, or market (frozen, chip, fresh, seed), 2) track their IPM adoption results over a five-year history, and 3) identify IPM

practices of others they might also adapt. Grower web pages are accessible only by the grower with results provided only to food companies as selected by the grower. Public reporting is communicated through two web reports. Other initiatives implemented by McCain Foods with regards to IPM implementation will be discussed.

Detecting future invaders: The use of molecular assays in invasive species monitoring in aquaculture regions.

S.E Stewart-Clark*¹ S Greenwood² and J. Davidson³

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²Department of Biomedical Sciences, Atlantic Veterinary College, UPEI, 550 University Ave. Charlottetown PEI, C1A 4P3

³Department of Health Management, Atlantic Veterinary College, UPEI, 550 University Ave. Charlottetown, PEI, C1A 4P3

Monitoring for invasive tunicates in aquaculture regions in Atlantic Canada has been greatly enhanced by the development of molecular assays that can detect minute quantities of invasive tunicate material in a highthroughput manner in bay water surrounding shellfish aquaculture leases. While these current assays can detect invasive tunicates which are currently present in some areas of Atlantic Canada, (*Ciona intestinalis*, *Botrylloides violaceus*, *Botryllus schlosseri*, *Styela clava* and *Diplosoma listerianum*), new assays are required to protect the Canadian aquaculture industry from potential new invasions of other species of invasive tunicates. This project involves the development of 17 new assays to detect tunicates which have been labeled as high risk for future invasion to Atlantic Canada. Having a highthroughput, efficient and comprehensive assay to screen and monitor for these potential new invasions will facilitate early interventions if new invasions are detected, offering increased protection to the aquaculture industry in Atlantic Canada.

The ECO Bath System: A paradigm shift for Atlantic salmon sea lice management

C.J. Bridger¹, P. Dobson¹, E. Kearney², B. Hogans³, A. Garber*³, M. Beattie⁴ and J. Snider⁵

¹AEG Innovative Solutions Inc., 73A Frederick Street, St. Andrews, NB E5B 1Y9

²Admiral Fish Farms Ltd., Grand Manan, NB E0G 1X0

³Huntsman Marine Science Centre, St. Andrews, NB E5B 2L7

⁴New Brunswick Department of Agriculture Aquaculture and Fisheries, St. George, NB E5C 3S9

⁵InVentures Technologies Inc., Fredericton, NB E3B 5C8

The ECO-Bath System treats sea lice infection while maximizing fish welfare, environmental stewardship and treatment efficacy within a fully contained bath system that filters and oxygenates the treatment water. A treatment trial was performed to treat Atlantic salmon using Salmosan within the ECO-Bath System with impressive results:

- Calculated oxygen uptake (0.23 g O₂/h/kg fish) indicated that treated salmon were unstressed during the trial.
- Removal of all sea lice life stages was 75.5% 24 hours post treatment (81% mobile sea lice; more than 61% of chalimus sea lice; nearly 55% of adult female sea lice).
- All sea lice (dead or alive) not returned to the ocean environment from the ECO-Bath System.
- Nine salmon mortalities 24 hrs post-treatment or 0.38% of the treated population. Chronic long-term mortality also not evident.
- The ECO-Bath System retained pesticides between treatments therefore requiring significantly less pesticides to treat whole sites compared to tarp and well boats.
- Integration of a filtration system possible to completely remove pesticide active ingredient after all cages treated rather than releasing any of the pesticides to the environment (trials measured removal of 99.79% of Alphamax and 99.99% of Salmosan).

Development of shark and predator resistant aquaculture containment nets

K. Robertson¹ *, K. Tamura²

¹ DSM Dyneema® 101 Highway 27 South Stanley, North Carolina, 28164, USA

² NET Systems, 7910 N.E. Day Road West, Bainbridge Island, WA 98110 USA

All warm water aquaculture sites and some cold water aquaculture sites, are susceptible to attacks from sharks. The losses due to sharks, and other predators, can result in significant mortality, escapes, and requires expensive and laborious repair efforts.

The cutting efficiency of a shark's tooth, combined with their powerful jaws and thrashing movement, makes the shark unique and highly efficient at tearing nets. Novel lab tests to simulate a shark bite on netting and to predict net performance in the ocean were required. Utilizing the new lab tests and collecting data from sea trials in shark infested waters drove development efforts to create a hybrid netting using Dyneema® fiber in an Ultra Cross Knotless® Braided construction.

This new netting product provides options for the fish farmer to deploy a lightweight solution for fish farmers facing predation by sharks and seals while avoiding secondary anti-predator nets.

Tunicate infestation in Prince Edward Island Canada: development of an integrated management approach

T. Landry*^{A,B}, J. Davidson^B and A. Locke^A

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A- Dept of Fisheries and Oceans, Gulf Region Moncton, NB Canada;

B- Atlantic Veterinary College, UPEI, Charlottetown PE Canada.

The waters of Prince Edward Island (PEI) have recently been invaded by four tunicate species with significant economical and ecological impacts. The important mussel aquaculture industry has been severely affected by these fouling species. They compete with mussels and associated fauna for space and food, potentially decreasing the productivity of the farms by reducing the growth rates and meat yields of cultured mussels.

The management of tunicate infestation in mussel producing areas has been focused on the developments in treatment application. Here, the impact of treatment timing and frequency has been investigated to minimize the cost of treatments and impacts on farm productivity. Results to date suggest that a minimum of 2 treatments per year is required to sustain the mussel production in infested bays. This economical consideration is the first threshold sought in the development of an Integrated Pest Management (IPM) strategy. The second threshold is the level at which invasive species populations or environmental conditions indicate that control action must be taken to minimize environmental impacts at farm or bay-scales. The other components of the IPM that need to be considered are the various environmental output of pest management in aquaculture, including i) waste management, ii) propagule pressure and iii) therapeutants release. This approach will be discussed with reference to on-going research on tunicate infestation management in PEI. .

***Ciona intestinalis* environmental control points? Field and laboratory investigations**

B. Vercaemer^{*1}, D. Sephton¹, J. M. Nicolas², S. Howes¹, J. Keays³ and J. Ouellette-Plante⁴

¹Fisheries and Oceans Canada, Bedford Institute of Oceanography, 1 Challenger Drive, Dartmouth, NS B2Y 4A, Canada

²Nova Scotia Power Inc., 25 Lakeside Drive, Halifax, NS B3T 1M9, Canada

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⁴Department of Biology, McGill University, Montreal, QC H3A 1B1

Life history processes, such as reproduction, survival and growth, are known to be strongly affected in ascidians by different types of environmental factors including temperature and salinity. In a field study conducted from 2005 to 2011 in southern Nova Scotia, an area affected by invasions of *Ciona intestinalis*, low winter and high summer temperatures were shown to be strongly associated with intra- and inter- annual variation in larval recruitment. No clear patterns of association were seen with other environmental variables such as chlorophyll and indices of nutrient concentrations. In a 12 week challenge experiment in the laboratory, survival and growth of juvenile *C. intestinalis* were affected by both salinity and temperature. Individuals exposed to high temperature (25°C) and low salinity (20) did not survive the sustained exposure. In addition, Individual Specific Growth Rates were shown to decrease as salinity decreased. Temperature and salinity are factors which will subsequently influence distribution, persistence and potential for spread of adult populations. New favourable temperature and salinity conditions (e.g., potentially resulting from global climate change) will likely alter the distribution patterns of *C. intestinalis*. Conversely, infestation management techniques or site selection could benefit from unfavourable sustained temperature and salinity conditions.

Atlantic Canada Aquaculture Industry R&D Network (ACAIRDN) session

Tuesday, May 29, 2012 – mardi 29 mai, 2012

14:00 PM – 16:20 PM

Location: Georgian Ballroom

Chair: Danielle Goodfellow

14:00 S. Theriault

Three Oaks Innovation

14:20 R. Isnor

Maximizing the potential for university-college-industry research collaborations in Atlantic Canada

14:40 J. Parsons

Fisheries and Oceans Canada - Aquaculture Science Research Funding Programs

15:00 S. Vatcher

National Research Council of Canada – Industrial Research Assistance Program (IRAP)

15:20 G. Falk

Aquaculture Innovation and Market Access Program (AIMAP)

15:40 D. Green

A strategy for targeted aquaculture research in Newfoundland and Labrador (STAR-NL)

16:00 B. Harnish

A high level overview of the Scientific Research and Experimental Development (SR&ED) Tax Incentive Program at the Canadian Revenue Agency

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

Maximizing the potential for university-college-industry research collaborations in Atlantic Canada

R. Isnor¹

¹Manager, Atlantic Regional Office, Natural Sciences and Engineering Research Council of Canada, 100 rue des Aboiteaux, Room 1300, Moncton, NB. E1A-7R1

Through the Natural Sciences and Engineering Research Council (NSERC), the federal government currently invests significantly in aquaculture-related research conducted by Canada's post-secondary institutions. This is in addition to the direct and in-direct federal investments made in aquaculture-related R&D conducted by the business community, research funded through regional economic development agencies and provincial governments, and research conducted by federal departments and agencies such as Fisheries and Oceans Canada. Funding mechanisms for post-secondary research in Canada have evolved considerably in the past decade to favour collaborative partnerships. Numerous studies have shown that collaboration is the lifeblood of innovation, necessitating strong linkages between industry, academia and government agencies. Atlantic Canada must continue to embrace and pursue collaborative research arrangements between our post-secondary institutions and industry in order to advance regional innovation in our aquaculture sector and to enhance future prospects for industry. This presentation will provide an overview of collaborative research partnership opportunities in Canada and Atlantic Canada, drawing on examples of collaborative aquaculture research underway, as well as outlining opportunities for Atlantic Canada to seek further benefit from collaborative research arrangements involving industry and post-secondary institutions.

Fisheries and Oceans Canada - Aquaculture Science Research Funding Programs

G.J. Parsons*¹, J. Power¹, C. Busby¹

¹ Aquaculture Science Branch, Fisheries and Oceans Canada, 200 Kent St., Mail Station 12E239, Ottawa, Ontario, K1A 0E6

Fisheries and Oceans Canada (DFO) continues to play a key role in the support of Canadian aquaculture research and development initiatives. This support has been provided through two programs in particular: the Program for Aquaculture Regulatory Research (PARR) and the Aquaculture Collaborative Research and Development Program (ACRDP). These programs serve distinct purposes with regards to supporting aquaculture research. The PARR supports regulatory research of interest to DFO management clients, other federal regulators and provinces with regulatory responsibilities for aquaculture. The ACRDP is a collaborative program available to aquaculture industry stakeholders who have particular research needs that are in line with the broad objectives of the program – fish health and environmental performance. This

presentation will provide further information on how initiatives under these research and development programs are contributing to the sustainable development of the Canadian aquaculture industry. It will also provide an update on recent changes to the ACRDP and how industry may participate in these programs.

Aquaculture Innovation and Market Access Program (AIMAP)

G. Falk*¹

¹ Fisheries and Oceans Canada

Aquaculture Operations Management Directorate, Ottawa, Ontario, K1A 0E6

The Aquaculture Innovation and Market Access Program (AIMAP) is completing its fifth year in 2013. The overall goal of this Fisheries and Oceans Canada (DFO) contribution program is to catalyze aquaculture industry investment from the private sector, as well as other sectors, that will: (1) Improve the competitiveness of a sustainable Canadian aquaculture industry by encouraging an aquaculture sector that continuously develops and adopts innovative technologies and management techniques to enhance its global competitiveness and environmental performance; and (2) Position Canadian aquaculture products as having high value in the market place based on their environmental performance, traceability and other considerations. Since 2008, more than 160 projects have been funded through AIMAP under the following priorities: (1) Sustainable production; (2) Green technology; and (3) Species diversification. In the five years of the program, \$23.5 million in AIMAP funds have been invested in innovative projects with nearly \$100 million being leveraged from industry and other funding partners. AIMAP focuses on funding projects at the pre-commercialization end of the research and development continuum.

A Strategy for Targeted Aquaculture Research in Newfoundland and Labrador (STAR-NL)

D. Green*¹

¹Newfoundland Aquaculture Industry Association, Suite 209, 11 Austin St., St. John's, NL A1B 4C1

To grow and compete globally companies, and sectors, must have access to knowledge gained through research in order to develop and/or improve products and services. The aquaculture industry has a great need for the transfer of such knowledge and the innovation it will undoubtedly foster.

The Newfoundland Aquaculture Industry Association (NAIA) is currently developing a Strategy for Targeted Aquaculture Research in Newfoundland and Labrador (STAR-NL) which will outline an industry-focused and demand-driven approach to research and

development. The goal of the STAR-NL is the creation of a more formal communications structure which will relay industry priorities, fully utilize our R&D capacities and infrastructure, fully engage academic and government researchers and create a collective vision of aquaculture R&D within NL. Processes such as industry priority collection and categorization, communication and coordination, capability mapping, research planning and research evaluation / gap analysis are some of the areas of focus for the strategy in 2012.

A high level overview of the Scientific Research and Experimental Development (SR&ED) Tax Incentive Program at the Canadian Revenue Agency

Harnish, B.

The presentation will contain a general overview of the SR&ED program. We will cover the 3 SR&ED eligibility criteria, the investment tax credit rates and the eligible SR&ED expenditures.

Environmental Monitoring (continued)

Tuesday, May 29, 2012 – mardi 29 mai, 2012

14:00 PM – 16:20 PM

Location: Provinces Lounge

Chair: Karen Coombs

14:00 D. Drover

Exploration of a visual based approach to benthic environmental monitoring of finfish cage culture sites in Southern Newfoundland

14:20 J. Grant

Near-field and far-field perspectives on aquaculture monitoring: implications for models and measurements used in management

14:40 D. Hamoutene

The use of bacterial mats (*Beggiatoa spp.*) and opportunistic polychaete complex as potential indicators of habitat alteration around finfish aquaculture sites over hard bottom

15:00 G. Mabrouk

Validation of the DEPOMOD for estimating desposition from fish farms on the South Coast of Newfoundland

15:20 C. Salvador

Marine finfish aquaculture hard seabed monitoring in British Columbia

15:40 Facilitated Panel Discussion: Sharon McGladdery

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

Exploration of a visual based approach to benthic environmental monitoring of finfish cage culture sites in southern Newfoundland

D. Drover*¹, G. Mabrouk¹, T. Bungay¹, and D. Hamoutene¹

¹Aquaculture, Biotechnology and Aquatic Animal Health Section, Fisheries and Oceans Canada, PO Box 5667, St John's NL A1C 5X1.

The fast development of aquaculture on the South Coast of Newfoundland raised the importance of efficient and appropriate monitoring to address any potential impacts on the nearby habitat. Rapid survey methods, such as those using remote videography, can be used to describe the pre-cage and post-cage benthic environment and species assemblage. However, video methodologies needed to be explored first to ensure suitability for the environmental conditions and biological assemblages likely to be encountered. Video-based surveys were collected at on the south coast of Newfoundland in summers of 2009 and 2010. Substrate type and species were recorded along with the confidence level of that identification, based on image quality.

The objective of this study was to assess the quality of the underwater videos provided, by analyzing the usefulness of camera systems among different environmental conditions and biota. In other words, to collect secondary survey information along with the primary information usually taken, and to provide recommendations for improvements of future video-based surveys.

Near-field and far-field perspectives on aquaculture monitoring: implications for models and measurements used in management

J. Grant* and R. Filgueira

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The monitoring of environmental impacts at aquaculture sites attempts to comply with the requirements of the Fisheries Act, largely oriented toward benthic impacts. The types of impacts occurring in the near-field and far field are fundamentally different, and thus the approaches to monitoring should be different as well. For example, it is unlikely that solid wastes from fish farming will spread large distances from farm sites. In contrast, dissolved nutrients may have greater dispersal distances. Bay scale hydrodynamic models are thus useful for far-field effects, and should be developed for regions of extensive aquaculture development. For near-field impacts the prediction of culture footprint is conventional, through approaches such as DEPOMOD. However, the spatial extent of the predicted footprint is relatively constant, and thus of limited use in monitoring. The rate of deposition is potentially useful in empirical relations with sulfide, or in diagenetic

models. Examples of both types of models are provided. In addition, a new deposition tool is presented with an emphasis on deposition rate, without the need for footprint mapping. Finally, the prognosis for better assessment tools used in groundtruthing (such as sediment profile imaging) is given.

The use of bacterial mats (*Beggiatoa* spp.) and opportunistic polychaete complex as potential indicators of habitat alteration around finfish aquaculture sites over hard bottom substrates in Newfoundland, Canada.

D. Hamoutene,*¹; L. Sheppard, L¹; D. Drover¹; V. Oldford¹, G. Doyle¹; E. Coughlan²; G. Mabrouk¹; C. Grant².

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Although more than 120 biological and geochemical variables have been used to assess benthic condition near finfish aquaculture sites, none of these indicators have been assessed fully on hard substrates. Two indicators used on soft substrates may have utility on hard substrates because they are conspicuous members of the benthic fauna and are known to occur near finfish sites. *Beggiatoa* may be a primary indicator as it occurs at the interface of oxic and anoxic conditions and is typically associated with elevated sulphide levels. The second potential indicator, opportunistic polychaete complex (OPC), is frequently observed in areas with organic enrichment and reduced oxygen conditions. However, the relationship between *Beggiatoa* or OPC and benthic biodiversity on hard substrates is not very well established. Through the review of monitoring reports provided by the aquaculture industry (reference, end of production, end of fallow), we are evaluating the utility of *Beggiatoa* and OPC as indicators of benthic condition over hard substrates. Moreover, video analyses from underwater camera sampling along transects at six sites in their second year production will be discussed in an attempt to establish relationships among potential indicators of impact and benthic habitat descriptors.

Validation of the DEPOMOD for estimating desposition from fish farms on the South Coast of Newfoundland

G. Mabrouk*¹, A. W. Ratsimandresy¹, J. Curry¹, T. Bungay¹, D. Drover¹, L. Sheppard¹, and R. Losier²

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² Saint Andrews Biological Station, St Andrews, NB.

The release of organic particles during farm operations gets transported, dispersed and potentially degraded as they sink toward the bottom. The consequence to the bottom ecosystem depends upon the rate at which the material settles on the bottom and the ability of the ecosystem to assimilate the added flux of organics. In order to assess the surface area of deposition underneath and in the vicinity of fish farms in the South Coast of Newfoundland, currents at different depths were recorded using Acoustic Doppler Current Profiler at locations near aquaculture farms. The current velocity time series together with the bathymetry of the area and the feed input data are used to feed the aquaculture waste deposition model DEPOMOD- which is used to model the deposition and biological effects of waste solids from marine cage farms. The result of the analysis of the model output and that of the sensitivity studies for the model will be presented. The output is validated using measured carbon deposition at the bottom obtained from the analysis of data from sediment traps installed around the sites. The comparison shows that the model can reproduce the amount of carbon that is measured around the sites. The study also shows that hard and deep bottom under fish farms is depositional. This work discusses the validity of the use of DEPOMOD as a tool for understanding and forecasting the foot-prints of aquaculture activities in relatively deep-water region on the south coast of Newfoundland.

Marine finfish aquaculture hard seabed monitoring in British Columbia

C. Salvador*¹

¹Aquaculture Environmental Operations, Fisheries and Oceans Canada, Campbell River, British Columbia V9W 3M5

Approximately 40% of marine finfish aquaculture facilities in British Columbia are located over hard seabed substrates where sediment grabs and other conventional soft bottom sampling techniques are inappropriate. Characterized by generally higher currents and lower natural sediment accumulation, the biological communities at these sites are dominated by epibenthic organisms and lack much of the infauna of soft bottom communities. Following a change of regulatory regime from provincial to federal

governments, compliance thresholds set out in aquaculture licences have been implemented at hard bottom sites for the first time anywhere in Canada.

The tool chosen for operational monitoring is the collection of video data at a designated zone of compliance and the assessment of percent cover of *Beggiatoa spp.* and Opportunistic Polychaete Complexes (OPC) as indicators of impact. Limitations to this technique have shown to be consistently interpreting video data and Remote Operated Vehicle (ROV) positioning, but consensus audits and navigation software may lead to a more consistent approach. Limitations to the chosen indicators of impact relate to using species that are observed in soft sediments rather than those usually found on hard substrates. More research into possible secondary compliance parameters and determining harmful impacts to hard bottom communities from organic enrichment near marine finfish aquaculture operations is needed.

Cultured Shellfish Forum

Wednesday, May 30, 2012 – mercredi 30 mai, 2012

08:15 AM – 09:35AM

Location: Victorian Ballroom

Chairs: Peter Warris and Jarrod Gunn-McQuillan

08:15 L. Duncan

Marketing to food service

08:35 D. Tillapaugh

The Vancouver Island University Deep Bay Marine Field Station –leadership in design and innovation

08:55 C. Hendry

Innovation in Newfoundland shellfish aquaculture

09:15 F. Bourque

Various Technological Developments in the Québec Aquaculture Industry

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

Marketing to food service

L. Duncan ¹

¹Mussel Industry Council of North America, 101 Longworth Ave, Charlottetown, PEI C1A 5A9

For the past three years, the Mussel Industry Council has been focused on increasing the volume of mussels eaten and making mussels Top of Mind. A large portion of this marketing activity has been directed at Chefs and Food Service. This presentation will be an examination of the influence chefs have on the consumption of certain seafood, how we engaged them and also a look at their sustainability values.

The Vancouver Island University Deep Bay Marine Field Station –leadership in design and innovation

D. Tillapaugh

Centre for Shellfish Research, Vancouver Island University, Nanaimo, BC, Canada, V9R 5S5

The award winning Deep Bay Marine Field Station is based on the traditional field station model which includes a university based research centre (the Center for Shellfish Research at Vancouver Island University in Nanaimo) and a field station located in the heart of the industry (i.e. Baynes Sound which produces fully half the shellfish produced in BC). To address diverse industry needs (e.g. R&D, technology innovation, training, product development, public education and engagement, etc.) the Field Station was designed to facilitate the concurrent delivery of multiple shellfish related programs. To demonstrate leadership in environmental sustainability and highlight the need to maintain coastal water quality the Field Station was designed as a green building to meet the highest construction standard -LEED Platinum™. Financial self sufficiency is the basis for the business model guiding day to day operations. Currently in the first year and ramping up programs and operations, the Field Station derives revenues from private events and public education, training activities, contract and grant funded research and philanthropic donations. This presentation will review the history of the Field Station and discuss the financial challenges and future opportunities for the Field Station using this new multi-dimensional, integrated model.

Innovation in Newfoundland shellfish aquaculture

C. Hendry*¹, G. Simms², T. Mills³, S. Allen⁴, D. Walsh⁵, L. Fudge⁶, and J. Roberts⁷

¹ Northwest Atlantic Fisheries Centre, Fisheries and Oceans Canada, PO Box 5667, St. John's, NL A1C 5X1

² LBA Enterprises Ltd, P. O. Box 69, Little Bay, NL A0J 1J0

³ Nortlantic Processors Ltd., PO Box 99, Winterton, NL A0B 3M0

⁴ Allen's Fisheries Ltd., PO Box 40, Benoit's Cove, NL A0L 1A0

⁵ Newfoundland Organic Seafoods Inc., 34 Devereaux Lane, Logy Bay, NL A1K 3A6

⁶ Cross Bay Mussel Farms, Brighton, NL A0J 1B0

⁷ Badger Bay Mussel Farms Ltd., 85 Main Street, PO Box 316, Triton, NL A0A 1U0

Since its inception in 2008, the Aquaculture Innovation and Market Access Program (AIMAP) has provided funding to several companies in Newfoundland to apply innovative methods or technologies towards the goals of increased sustainable production, increased diversification, and green technologies. In the shellfish aquaculture sector, this program has assisted in adoption of submersible longline technologies, optimization of hydraulic systems, a live holding system, a pilot-scale blanched processing system, and the development of an oyster aquaculture sector. This presentation aims to provide an overview of these projects, share results, and help continue the growth in the shellfish aquaculture sector in Canada.

Various technological developments in the Québec aquaculture industry

F. Bourque¹, H. Murray*² and D. Leblanc¹

¹ Merinov, 107-125, chemin du Parc, Cap-aux-Meules, Québec, G4T-1B3

² Merinov, 6 rue du Parc, Grande-Rivière, Québec, G0C-1V0

The Quebec aquaculture industry, by its geographical situation, faced several technical and technological challenges. In the last years, a technical support service in marine aquaculture has been introduced in order to help producers to solve the technical problems they are dealing with. Several devices have been developed over the last 4 years to mechanize operations, reduce production costs or reduce the risk of injuries. The improvement of an embedded anchoring system offers a quick and secure method of installing mussel longlines. A new buoy washer reduces by four the time allocated to this

task. A lantern net cleaner also decreases the time allocated to this task. A clam harvester and others equipments are currently in development.

Contributed Papers

Wednesday, May 30, 2012 – mercredi 30 mai, 2012

08:15 AM – 09:35 AM

Location: Georgian Ballroom

Chair: Marc Ouellette

08:15 G. K. Reid

Using image analysis software and the Archimedes Principle to determine the submersed weight supported by a buoy

08:35 D. W. Fredriksson

Development of an aquaculture net finite element modeling technique with laboratory bench-top measurement validation

08:55 C. Uhlig

An integrated concept for land-based mariculture with particular emphasis on microalgae based biofilter in Norway

09:15 G. Mabrouk

Characterization of the oceanographic conditions in the South Coast of Newfoundland in support of aquaculture

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

Using image analysis software and the Archimedes Principle to determine the submersed weight supported by a buoy

G.R. Reid^{1,2}, K. Ross²

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The proportion of a buoy submersed can provide insight into the weight it supports, which in turn may provide useful information such as shellfish growth rates and product loss. As part of a high school summer student project, image analysis software was used in conjunction with the Archimedes Principle (the weight of the water displaced is equal to the weight of the object) to determine the supporting weight of the buoy. The volume of a spherical buoy was calculated, validated, deployed in salt water, and photographed supporting three different weights. Image-j software juxtaposed the two dimensional image area of an unsubmersed portion above the waterline with the two dimensional image area of the full buoy, to determine the percentage submersed. This percentage was multiplied by the full volume of the buoy to determine the volume displaced and weight supported. The hung weights were measured empirically and water displaced by the weights subtracted, to determine actual submersed weight. The use of image analysis to estimate the supported weight of a spherical buoy was highly correlated with the actual submersed weight ($r^2 > 0.90$). Correction factors can be applied to estimate the weight of materials out of water.

Development of an aquaculture net finite element modeling technique with laboratory bench-top measurement validation

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The escape of fish from an aquaculture facility can be considered a major threat to wild populations. Openings in the containment net can occur from stresses induced by

inadequate attachment, abrasion or fish bite. Upon failure, stresses within the net can become further concentrated and may propagate. The objectives involve the development of a net finite element model with focus on accurate material properties and a representation of the net twine structure. The approach includes a combination of numerical simulations and bench-top laboratory tests. Material and geometric properties of a net panel were obtained from peer-reviewed literature, complemented with mesh tensile testing. Preliminary simulations were performed under operational conditions to estimate tension values within the net. Since the distribution of tension can be viewed as a two-dimensional problem dependent on mesh construction technique, a set of elongation experiments were conducted under orthogonal loading conditions with planar deflections measured. Finite element models were then built with a focus on the twine attachment structure (i.e. “super-knot”) and loaded comparing results with the bench-top laboratory data set. Once the tension response of the panel was adequate, techniques were investigated to incorporate the modeling approach on a full size net pen or fish cage.

An integrated concept for land-based mariculture with particular emphasis on microalgae based biofilter in Norway

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Norwegian Institute for Agricultural and Environmental Research, Fr. A. Dahlsvei 20, N-1432 Ås, Norway

The use of open sea fish cage systems for salmon production cause increasing environmental challenges regarding pests, biodiversity and pollution. These problems may be avoided by using land-based fish farms, where effluent quantity and quality are controlled. However, there are several obstacles when treating wastewaters from fish farms. This paper presents a theoretical mass balance approach for an experimental land-based salmon farm with a capacity of 780t fish per year near Trondheim (64° N), with particular emphasis on the potential of wastewater treatment due to microalgae production. After microfiltration of the particulate nitrogen (N) and phosphorous (P) an annually emission of approximately 24t dissolved N and 3t P is available for microalgae production. An on-site annually average photosynthetically active radiation (PAR) of 240 $\mu\text{mol photons m}^{-2} \text{s}^{-1}$ could theoretically yield about 140t dry microalgae per hectare, thus neutralizing 7t N und 1t P ha^{-1} . However, seasonally PAR limitations during winter and photoinhibition during summer reduces productivity probably to about 100t $\text{ha}^{-1} \text{yr}^{-1}$. However, with an calculated effluent rate of 1.7 $\text{m}^3 \text{s}^{-1}$ the main challenges appears to be the proper balance between bioreactor surface exposed to PAR, water flow rate, residential time and nutrient concentrations.

Characterization of the oceanographic conditions in the South Coast of Newfoundland in support of Aquaculture

G. Mabrouk^{*1}, A. W. Ratsimandresy¹, D. Drover¹, P. Goulet, R. Losier², and L. Sheppard¹

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² Saint Andrews Biological Station, St Andrews, NB.

Unlike many regions in Canada, total aquaculture production in the NL region has demonstrated continuous growth since 2005 and is expected to increase fourfold in the near future. The fast expansion of aquaculture operations in Bay D'Espoir and Fortune Bay presents significant challenges in site selection, habitat assessment and the establishment of bay management areas (a necessary approach for the sustainability of the industry). The aquaculture oceanography project under the Program for Aquaculture Regulatory Research by DFO Science addresses the need for understanding the oceanography on the South Coast. This knowledge will help in establishing scientifically validated production and management of aquaculture.

Through Program for regulatory aquaculture research (PARR), a project was initiated 2008 and still ongoing to collect oceanographic and atmospheric parameters in many areas of Bay D'Espoir and Fortune Bay. This work presents results of these measurements and their analysis. It will describe the spatial and temporal variability of the oceanographic conditions where farmed fishes evolve and provides an insight of the similarities and differences between the two bays. An attempt will be given to relate these environmental conditions to various aquaculture issues such as assessing carrying capacity, harmful alterations or destruction of habitat, near- and far-field environmental and fish-to-fish interactions, disease management, and farm siting.

Sustainability Forum – Transparency, Standards, and Science Communications

Wednesday, May 30, 2012 – mercredi 30 mai, 2012

08:15 AM – 09:35 AM

Location: Provinces Lounge

Chair: Cyr Couturier

08:15 C. Roper

Building a supply chain business case For aquaculture certification schemes

08:55 W. More

Best aquaculture practices - An update on sustainable production and certification

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

Building a supply chain business case for aquaculture certification schemes

C. Roper¹

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Whether domestic or international, supply chain growth is a result of the relationship between production capacity and consumer expectations expressed as product demand. This presentation explores the interactions between these two from a sustainability perspective (as either opportunities or constraints) and the implications for the Canadian aquaculture industry. Key areas of the presentation include: the evolution of sustainability as an issue and certification schemes as they relate to aquaculture; current global certification issues positively or negatively impacting demand for aquaculture products; and how Canadian aquaculture enterprises can proactively prepare to build effective and efficient supply chains through aquaculture certification.

Best aquaculture practices – An update on sustainable production and certification

W. R. More

BAP Program Director, Global Aquaculture Alliance, aquacert_1@tampabay.rr.com

Supply dynamics continue to dominate product demand and markets for aquaculture product remains fragmented due to trade barriers, litigation and consumer concerns regarding the safety of the product they eat and the effect of farming practices on the environment. Responsible, properly conducted certification programs like Best Aquaculture Practices (BAP) benefit the flow of responsibility produced safe goods into the market place, promote sustainability and increases buyer and consumer confidence in the way the product is produced and traced back to its origin. Globally, BAP is the largest process certification program for aquaculture products. Over 650 seafood processing plants, farms, hatcheries and feed mills have been certified since the BAP program was implemented in 2005. As of April 1, 2012, more than 1.13 million metric tons of BAP certified farmed shrimp, tilapia, *Pangasius*, catfish and salmon were available worldwide. A new mussel standard developed by the standard owner Global Aquaculture Alliance (GAA) will be implemented in the fall of 2012.

Cultured Shellfish Forum (continued)

Wednesday, May 30, 2012 – mercredi 30 mai, 2012

11:00 AM – 12:20 PM

Location: Victorian Room

Chairs: Peter Warris and Jarrod Gunn- McQuillan

11:00 C. Gionet

Wild spat collection at Little Shemogue Oyster Company

11:20 L. A. Davidson

Culturing oysters glued to strings in an exposed site vs. a sheltered site in Baie des Chaleurs, NB

11:40 D. Méthé

Oyster nursery in low salinity sites: effect on productivity and physiology

12:00 L. Hiemstra

Overview of new scalable hatchery developed for increasing the production of *Mytilus* seed for BC aquaculture

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

Wild spat collection at Little Shemogue Oyster Company

C.Gionet^{*1} and P.Firminger²

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Little Shemogue Oyster Company has been growing oysters since 2006. They are collecting spat from the wild like most of the oyster growers in New Brunswick. They have experienced bad spat collection in over the last two years. Collectors need to be limed to attract oyster spats. After talking to growers from different parts of the Atlantic Provinces, they realized everyone had different cement recipes. They tried two different formulations and observed differences in number of spat collected. The company wanted to try to find the best cement for an optimum spat collection for their oyster culture. Also, biofouling is a particularly challenging problem for shellfish aquaculture producers. The cost of labor to remove biofouling is significant. It was therefore an important addition to this trial. The objective of this project was to evaluate five cement preparations and five different biofouling treatments. Results demonstrated that the best cement is the PEI recipe and the dip for biofouling treatment. Surprisingly, the results of this study seemed to demonstrate that cement attracts barnacles as much as oysters. The collectors which had no cement may represent a better choice.

Culturing oysters glued to strings in an exposed site vs. a sheltered site in Baie des Chaleurs, NB

M. Niles¹, L.-A. Davidson^{†*}, R. Nowlan¹, S. Doiron², R. Sonier¹, L. Comeau¹

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Traditionally, the eastern oyster (*Crassostrea virginica*) is cultivated in sheltered bays and estuaries. However, a feasibility study was conducted on oysters grown in an exposed (off-shore) environment using the oyster glued on string method. This method consists of gluing oysters in clusters of three with a special cement mixture on strings which are then suspended horizontally within a rebar frame. For the feasibility study, the exposed site, at two depths, in Stonehaven NB was compared to a sheltered (in-shore) site in Caraquet Bay NB in terms of oceanographic parameters and oyster growth and survival. Both sites experienced north-east and south-west dominant currents. Current velocities were 25 X greater at the off-shore site than at the in-shore site with averages of 15.3 cm/s and 0.6cm/s, respectively. Oysters grown inshore had significantly greater

growth than those grown offshore. The condition index of oysters grown offshore were also compared to those grown inshore during the spawning season.

Oyster nursery in low salinity sites: Effect on productivity and physiology

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²Atlantic Veterinary College, University of Prince Edward Island, Charlottetown, PE

Oyster aquaculture in Atlantic Canada has been developed mainly in areas where wild populations naturally occur. The use of non-traditional sites is gaining more interest with the growth of the oyster industry. Given that low salinity environments are less impacted by pests, pathogens and diseases, this project aims to assess the benefits of extending oyster farming operations upriver (12 ppt) in the Richibucto estuary (New Brunswick, Canada). Oyster juveniles cultivated at an upriver site for initial grow-out would subsequently be transferred to the mouth of the river in the final year.

In this field study, oysters from 2 different sources have been submitted to a reciprocal transfer experiment (May-October) to assess the effect of salinity changes on oyster growth, CI, mortality, lysosomal destabilization (measured using neutral red retention assay) and digestive tubule atrophy. The study suggests that oyster productivity (shell growth, CI, mortality) may not be affected by short-term natural stressors such as salinity, and in fact, may benefit from the ecological conditions offered by a low salinity site (warmer waters, more nutrients, limited fouling etc.). However, in the fall (October) the magnitude of change in salinity is highly variable at a low salinity site and oysters demonstrate high lysosomal destabilization (63.6%) and tubule atrophy. This study also revealed that additional consideration must be given with the application of neutral red retention assay on oysters from a cold environment.

Overview of new scalable hatchery developed for increasing the production of *Mytilus* seed for BC aquaculture

Grant Hunt¹ and Linda Hiemstra^{1*}

¹Island Sea Farms, PO Box 445, Ganges, Salt Spring Island, BC V8K 2W1

Island Sea Farms Inc is a BC company that cultivates mussels in a land based hatchery on Salt Spring Island and on deepwater sites near Cortes Island, BC. The company has designed an innovative modular hatchery for the purpose of increasing the production of seed by 50% without increasing the hatchery footprint. In a project supported by Fisheries and Ocean Canada Aquaculture Innovation and Market Access Program, three

modules (algal production, larval production, and nursery culture) were constructed separately and scaled to production requirements that allow for future increases in production. The new hatchery was complete in the fall of 2011. In March 2012 (mid-point of spawning) production of algae, larvae and juveniles each exceeded expectations with a 43%, 58%, 38% increase respectively. Production of seed increased 52% at the density previously determined optimal for grow-out. The addition of an innovative greenhouse, a component of the algal module, contributed to an increase in culture densities and doubled algal production with no increase in fuel costs.

Advances in Fish Nutrition

Wednesday, May 30, 2012 – mercredi 30 mai, 2012

11:00 AM – 12:20 PM

Location: Georgian Ballroom

Chair: André Dumas

11:00 M. Boudreau

Preparation and investigation of experimental feeds for American lobster (*Homarus americanus*) larvae

11:20 C. Bullerwell

Performance of rainbow trout (*Oncorhynchus mykiss*) fed *Camelina sativa* seeds and high oil residue meal

11:40 R. Yossa

The effects of dietary biotin on zebrafish *Danio rerio* reproduction

12:00 J. Fraser

Digestibility of *Camelina sativa* seed and its by-products by Atlantic cod (*Gadus morhua*), rainbow trout (*Oncorhynchus mykiss*), and Atlantic salmon (*Salmo salar*)

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

Preparation and investigation of experimental feeds for American lobster (*Homarus americanus*) larvae

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The lobster industry is responsible for one of the most important aquatic exports in Canada. The preservation of American lobster populations are of great priority for the well-being of our marine ecosystem as well as our economy. A decade ago, Homarus Inc. undertook a lobster stock enhancement project in the Maritimes through a stage IV post-larvae release program in an effort to raise the lobster population in areas where landings were in decline. In order to develop this program, a large scale and cost-effective hatchery production was necessary. One area where there are improvements to be made is in the cost and efficiency of the feed. Currently, feeds used in lobster larviculture are based on commercial products made from *Artemia* and are not specifically adapted for lobster rearing. Therefore, this project aims at developing a feed that meets the nutritional requirements of lobster larvae, while being cost-effective. Biochemical profiles (proteins, lipid composition, amino acids) will be used to evaluate the quality of the larvae fed experimental feeds compared to wild lobster larvae. Preliminary results show strong differences in fatty acid profiles, notably the prevalence of cetoleic acid (22:1 n-11) in wild lobsters, which is almost non-existent in hatchery raised larvae.

Performance of rainbow trout (*Oncorhynchus mykiss*) fed *Camelina sativa* seeds and high oil residue meal

C. Bullerwell*, and D.M. Anderson

Department of Plant and Animal Sciences, Nova Scotia Agricultural College, PO Box 550, Truro, NS, B2N 5E3

The aquaculture industry requires dietary alternatives to fish meal. Plant protein sources such as Camelina meal (CM) may be a promising alternative. A feeding trial with 720 Rainbow trout was conducted using eight, randomly assigned, isocaloric and isonitrogenous diets including a control diet, 10, 20 and 30% inclusion of either Camelina seeds (CS) or high oil residue CM (HO), a double replacement diet (DR) with 10% solvent extracted CM and 100% Camelina oil. Twenty-four tanks (40L) supplied with flow-through freshwater at 14°C each contained 30 fish fed to satiation three times a day and weighed every 4 weeks. Mean body weights (BW), feed consumption (FC), feed conversion ratio (FCR) were calculated for 0-4, 4-8 and 8-12 weeks. At week 12, BW were lower ($P \leq 0.05$) for fish fed DR, 20CS, 30CS and 30HO diets compared to all other

diets. FC was not affected by diet. FCR was poorest ($P \geq 0.05$) for DR and 30HO diets during 0-4 weeks, and best ($P \geq 0.05$) for 10CS and 10HO diets. During 4-8 weeks, FCR was increased ($P \geq 0.05$) for 30CS and 30HO compared to all other diets. FCR was similar ($P > 0.05$) for all diets during 8-12 weeks. Inclusion of 10CS, 10HO and 20HO did not affect performance of rainbow trout.

The effects of dietary biotin on zebrafish *Danio rerio* reproduction

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Groupe de Recherche en Recyclage Biologique et Aquaculture, Département des sciences animales, Université Laval, Québec, QC, Canada, G1V0A6.

An experiment was conducted to investigate the effects of dietary biotin on zebrafish *Danio rerio* reproduction. Biotin and avidin (biotin antagonist) were added to two isonitrogenous and isocaloric purified diets to provide molar avidin:biotin ratios of 0:1 (biotin-sufficient diet) and 120:0 (biotin-deficient diet). Each diet was fed to a group of males (mean initial mass 0.262 g) and females (mean initial mass 0.285 g) for 99 days. Following this feeding period, males fed the biotin-sufficient diet exhibited higher gonado-somatic index (I_G), sperm density, sperm motility and sperm viability than those fed the biotin-deficient diet ($P < 0.05$). In the presence of biotin-sufficient males, biotin-sufficient females spawned more eggs (222.2 eggs) than biotin-deficient females (18.8 eggs) ($P < 0.05$). The same pattern was observed with biotin-deficient males (7.6 vs. 1.8 eggs) ($P < 0.05$). Biotin-sufficient males generated a higher percentage of fertilized eggs (90% vs. 42%), hatching rate (62% vs. 27%), larvae survival (98% vs. 37%) and larvae length at 7 day-post-fertilization (4.4 mm vs. 4.2 mm) than biotin-deficient males ($P < 0.05$). These results show that biotin status of the male is of high consideration for successful breeding in zebrafish. The present study provides first evidences of the importance of dietary biotin in zebrafish reproduction.

Keywords: Avidin, biotin, reproduction, sperm quality, zebrafish

Digestibility of *Camelina sativa* seed and its by-products by Atlantic cod (*Gadus morhua*), rainbow trout (*Oncorhynchus mykiss*), and Atlantic salmon (*Salmo salar*)

J.M. Fraser*¹ and D.M. Anderson¹

¹ Department of Plant and Animal Sciences, Nova Scotia Agricultural College, 58 River Road, Truro, Nova Scotia, Canada, B2N 5E3

The oilseed *Camelina sativa* and its by-products have potential in diets for Atlantic cod (AC), rainbow trout (RT), and Atlantic salmon (AS). Ground full-fat seed (FFS), pre-

pressed meal (PP), oil (O), and PP solvent extracted meal (PPSE) were tested. A basal diet with chromic oxide (dietary marker) had test ingredients added at 30% (O, 20%) of the diet. The experiment was completely randomized (diets in triplicate) in an 18-tank flow-through system; AC (69.5 g/fish \pm 0.8), saltwater (7.0°C \pm 0.04); RT (153 g/fish \pm 1.4), freshwater (10.0°C \pm 0.03); AS (105.8 g/fish \pm 2.1), freshwater (10.4°C \pm 0.03). Feces were collected via sedimentation. Apparent digestibility coefficients (ADC) of dry matter, crude protein, gross energy and crude fat were calculated using the indicator method. All parameters were subjected to ANOVA using the mixed model of SAS ($p \leq 0.05$). Protein ADC (%) were high for all species; FFS (AC, 89.7; RT, 79.2; AS, 87.9); PP (AC, 90.0; RT, 86.9; AS, 87.6); PPSE (AC, 88.4; RT, 83.9; AS, 85.8). Gross energy ADC (%) were species specific for each ingredient; RT (FFS, 45.0; PP, 62.9; O, 86.0; PPSE, 57.4); AS (FFS, 66.7; PP, 69.6; O, 95.9; PPSE, 62.3); AC (FFS, 69.0; PP, 68.9; O, 53.3; PPSE, 74.6). Digestible nutrients are available for future ration formulations.

**Sustainability Forum – Transparency, Standards, and Science Communications
(continued)**

Wednesday, May 30, 2012 – mercredi 30 mai, 2012

11:00 AM – 12:20 PM

Location: Provinces Lounge

Chair: Cyr Couturier

11:00 R. Salmon

Providing options for Canadian farmed seafood suppliers - Canadian organic farmed aquaculture standards and FAO-based certification option

11:20 J. Smith

The aquaculture sustainability reporting initiative – reaching out to Canadians

11:40 G. Marty

A fish pathologist's view of science communication

12:00 DFO Science Communications

12:20 Panel Discussion

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

Providing options for Canadian farmed seafood suppliers - Canadian organic aquaculture standards and FAO-based certification option

R. Salmon

Executive Director, Canadian Aquaculture Industry Alliance, Box 81100, World Exchange Plaza, Ottawa, ON, K1P 1B1

Canadian Organic Aquaculture Standards were released this spring, after several years of development and validation by industry, regulators, environmental and public stakeholders. Canadian consumers will now have the opportunity to choose certified organic aquaculture products including finfish, shellfish and aquatic plants. The new organic aquaculture standard will enable aquaculture operators to transition their farms to organic production according to the specific management and production practices described in the new standard. These practices extend the principles of organic farming to the farming of aquatic plants and animals, thus enhancing the quality and sustainability of the environment. CAIA is also assessing the possibility of developing a unique, credible and internationally-relevant certification system for Canadian aquaculture producers to demonstrate commitment to quality, environmental responsibility and food safety. This pilot project is based upon FAO-responsible aquaculture management guidelines, and may offer yet another market option for Canadian producers to be certified for sustainable practices.

The Aquaculture Sustainability Reporting Initiative (ASRI)

J. Smith.

Aquaculture Management Directorate, Fisheries & Oceans, Ottawa, ON.

Sustainability reporting is the practice of measuring, disclosing, and being accountable to internal and external stakeholders for organizational performance toward the goal of sustainable development. Reporting must be relevant, balanced, substantive and transparent, addressing both positive and negative conditions and trends.

The ASRI was developed to meet a growing desire to enhance transparency with respect to the aquaculture sector and to serve the information needs of federal, provincial, and territorial governments, industry, Aboriginal communities and other interests related to the social, economic and environmental aspects of aquaculture. Following are the objectives of the ASRI:

- Establish a means for reporting conditions and trends in the aquaculture industry in Canada;

- Provide relevant information on the sustainability of aquaculture in Canada; and
- Establish a baseline for evaluating the extent to which DFO program activities are working to foster a sustainable aquaculture sector in Canada.

Through the ASRI process, DFO and its provincial and territorial partners will further engage stakeholders in the development of relevant performance measures and information for future reports. It is anticipated that the ASRI and the resulting reports will help build public confidence and enhance the social licence for aquaculture in Canada, as well as access to markets for Canadian aquaculture products. Aquaculture sustainability reporting is a central element of the National Aquaculture Strategic Action Plan Initiative.

A fish pathologist's view of science communication

G. Marty

Animal Health Centre, Ministry of Agriculture, 1767 Angus Campbell Rd., Abbotsford, BC, V3G 2M3

As a veterinarian, communicating principles of medical science to the public must follow a code of ethics that can simultaneously enhance and restrict my efforts. My efforts are enhanced by an ethical responsibility to contribute to the education of the public about the health of animals. My efforts are restricted because medical records can only be released on authorization of the owner of the information in the records. Also, governments are disinclined to have their employees speak freely with the press. My success in overcoming these challenges began in September 2011, when my histopathology database of 2,706 farmed salmon was released to the public during the Cohen Commission hearings. A columnist for a BC newspaper wrote, "You will be staggered by how many hundreds of times [classic symptoms of ISA] were found in fish farm Atlantic salmon." I responded the next morning, "From 2003 to 2010, the province tested 4,726 dead farm fish for the ISA virus, and all fish tested negative—no virus." By noon the newspaper had posted a correction online, and the columnist no longer discusses fish farms in the newspaper. Over the next several months, my simple response was used widely in government and industry communications.

Culture Shellfish Forum (continued)

Wednesday, May 30, 2012 – mercredi 30 mai, 2012

14:00 PM – 15:20 PM

Location: Victorian Room

Chairs: Peter Warris and Jarrod Gunn - McQuillan

14:00 J. Wyatt

The effect of extended holding time on the condition, physiology and stress response of cultured blue mussels (*Mytilus edulis* L. 1758) following commercial harvest in northeastern Newfoundland

14:20 J. Willis

Cryptosporidium and *Giardia* in contaminated American Oysters from Prince Edward Island: Current knowledge and ongoing efforts to distinguish human pathogenicity of biased samples

14:40 D. Gallardi

Evaluation of long-term live holding in blue mussels: changes in condition, lipid profile and organoleptic testing

15:00 L. Gilmore Soloman

Oyster production in hanging structures suspended from mussels long lines in Magdalen Islands, why not?

15:20 HEALTH BREAK

15:50 C. Gionet

Next steps towards the development of the American oyster (*Crassostrea virginica*) breeding program in New Brunswick

16:10 S. Backman

Improve production efficiency of scallop aquaculture by integrating HDPE salmon cage technology with existing lantern net culture methods and the addition of communal species

16:30 Discussion Panel

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

The effect of extended holding on the condition, physiology and stress response of cultured blue mussels (*Mytilus edulis* L. 1758) following commercial harvest during in northeastern Newfoundland

J. Wyatt^{1, 2}, S. Kenny¹, K. D. Hobbs¹, T. Mills³, H. D. Marshall⁴, H. M. Murray¹

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In order to determine the maximum time for live holding we investigated the physiological response of blue mussels held for up to 3 months in a commercial holding facility during the summer, fall, winter, and spring between 2010 and 2011. There was a significant decline in the dry weight condition index of held mussels over time for the summer, fall, and spring when compared to mussels harvested fresh from the lease while there was an increase during the winter. Neutral red retention time decreased significantly in holding for both seasons but not in the fresh harvest, indicating an increase in stress response as a result of extended storage. Expression of the antimicrobial peptide MGD2 was evident in the summer holding samples as early as 1 week but did not occur in the fall holding samples until 3 months. Expression of MGD2 was observed in the 1 week sample in fall fresh-harvested mussels. This suggests that holding conditions have stimulated the immune response in a manner potentially related to time in holding and environmental temperature. Based on our results we recommend one month be the maximum time allowed in ambient extended storage during warm water seasons.

***Cryptosporidium* and *Giardia* in contaminated American oysters from Prince Edward Island: Current knowledge and ongoing efforts to distinguish human pathogenicity of biased samples**

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Cryptosporidium parvum and *Giardia duodenalis* are zoonotic parasites capable of causing acute or chronic gastroenteritis in humans. Prevalence of these parasites is determined by direct immunofluorescence analysis (DFA), but molecular genotyping is required to confirm whether isolates have zoonotic potential. Both *C. parvum* and *G. duodenalis* have been recently detected in cattle farms and surrounding water sources in Prince Edward Island (PEI), raising speculation regarding their potential to contaminate local filter-feeding bivalves. Additionally, the Hillsborough Harbour area has undergone numerous shellfish closures since 2009 due to continual overflows of the sewage wastewater treatment facility from heavy rainfall events. Opportunistic samples of oysters (*Crassostrea virginica*) were collected in 2009, 2010, and 2011 from various locations closed to shellfishing for parasitological analysis. Parasites were isolated from the oyster homogenates and quantified by DFA. The prevalence of *Cryptosporidium* and *Giardia* in these biased samples will be reported at this meeting, and details regarding current efforts to distinguish the human pathogenicity of these isolated parasites via optimization of nested polymerase chain reaction protocols will be discussed.

Evaluation of long-term live holding in blue mussels: changes in condition, lipid profile and organoleptic testing

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Mussel aquaculture in Newfoundland is expanding. One of the challenges the industry needs to address is the extended storage of mussels. Due to transportation complications, freshly harvested product may not immediately be shipped to market, and thus may require extended holding in a processing facility. Wet storage of mussels over long periods has been shown to affect meat yield, quality, condition index, stress response and mortality. This is the first study to investigate the biochemical composition of mussel tissue (total lipids, fatty acids and glycogen content) and its relationship with condition index and meat palatability following extended holding. Morphometric measurement, total lipids and fatty acid content were determined for mussels held in a commercial holding facility for 1 month during both the fall and winter seasons in 2011/2012. Panellists were also asked to evaluate mussel palatability with both discriminative and descriptive tests. The data shows a progressive loss of dry tissue weight and an increase

in water content over the holding period. The palatability data shows that the panellists were unable to determine a significant difference between mussels kept in holding and those freshly harvested. Trends in total lipids and fatty acid content will also be discussed.

Oyster production in hanging structures suspended from mussels long lines in Magdalen Islands, why not?

L. Gilmore Solomon^{*1}, C. Cyr¹, J.F. Laplante¹

¹ Merinov-Centre d'innovation de l'aquaculture et des pêches du Québec. Centre des Iles, 107-125 Chemin du Parc, Cap-aux-Meules (Qc), G4T 1B3.

The American oyster (*Crassostrea virginica*) is known to be lucrative species in Maritimes region since many years. The economical feasibility of oyster culture has not been yet demonstrated for Magdalen Islands. Therefore, this new shellfish production avenue was explored in 2010 and 2011 in collaboration with mussel's grower which want to diversify their production.

The main objective of this project was to evaluate bio-technico-economic potential of oyster culture with hanging structures. Three rearing structures were compared: Japanese lanterns, oysters grown on vertical rope (glued) and oyster grown on horizontal rope (rack). These structures were put on long lines in two mussel's culture site: House Harbour (HH) lagoon and Plaisance Bay (PB) offshore site. Oyster growth results were higher for oyster grown on vertical ropes in the lagoon. Oyster grew about the double of their original size (from 30 to 67 mm in average) in one and half year. However, high mortality percentage and oyster lost percentage were noticed for this kind of structure. These oyster mortality/lost seems to be related with epibiont fouling on oyster shell.

A new project has started last September and is about the same as the one described above except for some issues, *e.g.* Gaspésie oyster grown attempts. In this project, which will last for two years, oyster structure cleaning techniques will be tried to solve the fouling problem.

Next steps towards the development of the American oyster (*Crassostrea virginica*) breeding program in New Brunswick

C.Gionet*¹, C.Herbinger², New Brunswick Professional Shellfish Growers Association³

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Genetics plays a crucial and significant role in increasing performance and efficiency of animal production, including shellfish. In 2005, the Coastal Zones Research Institute initiated a breeding program for the American oyster. The objectives consisted in (1) determining the amount of genetic variation and genetic structuration of different populations of New Brunswick using neutral genetic markers, and (2) assessing growth and survival of different hatchery-produced families to determine if these characters could be subjected to selection. Two groups of families of the first generation were produced in 2005 and 2007 and grown on an aquaculture site. The performances of these families were estimated and initial results were promising. Growth difference was observed among families and appeared have a genetic basis. Initial work also showed that care must be exerted to avoid confounding genetic and environmental source of variation for the traits of interest. A strategy for the continuation of this program has been proposed. This presentation will summarize the work done to date and present the next steps for the production of a second generation.

Improve production efficiency of scallop aquaculture by integrating HDPE salmon cage technology with existing lantern net culture methods and the addition of communal species.

S. Backman*¹

¹ Magellan Aqua Farms

Magellan Aqua Farms utilizes lantern nets suspended from a buoyed long line. In productive environments these culture methods suffer from high operational and maintenance cost. Magellan Aqua Farms is looking to improve efficiencies by adapting salmon cage technology with traditional lantern methods in combination with the addition of beneficial communal species. This project utilized modified Salmon Cage bird net stands constructed from High Density Polyethylene (HDPE) pipe to create larger more cost efficient rearing units.

The bird stand design currently used by salmon farms required only slight modification with the addition of a hub and spoke reinforcement to the top and bottom.

The design performed well with lower mortality relative to the lantern nets and the introduction of urchins significantly reduced fouling. This cage system once deployed demonstrated reduced fouling relative to the cohort lantern nets and therefore less required maintenance. Subjective assessment of net material suggested the Aquagrid[™] was easier to clean, less affected by fouling and provided a more stable substrate for the scallops.

Advances in Fish Nutrition (continued)

Wednesday, May 30, 2012 – mercredi 30 mai, 2012

14:00 PM – 15:20 PM

Location: Georgian Ballroom

Chair: André Dumas

14:00 S. Granier

Nutritional protein and lipid levels on growth of young-of-the-year Arctic charr
(*Salvelinus alpinus*)

14:20 X. Xue

Gene expression analyses of skeletal muscle and liver tissues of Atlantic cod
(*Gadus morhua*) fed diets containing *Camelina sativa* meal or oil

14:40 S. Plante

New natural ingredient for growth and flesh pigmentation in Atlantic salmon
(*Salmo salar*)

15:00 N. LeFrançois

Genetic and nutritional approach to improve omega-3 content of two *Salvelinus*
sp. and reciprocal hybrids

15:20 HEALTH BREAK

15:50 M-H. Deschamps

The effects of dietary P level on bone metabolism in rainbow trout
(*Oncorhynchus mykiss*): development of new indicators to prevent vertebral
abnormalities in fish farms.

16:10 T. Huynh Thanh

Effects of sucrose addition on Artemia biomass production

16:30 A. Y. El-Dakar

Use of black pepper seeds as a growth enhancer for juvenile of Florida Hybrid
Red Tilapia, *Oreochromis niloticus* (Linnaeus) X *Oreochromis mosambicus*
(Peters)

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

Nutritional protein and lipid levels on growth of young-of-the-year Arctic charr (*Salvelinus alpinus*)

S. Granier*¹, S. Plante² and C. Audet¹

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In fish, as in other vertebrates, feed insuring optimal growth can vary with developmental stage considered, each developmental stage presenting specific nutritional requirements. In fry, proteins requirements are high to sustain growth while lipids play important roles as energy reserves and membrane components. The objective of the present study was to test the effects of different diets characterized by different nutritional lipid and protein levels on growth and on the energetic status in first-feeding Arctic charr. Therefore, five feeds were tested: 1) low-protein, low-fat; 2) low-protein, high-fat; 3) high-protein, low-fat; 4) high-protein, high-fat; 5) commercially available fry feed. The experiment lasted for three months and the results indicate that fry fed diet with the highest protein content were longer, larger and had a higher condition index. On the other hand, fry fed high-fat diets had higher energetic content but a lower growth.

Gene expression analyses of skeletal muscle and liver tissues of Atlantic cod (*Gadus morhua*) fed diets containing *Camelina sativa* meal or oil

X. Xue*¹, M. Booman¹, C. Y. Feng¹, S. Hixson¹, C. Parrish¹, K. Johnstone¹, D. M. Anderson² and M. L. Rise¹

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² Department of Plant and Animal Science, Nova Scotia Agricultural College, P.O. Box 550, Truro, NS B2N 5E3

Due to increasing demand for fish meal and fish oil (marine-derived ingredients) in aquafeed, more sustainable alternatives such as plant-derived proteins and oils are needed. *Camelina sativa* is a viable alternative to marine-derived feed ingredients given the high oil and crude protein content in its seed and meal, respectively. The present experiment examined the nutritional value of camelina-containing diets, and their effects on growth performance, lipid content and composition, and global transcript expression (evaluated using microarrays) of muscle and/or liver in juvenile cod (initial weight ~20 g). Two solvent-extracted camelina meal containing diets (12% and 24% inclusion), two

camelina oil containing diets (40% and 80% replacement of fish oil), and a control diet (containing typical levels of fish meal and fish oil) were fed to cod in triplicate tanks per treatment diet for 10 weeks. There were no statistically significant differences in body weight, condition factor, or hepatosomatic index of cod fed with different diets at any time-point (week 0, 1, 4, or 10) in the feeding trial. The expression of selected genes involved in biological processes such as metabolism and regulation of growth will be studied in experimental and control diet-fed cod skeletal muscle and liver tissues using QPCR.

New natural ingredient for growth and flesh pigmentation in Atlantic salmon (*Salmo salar*)

S. Plante*¹, F. Béland², and M. McNiven³.

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³ Atlantic Veterinary College, University of Prince Edward Island, Charlottetown, PEI, Canada C1A4P3

The culture of carnivorous species such as salmon, greatly depends on the worldwide supply of fishmeal and fish oil. It is now well established that these key ingredients originated from heavily exploited fisheries. Although great progress in finding alternate sources of proteins and lipids have occurred during the last decade, it is important to continue this effort to diversify the high demand of feed ingredients and to reduce the fishing effort on wild fish stock. Flesh coloration is also an important element in salmonid aquaculture. Currently, flesh color is obtained by adding artificial pigments into the feed. Although these pigments are considered safe for human consumption, they still carried the label “artificial” or “color added”. The objective of the present study was to test the effect of adding a shrimp-based hydrolysate to fish feed on growth and flesh pigmentation in Atlantic salmon. This novel ingredient offers high protein (70%) and lipid (16%) levels as well as a good source of natural astaxanthin (600 mg/kg). Therefore, four feeds were tested: 1) no pigment (control); 2) shrimp hydrolysate-based feed; 3) control + artificial pigments added; control + natural pigments added. We will present results of growth performance, flesh quality and flesh color.

Genetic and nutritional approach to improve omega-3 content of two *Salvelinus* sp. and reciprocal hybrids.

N.R. Le François^{1,2*}, V. Desrosiers², F. Dufresne², B.A. Dupont Cyr², G.W. Vandenberg³, E. Wong¹ and P.U. Blier²

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The purpose of this research program is to develop tools and generate information that will enable the development of improved sources of Arctic charr and brook charr or hybrids for aquaculture. The objective is to develop strains capable of metabolizing advantageously vegetable oils with an increased capacity for the synthesis of omega-3. The cardiac benefits of omega-3 are recognized but, their consumption may also be a disadvantage due to their susceptibility to oxidation. High intake of omega-3 may also exacerbate degenerative processes induced by the generation of reactive oxygen species (ROS) and accelerate aging processes. Variability of the enzyme responsible for the desaturation of FA and synthesis of omega-3, the delta-6-desaturase, will be characterized in *S. alpinus*, *S. fontinalis* and hybrids, following diets based on fish or plants oils. The correlation between the expression of delta-6-desaturase and omega-3 content in tissues will be assessed allowing identification of strains and/or families demonstrating a greater potential to maintain good omega-3 profiles. The effect of the inclusion of an antioxidant to protect omega-3 from undesirable oxidation will also be assessed. The development of distinct aquaculture products for the health promoting food market represents a positive element to the growth and diversification of the sector and also should provide producers reduced production costs while introducing them to sustainable production principles.

The effects of dietary P level on bone metabolism in rainbow trout (*Oncorhynchus mykiss*): development of new indicators to prevent vertebral abnormalities in fish farms.

MH. Deschamps*, B. Bourdon, J. Le Luyer, N. Poirier-Stewart, E. Proulx and G. Vandenberg¹

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²Department of Animal and Poultry Science, University of Guelph, Guelph, Canada, N1G 2W1

The development of low phosphorus (P) diets could reduce negative environmental impacts and increase the sustainability of trout production. However, many questions remain regarding the potential of low P diets to trigger skeletal abnormalities during production. The short and long term effects of two P diets (available P = 0.29 and 0.45%) and two feeding regimes (pair-feeding and 80% satiety) on the growth of triploid rainbow trout (60.8 ± 1.6 g) was experimented in 12 circular tanks (n=140/tank; 10.1 to 52.7 kg m⁻³; 12 \pm 2°C; 18L:6D). Intensive sampling was performed to monitor growth performance and vertebral abnormalities (x-rays) and to collect bone tissues. Although no difference on growth was noticed, P deficiency greatly affected bone condition (ash and P content) and high prevalence of malformed fish was observed, reaching up to 57.8% (4 weeks) and 70.9% (24 weeks). A dynamic process during growth produced widely spaced vertebrae showing homogeneous compression and/or pronounced biconcave endplates. Collected samples for P status, hormonal regulation, biomechanics, morphology, histopathology and genomic will be analysed soon. *A posteriori* correlations will allow to find which indicators is the most interesting to follow/prevent the appearance of vertebral abnormalities.

Effects of sucrose addition on *Artemia* biomass production

T. Huynh Thanh*, G. Van Stappen, P. Bossier, P. Sorgeloos

Lab of Aquaculture & Artemia Reference Center, Ghent University, Belgium

Newly hatched *Artemia franciscana* nauplii were stocked at a density of two nauplii/ml in 15 days culture period under a limited-water exchange system. Four treatments provided with independently four different diets- normal feeding (NF) or ad libitum feeding, a half of NF (1/2NF), a one third of NF (1/3NF), and a quarter of NF (1/4NF). Every day, sucrose additions stimulated heterotrophic bacteria growth in the cultures at carbon/nitrogen (C/N) ratio of 10. The growth and biomass production in the treatments were compared to the control where *Artemia* were provided with only algae at NF feeding regime. A one-liter conical glass tube was used to culture *Artemia* containing 800 ml of instant Ocean synthetic sea salt (FIOSW) at 33 g/l salinity. The tubes were partially submersed in constant temperature water bath to maintain a uniform temperature of 28°C. The results indicated that bacteria grown on sucrose increased the artemia biomass production significantly. Whereby the production increased nearly 75% in NF-fed *Artemia*, 25% in 1/2NF-fed *Artemia*, and there was no significant difference between 1/3NF-fed *Artemia* and the control. Nevertheless, the nutritional supplement from bacteria could not increase production of 1/4NF-fed *Artemia* equal to the control. Additionally, the level of saturated fatty acid (SAFA) and polyunsaturated fatty acid (PUFA) did not decrease with half density of algae supply, there was no significant difference between the treatments and the control, but these fatty acids significantly dropped down to low levels in 1/3NF and 1/4NF-fed *Artemia* as compared to the control. The level of monounsaturated fatty acid (MUFA) in *Artemia* did not change, because

Artemia was provided with very low algae. There was no significant difference in total MUFA content among the treatments, between treatments and the control ($P>0.05$). In brief, the production of *Artemia* was constant in low density algae supply to 1/3NF combined with carbon addition to stimulate bacterial growth in culture unit. To sum up, the addition of carbon source into *Artemia* culture should take into account the reduction of production costs.

Use of Black Pepper Seeds as a growth enhancer for Juvenile of Florida Hybrid Red Tilapia, *Oreochromis niloticus* (Linnaeus) X *Oreochromis mosambicus* (Peters)

S. M.M. Shalaby¹, E. A. Saker¹, A. I. Abdel Moniem² and A.Y. El-Dakar*³

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²-Animal and Fish Production Department, Faculty of Agriculture, Alexandria University, Alexandria, Egypt.

³- Aquaculture Department, Faculty of Fisheries, Suez Canal University, Suez, Egypt

Nutritionists are encouraging use of natural growth promoters in live stock feeds due to their ability to prevent side effects that causes by chemical agents. Black pepper seeds are spices that may use as feed additives to enhance survival, and growth of fish. In the present study, we study the effects of graded levels of black pepper seeds meal (BSM) on growth performance, feed and nutrient utilization, body composition and cost-benefit analysis of Florida hybrid red tilapia juveniles were studied. Twelve glass aquaria with the dimensions of 70 x 30 x 40 cm were used to stock 15 fish averaging 8.6 g/fish. Four experimental diets were formulated to contain 0, 0.5, 1.0, and 2 % of BSM as feed additive in red tilapia. All the diets were isonitrogenous (29-30% crude protein) and isocaloric (457-463 kcal GE/100 g diet). The feed amount was given three times daily, six days a week for 60 days. Fish were weighed biweekly and feed amounts were adjusted on the basis of the new fish weight. Body weight, weight gain and specific growth rate (SGR) of fish fed the control diet was relatively lower than all diets containing BSM. Fish fed 0.5% FSM was significantly higher ($P<0.05$) SGR, feed conversion ratio (FCR), protein efficiency ratio (PER), productive protein value (PPV %) and energy retention (ER %) than other tested black paper levels. No significant differences ($P>0.05\%$) were found in moisture, protein, fat, ash and energy contents among all the fish groups fed BSM levels and the control diet. In addition, diet containing 0.5% BSM was economically superior to other tested levels of black paper in diets. It seemed to save about 28% of feed cost consumed to produce one kilogram fish gain (incidence cost). It was recommended to use black pepper seeds meal in fish feeds on the commercial scale

Key words: Black paper seeds, red tilapia, growth, feed conversion ratio and incidence cost

Advances in Land Based Aquaculture

Wednesday, May 30, 2012 – mercredi 30 mai, 2012

14:00 PM – 15:20 PM

Location: Provinces Lounge

Chair: Melissa Rommens

14:00 A. Desbarats

Advances in recirculating aquaculture technologies

14:20 J. Duston

Integrating red macroalgae into land-based finfish mariculture

14:40 J. Carr

Virginia Freshwater Institute:Land based research

15:00 G. Johnson

Land based Atlantic Halibut Farm on Prince Edward Island

15:20 HEALTH BREAK

15:50 D. Moran

Carbon dioxide and its implications in land-based aquaculture

16:10 P. Nickerson

An overview of heating and cooling process water in land-based aquaculture: best practices, & two case studies

16:30 T. Lyons

Development of a renewed land based aquaculture environmental management program for New Brunswick

Underline denotes presenter is a student eligible for Best Student Oral Presentation Award.

Advances in recirculating aquaculture technologies

A. Desbarats*

Atlantech Companies, 89 Hillstrom Ave, Charlottetown, PEI, C1E 2C8

Adrian Desbarats, Senior Biologist for Atlantech Companies will discuss the latest advances in recirculating aquaculture system (RAS) technologies and RAS design specific to finfish production with a focus on advancements in solids, ammonia, oxygen and carbon dioxide control as well as effluent treatment.

Additional discussion will consider challenges that still remain with RAS technologies specific to productivity, operating cost and environmental impact and what future advancements might be required to overcome these challenges.

Integrating red macroalgae into land-based finfish mariculture

J. Duston

Dept. Plant & Animal Sciences, Nova Scotia Agricultural College, Truro, Canada, B2N 5E3.

Land-based recirculation systems integrating fish and seaweed can fully address the pollution criticisms leveled at finfish mariculture. The challenge is making them economically viable. This presentation will summarize findings of a three-year project to quantify the bioremediation potential of *Chondrus crispus* (Irish moss) and *Palmaria palmata* (dulse) on a land-based Atlantic halibut farm in Nova Scotia coupled with lab-based trials. Experimental factors included macroalgae stocking density, light intensity, temperature, nutrient concentration and aeration duration. With effluent ammonium as high as 300uM, optimum stocking density for nutrient removal was 10g/L, several-fold higher than typical culture practices of red macroalgae. Removal of 50% of dissolved nitrogen would require an estimated biomass ratio of halibut:macroalgae of around 1:1 in winter and 1:6 in summer. Irish moss was a better performer year-round than dulse, the latter faring badly above 15 °C. Continuous aeration for tumble culture of the macroalgae was prohibitively expensive, but electricity costs could be cut 50% by intermittent aeration during the day and no aeration at night, with no loss of growth rate or nutrient removal. However, the low farm-gate price of Irish moss (C\$1/kg) and dulse (C\$0.4/kg) indicate operating costs would greatly exceed income, necessitating the integration of a more valuable end-product.

Atlantic Salmon grow out trial in a freshwater closed containment system

S. Summerfelt¹ and J. Carr^{*2}

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² Atlantic Salmon Federation, P.O. Box 5200. St. ANDREWS, NB E5B 3S8

As the global demand for salmon increases, so does the need for farmed salmon. Land-based closed-containment systems are a way to increase domestic fish production in the U.S. and Canada without polluting the environment, over-exploiting limited water resources, risking escape of domesticated fish into the wild, or exposing cultured fish to obligate pathogens. The objectives of this study were to provide data on growth rate, survival, fish densities, feed conversion, water quality, primary variable costs, waste loads, fish health, pesticide/antibiotic use, and fillet attributes for Atlantic salmon production to food-size within a freshwater commercial-scale closed containment system. Mean fish size exceeded 4 kg/fish in less than 25 months post-hatch and approximately 8-9 months sooner than Atlantic salmon harvested from net pens. Feed conversion was 1.05 kg feed per kg fish and survival exceeded 94%. No vaccines, harsh chemicals, or antibiotics were used. No disease or pathogens were observed. In blind taste tests, the flavor of the closed-containment produced salmon was preferred over the net pen salmon. The novel information obtained through this study will assist with future decision-making by the salmon farming industry and government regulators, resulting in better-informed decisions regarding land-based closed-containment systems for salmon grow out.

Land based Atlantic Halibut farm on Prince Edward Island

G. Johnson*, M. Rommens, J. Dunphy and B. Johnston

Halibut PEI Inc, 1 Causeway Road, Victoria by the Sea, PEI, Canada C0A1G0

After a pilot project in 2008, funded in part by the Department of Fisheries and Oceans Aquaculture Innovation and Market Access Program, Halibut PEI Inc (HPEI) repurposed the Morning Star lobster holding facility into a commercial Atlantic halibut growout facility. Using 3 moderate salinity, salt water wells between 100' and 400' deep, HPEI takes advantage of the geothermal heating and cooling to maintain close to optimal temperatures for Atlantic halibut from the 5 gram juveniles imported from Scotian Halibut in Nova Scotia to 3 kg market fish. HPEI provides Atlantic halibut to a variety of Canadian cities. The HPEI operation concentrates on maintaining a very low environmental foot print by processing effluent and collecting all waste for compost. This presentation describes the facility as it now exists.

Carbon dioxide and its implications in land-based aquaculture

D. Moran

Biology Department, Lund University, S-223 62, Sweden

I become interested in the topic of CO₂ in land-based aquaculture systems after being asked investigate why a newly built 600 tonne/annum saltwater finfish farm failed to maintain a fraction of the carrying capacity it was designed for. It was clear CO₂ was one of the main limiting factors, a feeling shared by many in the industry working with high density, warm water marine recirc systems. Finding a solution was difficult. Accurate CO₂ measurement is notoriously difficult in saltwater, there was little information available on what constitutes a safe level of CO₂ for marine fish species, and nothing was known about CO₂ stripping in saltwater. My research of the last 4 years has been focussed on these themes. I will present my findings to date, which can be summarized as follows:

- Incorrect measurement of CO₂ continues to hamper progress.
- Safe levels of CO₂ for closed systems need to be defined for each species and life stage.
- Stripping CO₂ from saltwater is more difficult than freshwater due to subtle differences in carbonate chemistry after the water exits a stripper.

I encourage participants to visit my webpage for more information:

www.microcosmofscience.com.

An overview of heating and cooling process water in land-based aquaculture: *best practices, & two case studies*

P. Nickerson, P.Eng.*

Scotian Halibut Limited, PO Box 119, Clarks Harbour, NS, Canada, B0W 1P0

The ability to create and maintain optimal water temperatures for fish production is touted as one of the benefits of choosing land-based aquaculture. However, heating and cooling water is often a significant capital and operational expense. Ever increasing energy costs and environmental impact awareness have led to advances in heating and cooling. This paper presents a review of the basic principles of heating and cooling process water in land-based aquaculture. Common pitfalls of designing, selecting, and operating, heating and cooling systems will be presented along with details on how to avoid them. Two brief case studies taken from commercial production facilities will be presented comparing the cost of different heating methods. One case study will show how a marine hatchery reduced cooling costs by 50% and its heating costs by 70%. The second case study will outline the design and selection process of a heating system for a new purpose built marine land-based grow-out site.

Development of a renewed Environmental Management Program for land-based aquaculture facilities in New Brunswick

T. Lyons

Department of Environment and Local Government, PO Box 6000, Fredericton, NB E3A 5T8

The New Brunswick Department of Environment and Local Government (DELG) have been responsible for the environmental management of freshwater finfish aquaculture facilities since 1982 under the authority of the Clean Water Act, Water Quality Regulation (82-126). Regulatory compliance to present day has primarily focused on the rate of water withdrawal in addition to the concentration of phosphorus and/or nitrogen within the receiving body of water. With this in mind the department has recently begun the development of a renewed Environmental Management Program for such facilities. This presentation will give an overview of various aspects being considered within the proposed regulatory framework for the renewed Environmental Management Program.

Posters / Affiches

Authors in attendance / Auteurs présents

Tuesday, May 29, 2012 / Mardi 29 mai, 2012: 16h30-18h00

Location: Georgian Terrace

Anderson, D. Nutrient digestibility of honeybees (*Apis mellifera*), house crickets (*Acheta domesticus*) and kelp meal fed to rainbow trout (*Oncorhynchus mykiss*)

Chen, Z. Digestibility of enzyme treated pre-pressed solvent extracted camelina meals by rainbow trout (*Oncorhynchus mykiss*)

Comeau, L. Winter quiescence and spring awakening of the Eastern oyster *Crassostrea virginica* at its northernmost distribution range

Del Bel Belluz, J. Spatial and temporal optical characterization of the particulate plume dispersing from the fed components at an Integrated Multi-Trophic Aquaculture (IMTA) system in Kyuquot Sound, British Columbia

Diessner, C Practical use of google earth and landsat thematic mapper to detect and evaluate aquaculture change over time

Dubé, A. Characterization of waste generated by trout fed commercial feed currently used in Canada

Ellis, L. The effect of dissolved oxygen concentration on critical thermal maximum in triploid brook charr, *Salvelinus fontinalis*

Frederiksson, D. The potential for controlled harvest aquaculture of *Crassostrea virginica* in the Chesapeake Bay using an in-situ technique

Fry, J. Determination of safe doses of ozone to use for fish egg disinfection: the case of Atlantic cod (*Gadus morhua*)

Lachance, A. Development of a new approach for holding farmed sea scallops in closed-system tanks

Le Luyer, J. Monitoring bone tissue specific whole-genome response to P-deprivation in rainbow trout (*Oncorhynchus mykiss*) vertebrae

Leavitt, N Metabolic response and scope for growth of the green sea urchin, *Strongylocentrotus droebachiensis*, fed Atlantic salmon faeces:

	inputs for modelling the deposit feeder niche in Integrated Multi Trophic Aquaculture (IMTA) systems
<u>McConnachie, S.</u>	Loma salmonae interactions between Blue Mussels (<i>Mytilus edulis</i>) and Rainbow Trout (<i>Oncorhynchus mykiss</i>) within Integrated Multitrophic Aquaculture Systems
Mohagheghi Samarin, A.	<i>In vivo</i> and <i>in vitro</i> storage of Kutum, <i>Rutilus frisii kutum</i> eggs at various temperatures
<u>Pace, S.</u>	The effect of temperature and feed ration on the apparent digestibility of sablefish (<i>Anoplopoma fimbria</i>) faeces
Power, J.	Fisheries and Oceans Canada - Aquaculture Collaborative Research and Development Program
Poirier Stewart, N.	Evolution of the mineralization of bone tissues in juvenile rainbow trout (<i>Oncorhynchus mykiss</i>)
<u>Rochus, C.</u>	Detecting family differences associated with resistance to the salmon louse (<i>Lepeophtheirus salmonis</i>) in Atlantic salmon
Sheibani, M.T.	Development of pylorus and pyloric caecum in larval stages of <i>Acipenser stellatus</i>
Sheibani, M. T.	Microscopic structures of liver and pancreas in <i>Acipenser persicus</i>
Sonier, R.	Fluorescence characterization of water entering and exiting a blue mussel (<i>Mytilus edulis</i>) aquaculture estuary
Vercaemer, B.	Monitoring for invasive tunicates and European green crab in Nova Scotia: 2010-2011
<u>Wyatt, J.</u>	The effect of extended holding time on the condition, physiology and stress response of cultured blue mussels (<i>Mytilus edulis</i> L. 1758) following commercial harvest during in northeastern Newfoundland

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Nutrient digestibility of honeybees (*Apis mellifera*), house crickets (*Acheta domesticus*) and kelp meal fed to rainbow trout (*Oncorhynchus mykiss*)

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A digestibility trial evaluated the use of honeybee (*Apis mellifera*) meal (BM), house cricket (*Acheta domesticus*) meal (CM) and kelp meal (KM) as dietary nutrient sources for rainbow trout (*Oncorhynchus mykiss*). Four diets formulated with 0.5% Cr₂O₃ fecal marker were the control diet (CD) and diets with 30% of CD replaced by BM, CM or KM. Eight tanks (500L) with re-circulated freshwater (2L/min) at 12°C contained 20 fish (440g) fed to satiation 3 times daily (two tanks/treatment). Fecal collection by stripping was performed on days 7, 12 and 16. Digestibility of crude protein (CP), crude fat (CF), gross energy (GE) and dry matter (DM) determined for diets and ingredients were analyzed by analysis of variance in this completely randomized experiment ($P \leq 0.05$). In the BM, CM and KM, digestibility of CP, CF, and GE were 50.7%, 68.1% and 51.2% CP; 57.8%, 75.9% and 91.1% CF and 84.7%, 51.9% and 31.0% GE respectively. The digestible CP and GE content of BM, CM and KM were 25.0%, 3801 Kcal/kg; 46.5%, 2497 Kcal/kg and 9.2%, 732 Kcal/kg respectively. These coefficients of digestion and digestible nutrient contents can be used in future diet formulations.

Digestibility of enzyme treated pre-pressed solvent extracted camelina meals by rainbow trout (*Oncorhynchus mykiss*)

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Pre-pressed solvent extracted camelina meal (PSCM) contains phytate and glucosinolates that may limit its use in fish diets, unless these anti-nutritional compounds can be effectively degraded. Dietary enzymes were used. PSCM was incubated in-vitro (35-40°C, 24 hours) with either Bio-phytase[®] (PSCM+PHY), Superzyme-OM[®] (a multi-carbohydrase) (PSCM+SUP), a mixture of Bio-phytase[®] and Superzyme-OM[®] (PSCM+MIX) or water (PSCM+H₂O) to create test ingredients. Six diets were formulated; the basal diet or the basal diet with 30% inclusion of one of the test ingredients. Chromic oxide was added as a marker to all the diets at 1 % of the basal diet. Fecal sample was collected via sedimentation. The apparent digestibility coefficients (ADC) and digestible nutrients were determined for rainbow trout. The apparent digestibility of dry matter (DM), crude protein (CP), gross energy (GE) and crude fat

(CF) determined by the indicator method, were analyzed by ANOVA with treatment means differentiated using LS means ($P \leq 0.05$). Bio-phytase[®] eliminated phytate phosphorus and water soaking decreased glucosinolates close to zero in PSCM. The apparent digestibility of the test ingredients were similar ($P > 0.05$). PSCM+MIX contained the highest content of digestible protein and fat ($38.9 \pm 1.43\%$ and $6.4 \pm 0.23\%$, respectively). These values can be used in future fish diet ration formulation.

Winter quiescence and spring awakening of the Eastern oyster *Crassostrea virginica* at its northernmost distribution range

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In this study, Hall element sensors were used to closely monitor the gaping behaviour of the eastern oyster, *Crassostrea virginica*, at its northernmost distribution limit (48 °N). Gaping was measured at 10 Hz simultaneously for 16 (2010) and 14 (2011) oysters over 113 (2010) and 34 (2011) days. Marked behavioural changes were detected across the sampling period and three distinct phases were apparent: quiescent (winter), awakening (spring), and active (spring). During the quiescent phase, water temperature was low (-1.0 to 2.8 °C), with the valves of most individuals being continuously closed. During the awakening phase, however, valves abruptly opened with a noticeable level of synchrony amongst individuals. In both study years, approximately one-half of the monitored population awoke within a 6.6 h period. Awakening occurred at a temperature of 5.3 °C in 2010 (SE = 0.3, n = 16) and 5.9 °C in 2011 (SE = 0.3, n = 14). This information could have potentially beneficial applications towards improving shellfish management practices, namely wet-holding protocols.

Spatial and temporal optical characterization of the particulate plume dispersing from the fed components at an Integrated Multi-Trophic Aquaculture (IMTA) System in Kyuquot Sound, British Columbia

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The rapid expansion of the finfish aquaculture industry has led to high concern over its environmental effects. A sustainable alternative to monoculture finfish aquaculture is Integrated Multi-Trophic Aquaculture (IMTA) where secondary unfed species (bivalves and macrophytes) are used to extract the waste dispersing from the finfish component of the system. Unfortunately, little is known about the properties and dispersion of particulate fish farm wastes through the water column in a field setting. This knowledge is necessary for the selection and placement of the uptake species. Thus, the objective of this research is to use *in-situ* optical oceanographic methods to identify and characterize the particulate wastes (timing, transport, concentration, composition) dispersing from the fish cages at an IMTA system. Preliminary analyses of the data have shown promise, with increasing attenuation and scattering measurements (proxies for particle concentration) directly down-current of the fish cages during and after feeding. Conversely, backscattering ratio values decreased, possibly indicating the increased presence of organic particles in the water column. Furthermore, attenuation and scattering values decreased, when compared to a reference site, on the down-current side of the scallop cages which may have been due to particulate uptake by the secondary species.

Practical use of google earth and landsat thematic mapper to detect and evaluate aquaculture change over time

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Landsat 1, the world's first civilian Earth observing satellite was successfully launched by the United States in July, 1972, and carried a four-band Multi-Spectral Scanner (MSS) imaging system. The Landsat Thematic Mapper (TM), an advanced multispectral system capturing high resolution (30m²) images every sixteen days in seven spectral bands, was successfully added to Landsat 4, which was launched in July, 1982. The multispectral capability of TM systems on Landsats 4, 5, and 7, coupled with its continuous collection of Earth's reflectance in the visible, near infrared, and short wave infrared, allows for a comprehensive assessment of change over time between 1982 and the present. I intend to explore changes to ecologically important areas that have experienced alteration as a result of aquaculture. The spectral bands (visible, infrared) acquired by TM will allow for

an investigation of possible changes in vegetation, bathymetry, and sedimentation. Furthermore, the imagery acquired by TM will be compared with the higher spatial resolution imagery of Google Earth. This evaluation will determine the practicality of using TM and Google Earth to assess and detect aquaculture change over time.

Characterization of waste generated by trout fed commercial feed currently used in Canada

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The Canadian freshwater aquaculture industry is facing many challenges, one of which concerns the protection of the environment. The release of nutrients (phosphorus, nitrogen, suspended solids) can have impacts on the surrounding environment and contribute to the eutrophication of receiving waters. The Canadian industry has responded by developing new high-energy feeds, with improved feed efficiency and producing less waste. However, these new feeds developed in Canada and around the world should be characterized. We must make nutrient budgets for rainbow trout and brook trout for these new feeds based on various parameters of importance for fish farming. These new budgets will be taken into account when developing plans for reducing outputs of fish farming.

The results of performance and outputs will be presented.

The effect of dissolved oxygen concentration on critical thermal maximum in triploid brook charr, *Salvelinus fontinalis*

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Induced triploidy is the most effective method of producing sterile salmonid fishes for aquaculture. However, triploid brook charr (*Salvelinus fontinalis*) have reduced tolerance to elevated temperatures and a lower thermal optimum when compared to their diploid counterparts. Thermal tolerance in fish is commonly assessed using a critical thermal maximum (CTM) test, where the non-lethal experimental endpoint (loss of equilibrium) provides an estimate of the upper lethal limit. To determine whether reduced temperature tolerance is a direct effect of temperature or an indirect effect of low dissolved oxygen, diploids and triploids were tested in CTM trials under varying oxygen concentrations: 1)

a “standard” CTM, 2) maintaining oxygen at 9-10mg/L, 3) supersaturating the water with oxygen and 4) using nitrogen to drive out oxygen. In all cases temperature was increased at 3°C/hr. A fifth trial was conducted to determine the critical oxygen concentration of both ploidies without changing the temperature. Based on preliminary results, treatment 4 showed the largest ploidy effect, so a more in-depth study was done on this treatment. Blood samples were taken during this trial and over an 18-hour recovery period for the determination of glucose, plasma ions and plasma osmolality. Plasma electrolyte and glucose levels were not affected by ploidy at either acclimation temperature but were affected by sample time (relative to CTM). Triploid brook charr show reduced thermal tolerance under hypoxic conditions but no difference in secondary stress response.

The potential for controlled harvest aquaculture of *Crassostrea virginica* in the Chesapeake Bay using an in-situ set technique

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Significant restoration of the eastern oyster (*Crassostrea virginica*) is necessary to counter the anthropogenic stresses in the Chesapeake Bay and to improve the fishery. The predominant restoration method sets spat-on-shell in a hatchery, which is then transported to a site for reef construction. The reef can then be allocated for harvesting or sanctuary purposes. As suitable substrate becomes increasingly difficult to obtain and the economic efficacy of the method questioned, alternate approaches are being initiated with perhaps, an aquaculture perspective. One possible technique involves publically leasing existing oyster shell bottom (with or without live oysters), deployment of a containment skirt system around a section of the reef, and application of “set-ready” spat. Once the oysters have settled on the reef, the containment skirt is removed and the oysters grown until marketable size for controlled harvested. With this approach, the harvest does not depend upon natural set dynamics and operational limitations associated with aquaculture in floats, trays or bottom cages. This presentation will describe a project being conducted to investigate the potential of such an approach and will include deployment skirt design, larval set efficiency experiments and preliminary economics.

Determination of safe doses of ozone to use for fish egg disinfection: the case of Atlantic cod (*Gadus morhua*)

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Ozone's ability to destroy viruses, bacteria, and fungi alike give it broad applications to the aquaculture industry. The disinfection of eggs by direct exposure to ozonated water is of particular interest as a means of ensuring disease-free eggs without the use of harsh chemicals. However knowledge gaps are numerous including safe contact times, exposure levels and long-term effects on cod. We tested the effect of different ozone doses (0.5-1.0, 1.5-2.0 and 2.5-3.0 ppm for 1.5 min.) on recently fertilized Atlantic cod (*Gadus morhua*) eggs vis-à-vis the disinfectant PerosanTM and a untreated Control (similar handling and husbandry) by investigating their effects on larval nucleic acid concentration, hatch rates, growth, and survival. Results showed that the DNA concentration of the 2.5-3.0 ppm ozone treatment was significantly lower than in the Control. PerosanTM treatment negatively affected the hatch rates ($56.9 \pm 27.9\%$) compared to the Control ($77.7 \pm 17.9\%$) and ozone treatments (60–80%). However, larval survival showed no effect of PerosanTM and larval growth (condition factor, length) was actually higher than the Control suggesting no long-term effect of PerosanTM on development (up to 30 dph). Overall, our study shows no negative effect/toxicity of ozone treatment on cod eggs and larvae up to 30 dph

Development of a new approach for holding farmed sea scallops in closed-system tanks

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Growers on the lower North Shore of Quebec farmed sea scallop (*Placopecten magellanicus*) and sell a part of their scallops live in the shell. Markets for scallops are often located at large distances from production sites, which complicates the sale of live scallops. The purpose of this project is to develop a suitable protocol for holding live scallops in closed-system tanks, filled either with natural or artificial seawater and to determine the life span and changes in quality (i.e., taste, texture, vitality) of sea scallops held in holding tanks. We evaluated the effect of the size category, the experimental

holding conditions and the day of the experiment on physiological (ex.: vitality) and organoleptic parameters (ex.: taste). In general, the size category did not seem to have an effect on the physiological parameters. The scallop conditions were slightly lower in the closed-culture tank filled with artificial seawater compare to the other tanks (open-water tank and natural seawater closed-culture tank). In general, the scallop conditions were affected by the duration passed in the tanks. However, the organoleptic parameters did not seem to be affected by any of the factors. This project demonstrated the technical feasibility of holding sea scallops in seawater closed-culture tanks.

Monitoring bone tissue specific whole-genome response to P-deprivation in rainbow trout (*Onchorynchus mykiss*) vertebrae

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Phosphorus (P) in freshwater aquaculture is a complex subject that requires optimizing dietary levels to avoid pollution and prevent development of skeletal abnormalities that are detrimental to industry productivity and animal welfare. While effects of P deficiency on reduced bone mineralisation and skeletal deformities are well documented, mechanisms of action at molecular level remain poorly understood. Although the skeleton is known as one of the main P reservoirs, unlike most soft tissue (liver, brain, testis, skin), no large-scale genomic study focusing on P metabolism and bone tissue specific response in fish has been reported. Our on-going study aims to 1) determine the genes involved in bone formation and remodelling and 2) assess effect of P-deprivation on vertebral bone formation by following gene expression in a promising biological model, the rainbow trout. Since no specific bone tissue library was yet available, production of a cDNA-normalised library sequenced through 454 Roche technologies using “extra-long reads” kit was a first mandatory step. Library construction from vertebrae (3 vertebrae/fish comprising ligaments and intervertebral tissue) was completed using CS010-1 kit (Evrogen, Russia) for a pool of 12 selected individuals (according to their time of sampling, absence or presence of deformities, type of deformities and dietary treatment). Information obtained will increase the amount of data already available in public databanks and help further DNA sequence alignments. In a subsequent phase, gene expression level quantification on experimental samples will be performed through HiSeq 2000-Illumina sequencing technologies (RNA-seq). Time-series samples will come from short (5 weeks) and long-terms (27 weeks) experiments carried out on triploid full-sib rainbow trout fed with diets having different available P levels (P-sufficient and P-deficient). To support genomic analysis, fish were X-rayed to monitor development of vertebral deformities and samples were taken to assess P status (scales,

vertebrae and carcass), hormonal regulation (plasma) as well as histo-morphometric, bio-mechanic and genomic responses (vertebrae). Expected results should represent an important step forward in understanding bone specific response to P-deprivation, tissue formation and remodelling in salmonid. Assessment of involved gene expression will help develop useful tools for more effective P management in freshwater fish farming operations.

Keywords: bone tissue, gene expression, 454, RNA-seq, phosphorus, rainbow trout.

Metabolic response and scope for growth of the green sea urchin, *Strongylocentrotus droebachiensis*, fed Atlantic salmon faeces: inputs for modelling the deposit feeder niche in Integrated Multi Trophic Aquaculture (IMTA) systems

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Cage aquaculture sites create a flux of organic and inorganic matter which may result in excess nutrient loading into the surrounding environment. Integrated multi-trophic aquaculture (IMTA) takes advantage of this through the intensive culture of trophically compatible species, with the transfer of nutrients from one species to another through the surrounding water. Open-water IMTA systems will include a deposit feeder niche below fish cages to mitigate settleable organics while providing the potential for an additional harvestable crop. The aim of this research is to investigate metabolic parameters of the green sea urchin (*Strongylocentrotus droebachiensis*) on a diet of Atlantic salmon (*Salmo salar*) faeces. Measures of absorption efficiency, respiration and excretion will be collected, and scope for growth calculated. Empirical measures will be used to validate nutritional mass balance estimates of proximate composition (lipids, protein, minerals and nitrogen free extract). Ultimately, these data will contribute inputs to a larger IMTA deposit feeder model that aims to estimate consumption of salmon organics based on the biomass of sea urchins harvested.

***Loma salmonae* interactions between Blue Mussels (*Mytilus edulis*) and Rainbow Trout (*Oncorhynchus mykiss*) within integrated multitrophic aquaculture systems**

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Loma salmonae is the causative agent of Microsporidial Gill Disease of Salmon (MGDS). Because spores are environmentally protected entities, it is difficult to manage and treat MGDS where it is endemic. One proposed mode of protection against MGDS is through the concept of integrated multi-trophic aquaculture (IMTA). It is beneficial to identify how mussels interact with *L. salmonae* spores and how that would translate to disease transfer within IMTA systems. In the present paper we explored a suite of experiments aimed at elucidating the fate of *L. salmonae* spores following exposure to blue mussels and subsequent infection in rainbow trout (*Oncorhynchus mykiss*). We were able to confirm that blue mussels do not deactivate *L. salmonae* spores upon contact with their tissue. MGDS infections develop after trout are allowed to consume mussel tissue, 4 hr post-filtration of concentrated spores. Although incidence of disease decreases significantly after 3d, results indicate that blue mussels may act as a reservoir for infectious *L. salmonae* spores for at least 7 d. It is also suggested that mussels expel viable spores through pseudofaeces and faeces. Results are discussed in the context of management through IMTA systems.

***In vivo* and *in vitro* storage of Kutum, *Rutilus frisii kutum* eggs at various temperatures**

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Effects of post-ovulatory and post-stripping retention time and temperature on egg viability rates were studied in kutum (*Rutilus frisii kutum*). For *in vivo* storage, Partial volumes of eggs were stripped and fertilized for 96 hours post-ovulation (HPO) (at 11 °C) and for 72 HPO (at 14 °C), and for *in vitro* storage, eggs were fertilized after 0, 2, 4, 6, and 8 hours post-stripping (HPS) at temperatures of 4, 10, 12, and 26 °C. In the first experiment, the highest egg viability rates occurred in the eggs fertilized immediately after ovulation. Egg viability was completely lost by 72–96 HPO at 11 °C, and 60–72 HPO at 14 °C. In the second experiment, the maximum eyeing and hatching rates of eggs took place at 0 HPS. As storage temperature increased, egg viability decreased. The eggs stored at 26 °C lost their viability almost completely after 4 HPS. The results demonstrate that egg stripping should take place within 168 °C-hours after ovulation and that complete loss of viability of the eggs occurs by 672 °C-hours after ovulation. Moreover, successful *in vitro* storage of eggs can be guaranteed at least within 8 hours at temperature ranging from 4 to 12 °C.

The effect of temperature and feed ration on the apparent digestibility of sablefish (*Anoplopoma fimbria*) faeces

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Integrated multi-trophic aquaculture (IMTA) is a sustainable form of mariculture which holds much promise in alleviating some concerns regarding current aquaculture practices. However, in order for IMTA to be successful much research on species capture and conversion efficiencies must be conducted. In order for sablefish (*Anoplopoma fimbria*) to be used as a principle finfish species in IMTA systems, information regarding the digestibility of sablefish faeces must be understood. This data is critically important in establishing the necessary relationships between various species in IMTA networks. This research project examines the effects of water temperature and feed ration on the apparent digestibility of juvenile sablefish faeces. The effect of temperature on digestibility was determined in triplicate groups of juvenile sablefish reared at 7.5°C and 12.5°C. The impact of feed ration on apparent digestibility was determined from feeding trials whereby juvenile sablefish were fed either once, twice, or three times per day. Faeces were then analyzed (using chromic oxide as a marker) for apparent digestibility, ash, moisture, protein and energy content. The results of these analyses will be presented, along with discussions on the possible implications the results have on species relationships required for IMTA systems utilizing sablefish as the principle finfish.

Fisheries and Oceans Canada - Aquaculture Collaborative Research and Development Program

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Fisheries and Oceans Canada (DFO) continues to play a key role in the support of Canadian aquaculture research and development initiatives. The Aquaculture Collaborative Research and Development Program (ACRDP) is one such program available. It provides an opportunity for industry to collaborate on research projects and workshops with departmental expertise. ACRDP is currently undergoing changes which are affecting its governance structure and research objectives – focussing in on aquatic animal health and environmental performance. This poster will provide further information on how ACRDP is contributing to the sustainable development of the Canadian aquaculture industry and will provide further updates on the recent changes to the ACRDP and what this means for industry participation.

Evolution of the mineralization of bone tissues in juvenile rainbow trout (*Oncorhynchus mykiss*)

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With the exception of radiographs, the study of skeletal abnormalities in fish usually requires sacrifice of the animal for tissue collection, which makes it undesirable to apply into the field. Ideally, bone condition could be inferred from more readily available tissues such as scales, hence the necessity to better understand normal specific mineralization patterns and to ensure the absence of spatiotemporal variations that could bias interpretation. Juvenile rainbow trout (N = 100; 56.9 ± 0.8 g) were fed to 80% satiety with commercial diets for 5 weeks. Twenty fish were sampled each week. Scales (S) from three body sections (truncal, median and caudal), vertebrae (V), opercula (O) and ribs (R) were removed separately to assess ash content. Ash content (%) increased with time but depends on bone types (O: 59.0 ± 2.0 ; R: 61.7 ± 0.8 ; V: 55.1 ± 2.2), probably in relation to developmental, chronological and functional specificities. Scales mineralization seems to be also a good indicator of vertebra mineralization. As no regionalization pattern was observed in scales (S: 34.9 ± 1.0), this offers many opportunities for technical monitoring. Further experiments should test the response to environmental conditions and nutrients to ensure the consistency of this observation related to reliable indicator of mineralization of bone tissue.

Detecting family differences associated with resistance to the salmon louse (*Lepeophtheirus salmonis*) in Atlantic salmon

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Development of a strain of Atlantic salmon that is resistant to the salmon louse (*Lepeophtheirus salmonis*) would economically benefit the aquaculture industry. We investigated differences in *L. salmonis* resistance among 41 families of the St. John River aquacultural strain. Fifteen recent smolts per family were challenged by releasing 30 *L. salmonis* copepodids per fish into each of two tanks. Four days later we challenged them again by releasing 60 copepodids per fish. We euthanized and froze all fish four days after the second infection and then quantified the *L. salmonis* on individual fish. Counts per fish were analyzed using a general linear model with the factors: body weight (covariate), interaction of tank by time of quantification (3 subclasses), and family. Family and weight were highly significant and the least squares mean counts per family ranged from 8.42 to 22.1 ($p < 0.0001$). Differences among families could be an indication of additive genetic effects. . Additional families will be challenged to estimate breeding values for their parents and grandparents to be associated with their genotypes at 6000 SNP loci to detect QTL for *L. salmonis* resistance.

Development of pylorus and pyloric caecum in larval stages of *Acipenser stellatus*

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Forty larvae from the first day to three weeks post hatch in order to investigating development of pylorus and pyloric caecum in larval stages of *Acipenser stellatus* were prepared. The larvae were collected randomly and immediately were fixed in Buin's fluid. After providing the samples, some sections at 6 micrometers were prepared, stained with hematoxylin and eosin and studied microscopically. The results showed that in the first day after hatch the abdominal cavity was filled with yolk. In the first week, pylorus with a thick musculature is apparent. The luminal surface of pylorus was lined with a simple columnar epithelium devoid of any secretory cells. Pyloric caecum has some short villi with simple columnar epithelium possessing some cytoplasmic vacuoles. Until the second week, pyloric caecum is pyramidal and its mucosal epithelium is simple columnar with cytoplasmic vacuoles. Up to the end of third week, the pylorus possesses some mucosal plicae with simple columnar epithelium with the least cytoplasmic vacuoles. At this time the luminal surface of caecum shows tall leaf shape villi with a simple columnar epithelium in which a few secretory cells are observed gradually. In caecum as well as pylorus the cytoplasmic vacuoles decrease and then disappear.

Microscopic Structures of liver and pancreas in *Acipenser persicus*

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Due to prominence of *Acipenser persicus* as one of the most precious sturgeons in the Caspian Sea and also importance of liver and pancreas as the main digestive glands, present survey aims to clarify the histological features of these glands in this sturgeon. For this, a total number of six fish from the Caspian Sea were subjected to study. The specimens after fixation in 10% formalin were sectioned for six microns. Then after staining with hematoxylin and eosin were studied microscopically. The surfaces of liver are covered by a row of simple cuboidal to short columnar cell associated with a layer of connective tissue. Hepatocytes containing glycogen and lipid vacuoles are formed as irregular plates. Amongst them many sinusoids with reticuloendothelial and kupffer cells are present. Some areas of connective tissue, as portal tracts, containing vascular branches and bile ducts and some lymphatic tissue are observed. Pancreas as a mixed gland including an exocrine portion consists of serous acini and endocrine portion consisted of langerhans islets. Acini consist of pyramidal cells containing zymogenic

granules, and their ducts possess simple cuboidal to stratified columnar epithelium. It is concluded that their massive diet necessitates such highly developed structure of these glands.

Fluorescence characterization of water entering and exiting a blue mussel (*Mytilus edulis*) aquaculture estuary

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This project measured the biomass (Fo) and health (yield = Fv/Fm) of phytoplankton entering and exiting St Peter's Bay, a mussel farming embayment in Prince Edward Island. From June 2nd to December 8th 2009, measurements were taken every 15 minutes by a submersible active fluorometer (PhytoFlash[®], Turner Design) and acoustic doppler current profiler (ADCP). Both instruments were sampling mid-depth in the water column at the mouth of the embayment. Results show that in early summer the phytoplankton biomass leaving the bay was significantly ($p < 0.001$) lower than the biomass entering the bay. Grazing by cultivated mussels may have contributed to the lowering of the biomass within the embayment. Tidal differences in phytoplankton health were first detected in late summer, at which time the phytoplankton leaving the bay was in poorer health than the phytoplankton entering the bay ($p < 0.001$). By contrast, in autumn, the phytoplankton leaving the bay was in better health than the phytoplankton entering the bay ($p < 0.01$). Biomass did not covary with health over the study period. Therefore, chlorophyll *a* measurements, which are routinely carried out in culture bays, are not necessarily indicative of phytoplankton health and community regeneration.

Monitoring for invasive tunicates and European green crab in Nova Scotia: 2010-2011

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Invasive species, such as tunicates and European green crabs, have impacted estuarine communities and habitats since their establishment in recent decades in coastal Nova Scotian waters. An ongoing Fisheries and Oceans Canada Aquatic Invasive Species (DFO-AIS) monitoring program has focused on documenting the presence and spread of

five tunicate species at geo-referenced monitoring stations since 2006. In 2011, additional monitoring was conducted on the south and eastern shores to document the abundance of green crab (*Carcinus maenas*) in areas where this species has been implicated in the destruction of eel grass and soft-shell clam (*Mya arenaria*) beds. The two tunicate species: *Styela clava* and *Didemnum vexillum* were not found in Nova Scotia in 2011, despite their presence in nearby PEI and Gulf of Maine waters, respectively. *Botryllus schlosseri* continues to be the most widely distributed species (69% of reports), followed by *Ciona intestinalis* (58% of reports), and *Botrylloides violaceus* was the least common tunicate (40% of reports). These tunicates are firmly established and spreading in Nova Scotia, and occupy a wide variety of hard substrates (natural and artificial) in marine and estuarine waters. The presence of green crab was noted at 7 monitoring stations, and at all 30 new monitoring (trapping) sites. Catch per unit effort (CPUE, or number of crabs.trap⁻¹.day⁻¹) ranged from 5 to 54 on the south shore, with the highest value in Central Port Mouton Bay, an area where there has been a significant decline in eel grass meadows. On the eastern shore, CPUE ranged from 5 to 340. Highest values were noted in the south basin of Cole Harbour (173) and in Clam Bay (340), both areas where declines in the soft-shell clam population have been noted by local fishers.

The effect of extended holding time on the condition, physiology and stress response of cultured blue mussels (*Mytilus edulis* L. 1758) following commercial harvest during in northeastern Newfoundland

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In order to determine the maximum time for live holding we investigated the physiological response of blue mussels held for up to 3 months in a commercial holding facility during the summer, fall, winter, and spring between 2010 and 2011. There was a significant decline in the dry weight condition index of held mussels over time for the summer, fall, and spring when compared to mussels harvested fresh from the lease while there was an increase during the winter. Neutral red retention time decreased significantly in holding for both seasons but not in the fresh harvest, indicating an increase in stress response as a result of extended storage. Expression of the antimicrobial peptide MGD2 was evident in the summer holding samples as early as 1

week but did not occur in the fall holding samples until 3 months. Expression of MGD2 was observed in the 1 week sample in fall fresh-harvested mussels. This suggests that holding conditions have stimulated the immune response in a manner potentially related to time in holding and environmental temperature. Based on our results we recommend one month be the maximum time allowed in ambient extended storage during warm water seasons.

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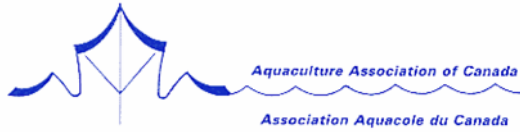
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